

TSTE05 Elektronik & mätteknik

Föreläsning 14

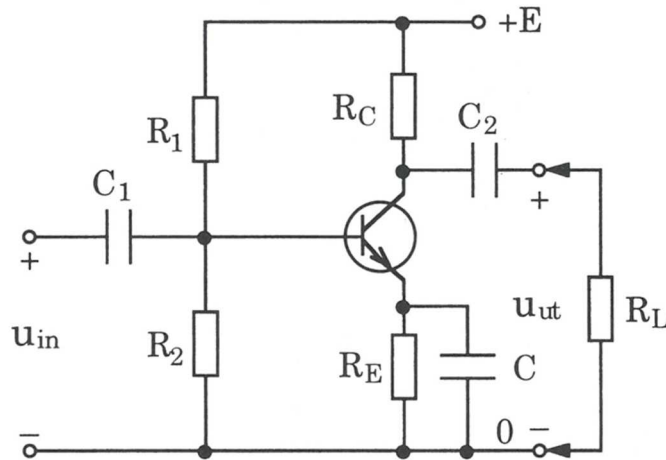
GE-steg - Småsignalschema

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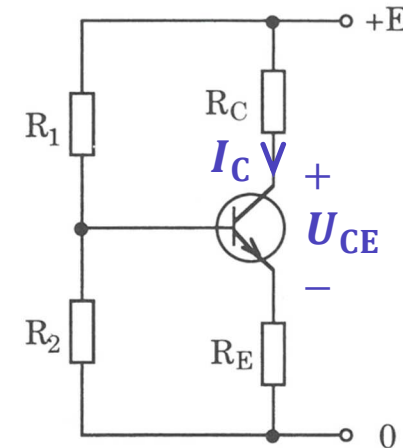
Ämnesområdet Elektroniska kretsar och system

Superposition – Separera likström och signal



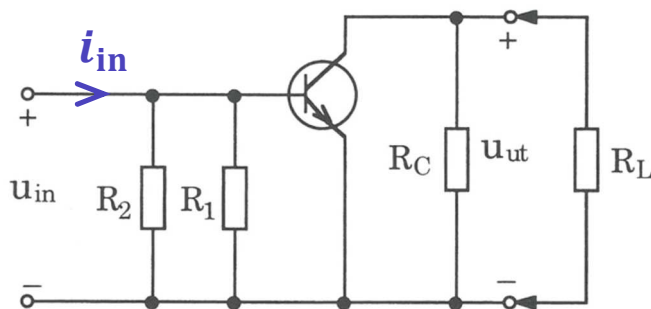
C_1, C_2, C
avbrott
→
ingen signal

Likströmsschema



C_1, C_2, C stora
⇒ kortslutning
↓
signal ⇒
 E kortsluten

Signalschema

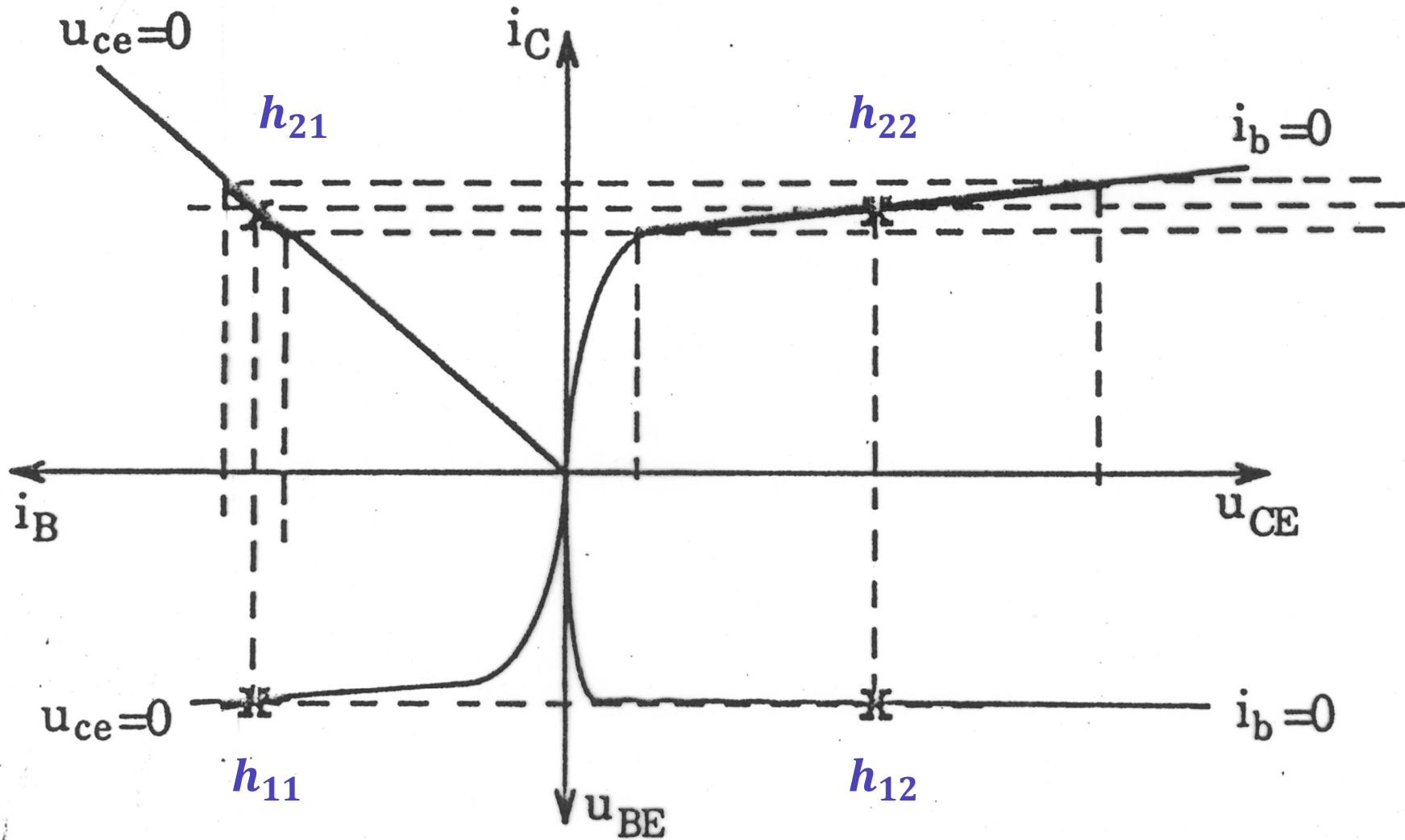


Analys: $R_1, R_2, R_C, R_E, E, \beta$ kända. Bestäm I_{CQ}, U_{CEQ} .

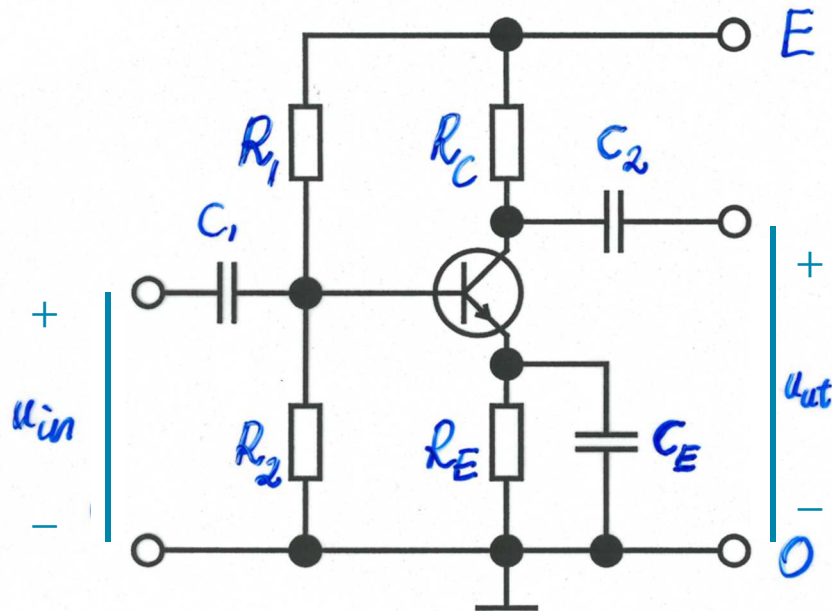
Syntes: I_{CQ}, U_{CEQ} givna. Bestäm R_1, R_2, R_C, R_E .
 E och β kan ev. vara givna eller behöva bestämmas.

Av intresse: Förstärkning $F = \frac{u_{ut}}{u_{in}}$.
Ibland frekvenssvar $H(\omega)$.
Inimpedans $Z_{in} = u_{in}/i_{in}$
Utimpedans Z_{ut}

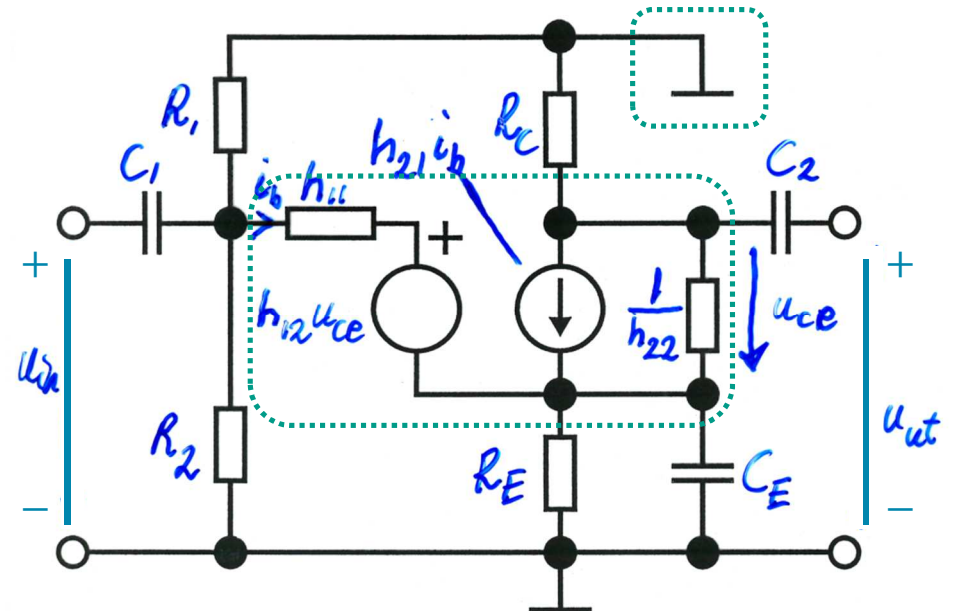
h-parametrar – derivator i arbetspunkten



GE-stegets småsignalschema 1(2)

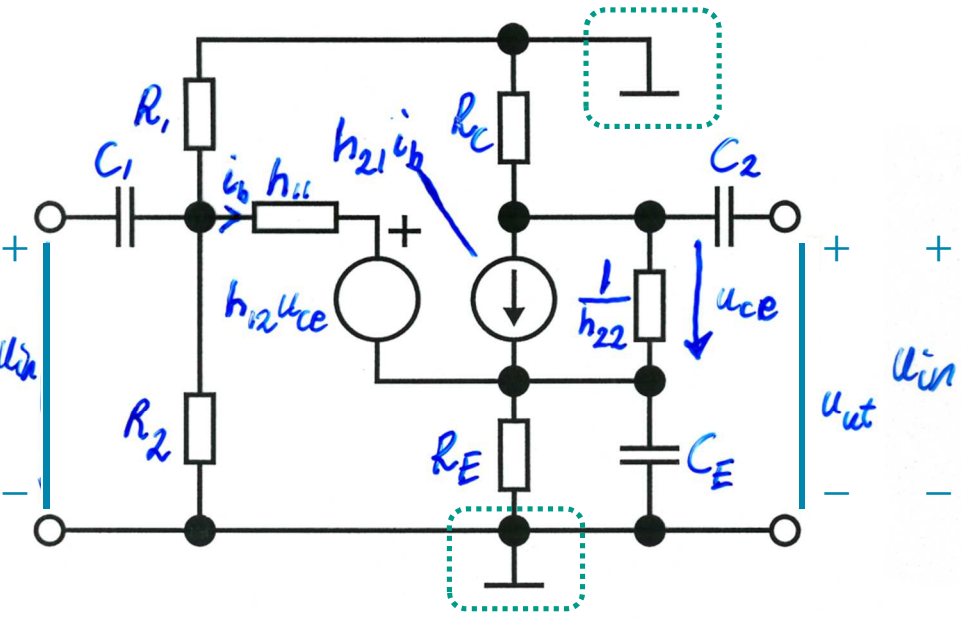


Förstärkarsteget

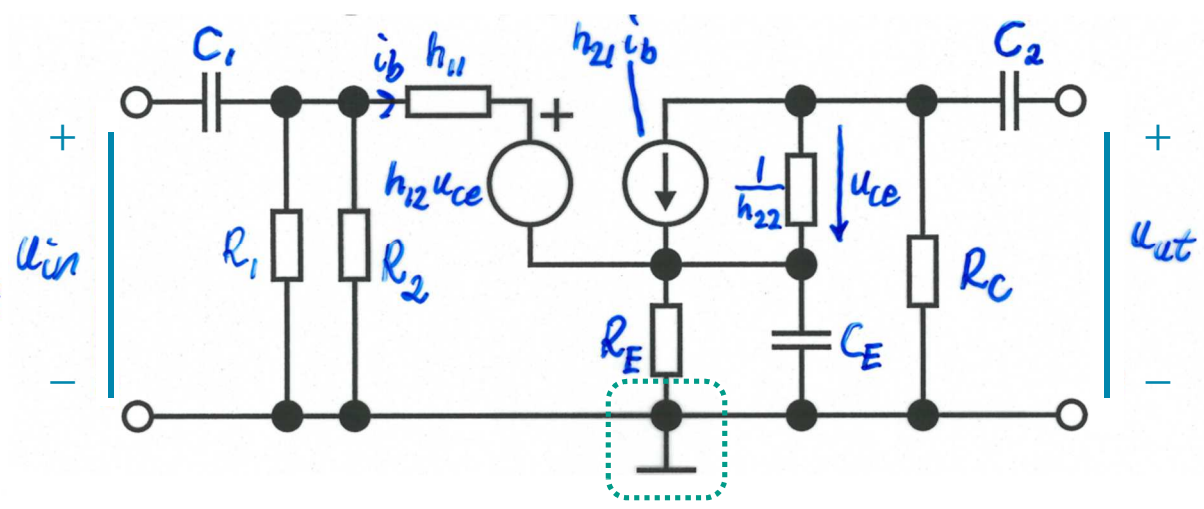


Ekvivalent småsignalschema

GE-stegets småsignalschema 2(2)

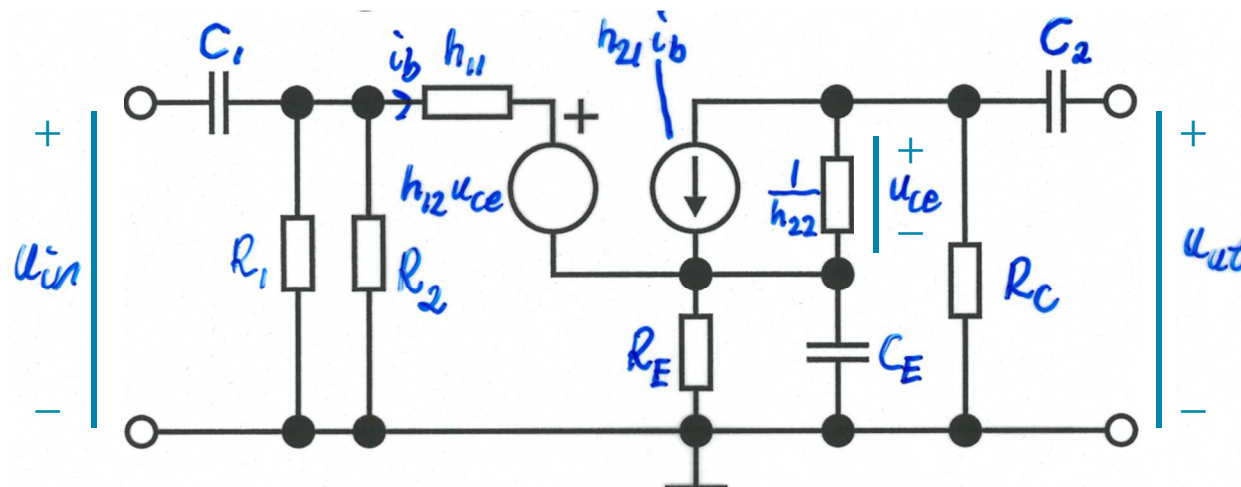


Ursprungligt ekvivalent småsignalschema

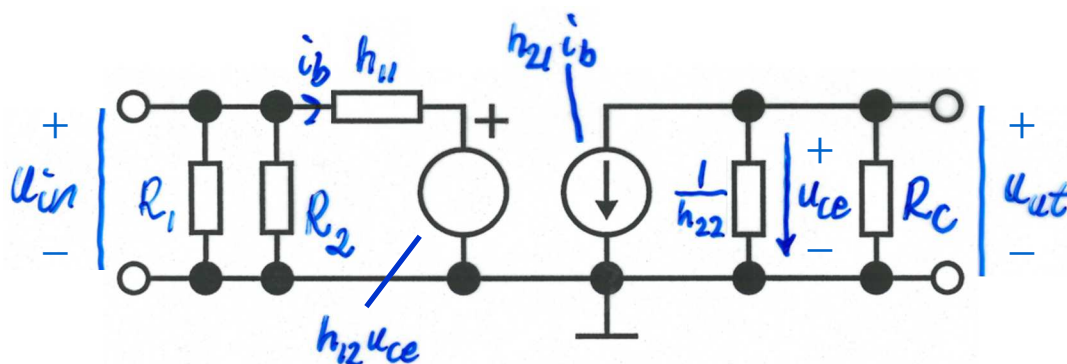


Omritat ekvivalent småsignalschema

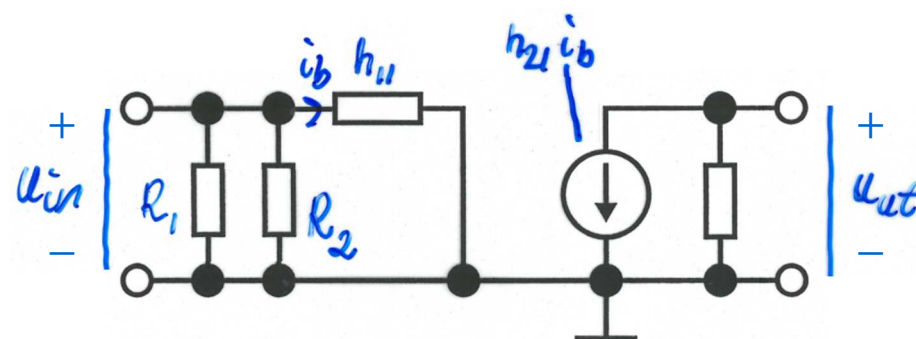
Vanliga approximationer



Fullständigt småsignalschema

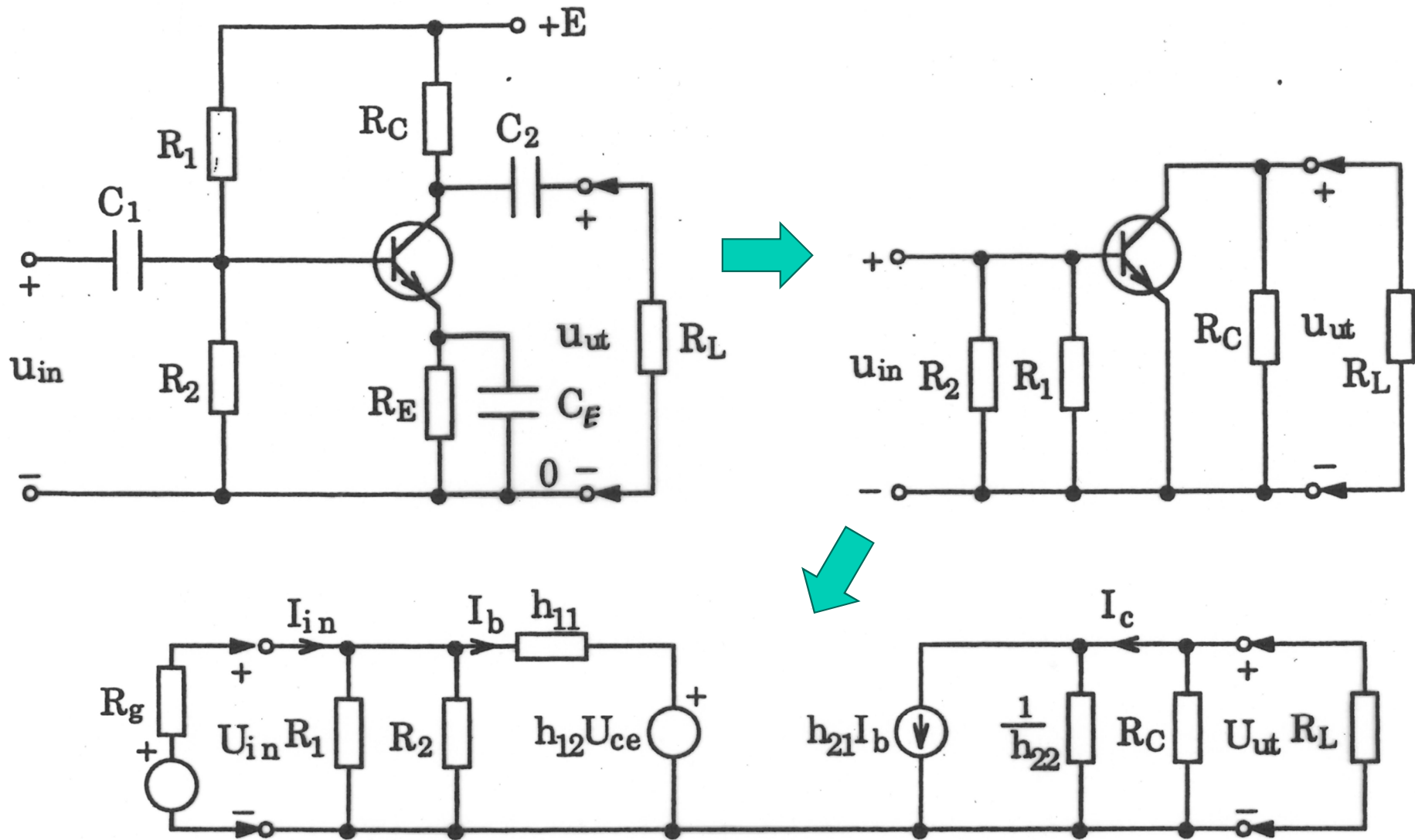


Stora kapacitanser



Förenklad transistormodell

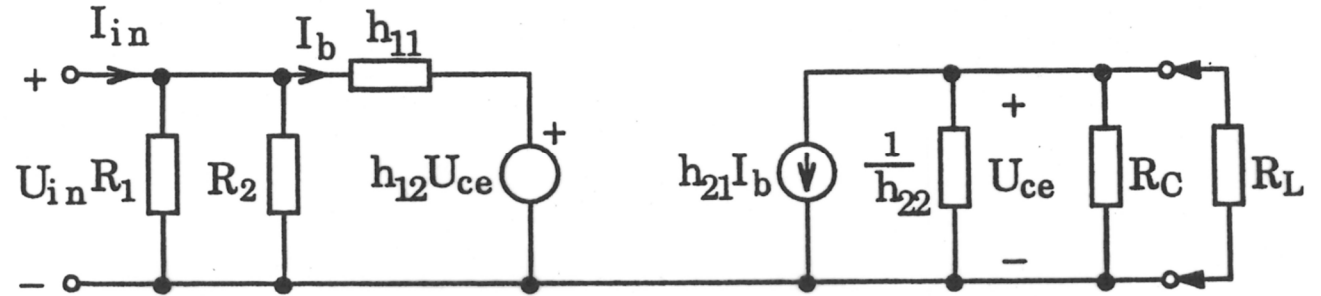
Småsignalschema – bokens väg



Inimpedans, utimpedans, förstärkning

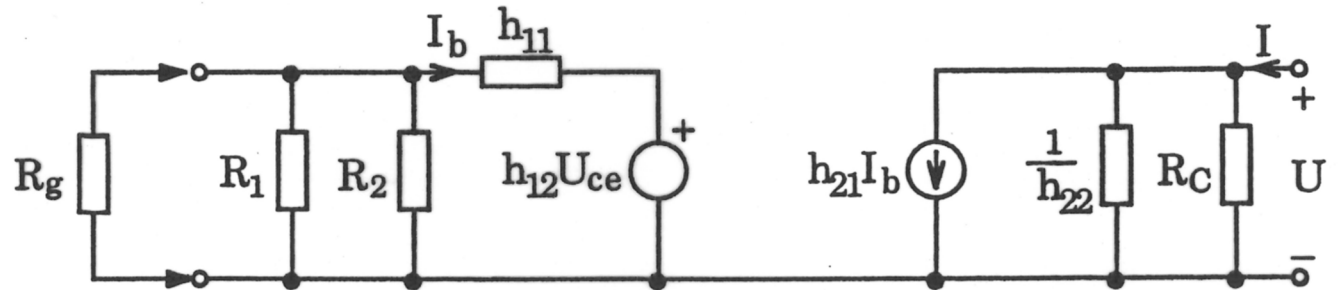
Bestämning av Z_{in}
(Inimpedans)

$$Z_{in} = \frac{U_{in}}{I_{in}}$$



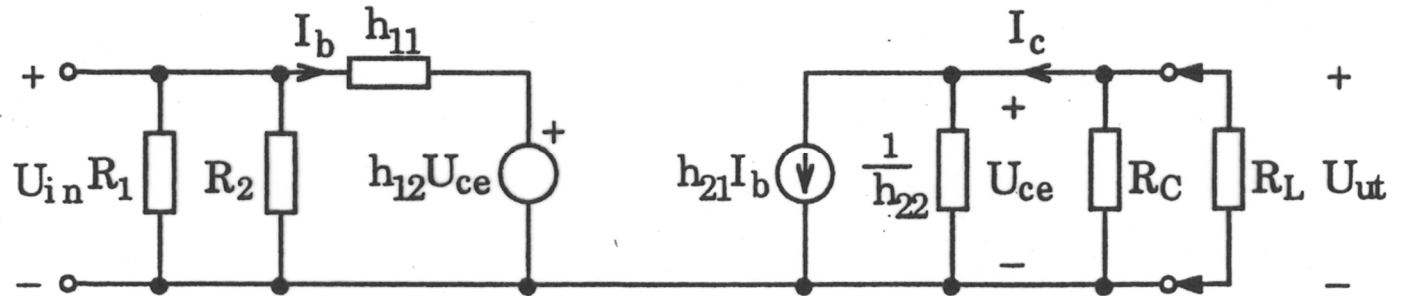
Bestämning av Z_{ut}
(Utimpedans)

$$Z_{ut} = \frac{U}{I}$$

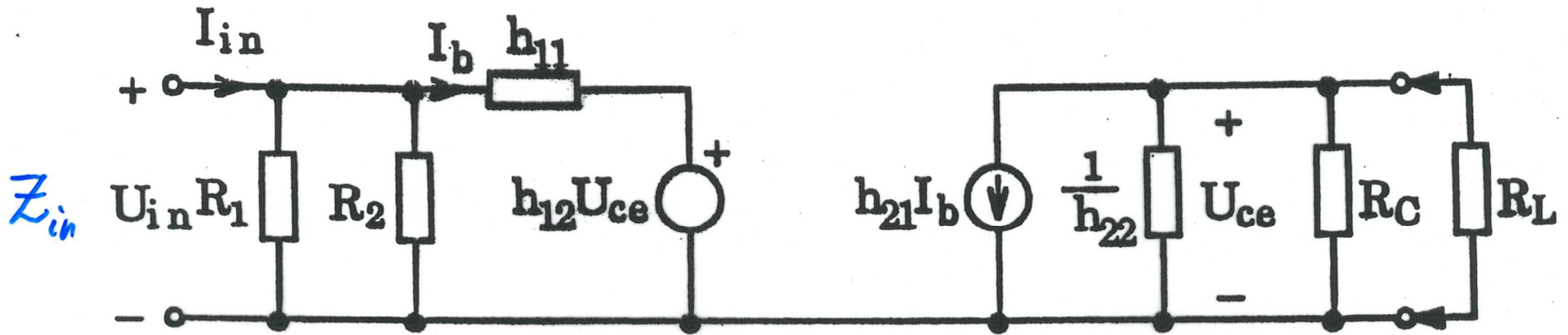


Bestämning av F
(Förstärkning)

$$F = \frac{U_{ut}}{U_{in}}$$



Bestämning av inimpedansen Z_{in}



$$Z_{in} = \frac{U_{in}}{I_{in}}$$

$$R_P = \frac{1}{h_{22}} // R_C // R_L$$

$$\text{KVL: } U_{in} - h_{11}I_b - h_{12}U_{ce} = 0$$

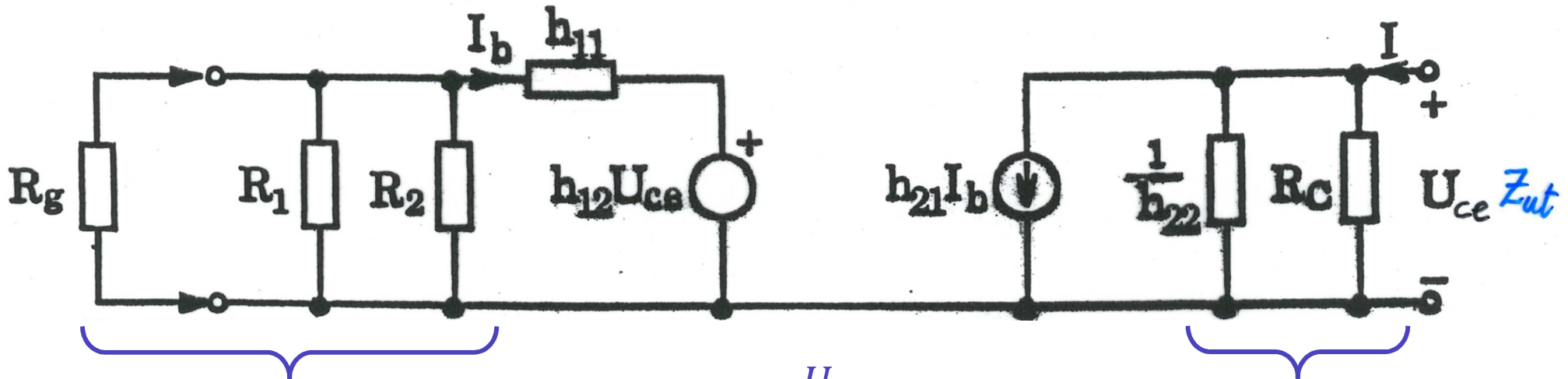
$$\text{KCL: } I_{in} - I_b - \frac{U_{in}}{R_1} - \frac{U_{in}}{R_2} = 0$$

$$\text{Ohms lag: } U_{ce} = -h_{21}I_b R_P$$

$$\Rightarrow Z_{in} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{h_{11}} - \frac{h_{12}}{h_{11} \left(h_{12} - \frac{1}{h_{21}R_P} \right)}} \approx R_1 // R_2 // h_{11}$$

$h_{12} \approx 0$

Bestämning av utimpedansen Z_{ut}



$$R_A \approx R_g // R_1 // R_2$$

$$Z_{ut} = \frac{U_{ce}}{I}$$

$$R = \frac{1}{h_{22}} // R_C$$

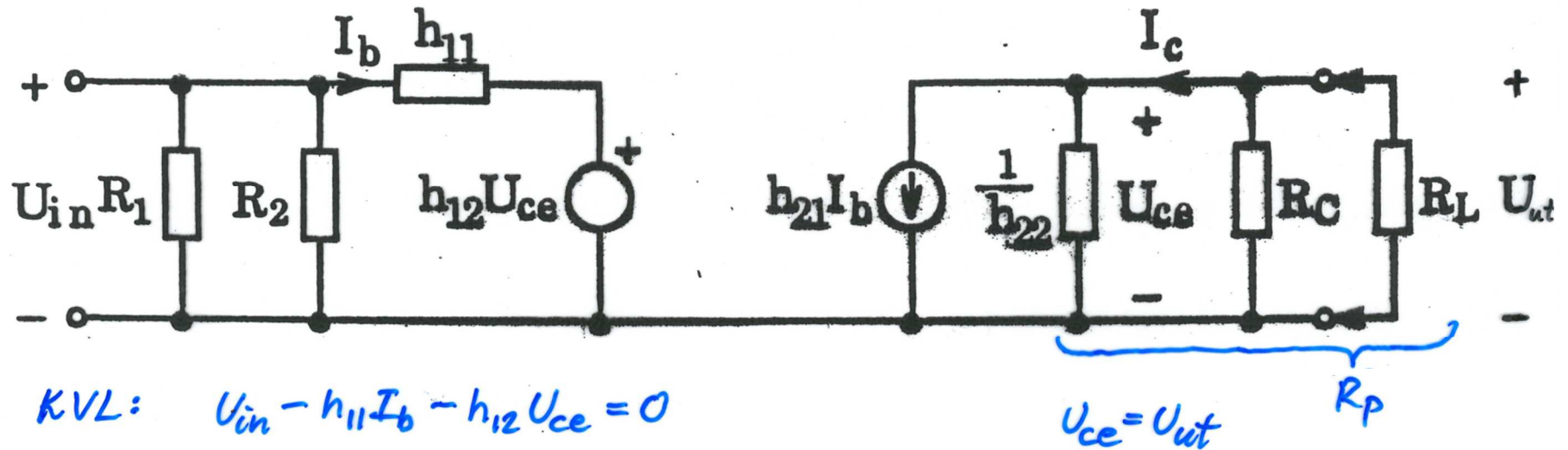
$$\text{KVL: } h_{12}U_{ce} + I_b \cdot (h_{11} + R_A) = 0$$

$$\text{KCL: } I - h_{21}I_b - \frac{U_{ce}}{R} = 0$$

$$\Rightarrow Z_{ut} = \frac{1}{h_{22} + \frac{1}{R_C} - \frac{h_{12}h_{21}}{h_{11} + R_A}} \approx \frac{1}{h_{22}} // R_C$$

$h_{12} \approx 0$

Bestämning av resulterande förstärkning F



KVL: $U_{in} - h_{11}I_b - h_{12}U_{ce} = 0$

Ohms lag: $U_{ut} = -h_{21}I_b \cdot R_p$

$$\Rightarrow F = \frac{1}{h_{12} - \frac{h_{11}}{h_{21} \cdot \left(\frac{1}{h_{22}} \parallel R_C \parallel R_L\right)}} \approx -\frac{h_{21}(\dots)}{h_{11}} \approx -\frac{h_{21}}{h_{11}} \cdot (R_C \parallel R_L)$$

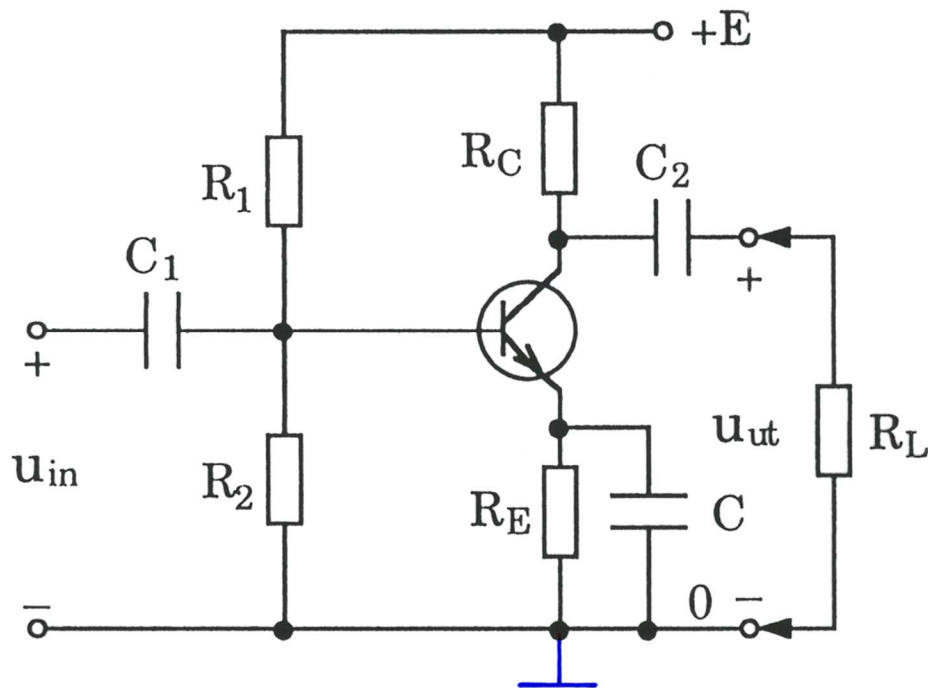
Rärförstärkning (Ta bort R_L):

$$A = \frac{1}{h_{12} - \frac{h_{11}}{h_{21} \cdot \left(\frac{1}{h_{22}} \parallel R_C\right)}} \approx -\frac{h_{21}}{h_{11}} \left(\frac{1}{h_{22}} \parallel R_C\right) \approx -\frac{h_{21}}{h_{11}} \cdot R_C$$

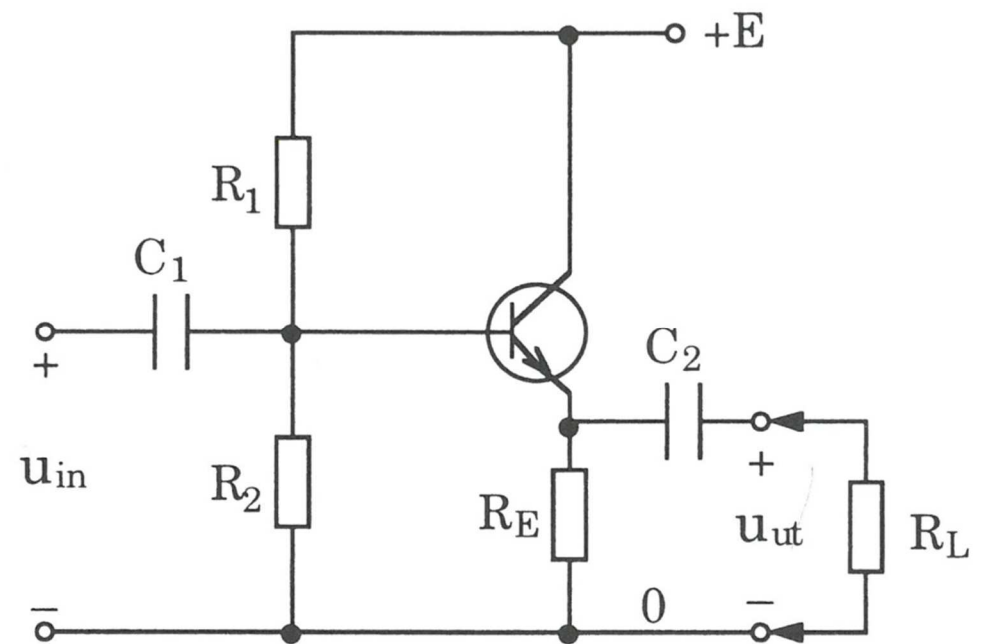
$h_{12} \approx 0$ $h_{22} \approx 0$

GE-steget vs EF-steget (emitterföljare)

GE-steget



EF-steget



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