

TSTE05 Elektronik & mätteknik

Föreläsning 15

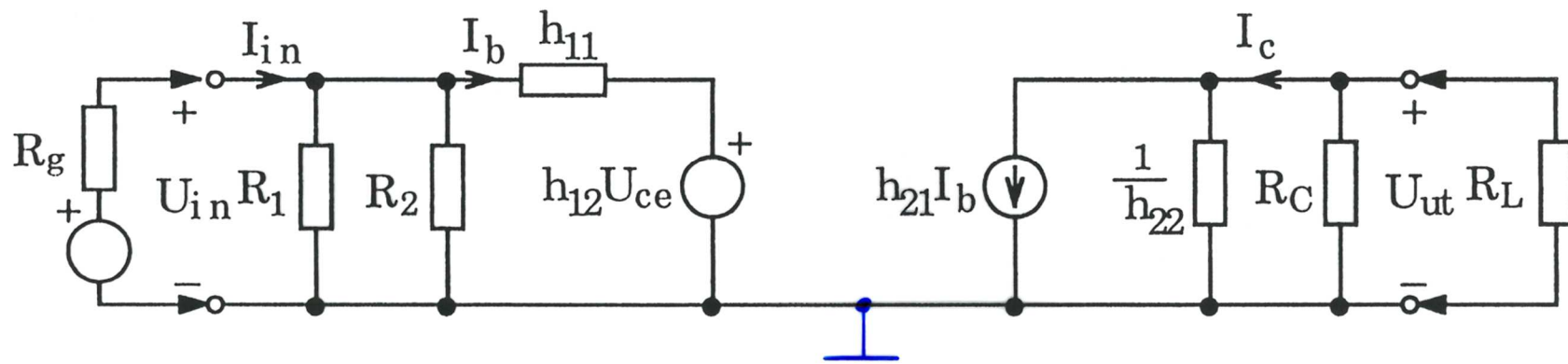
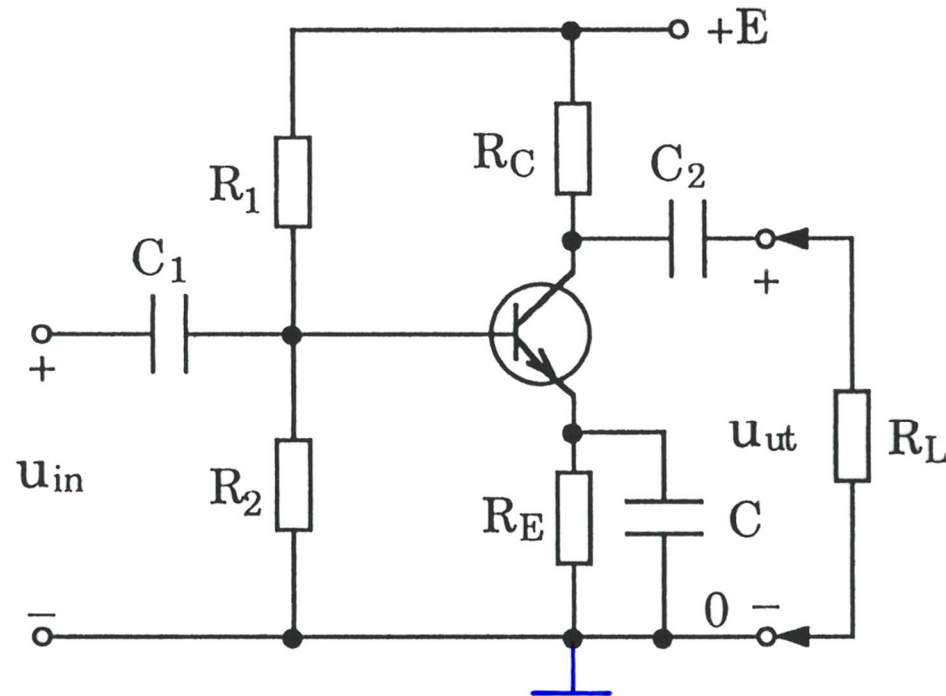
Emitterföljare och fälteffekt-transistorer

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Institutionen för Systemteknik (ISY)

Ämnesområdet Elektroniska kretsar och system

GE-steget (Gemensam emitter)

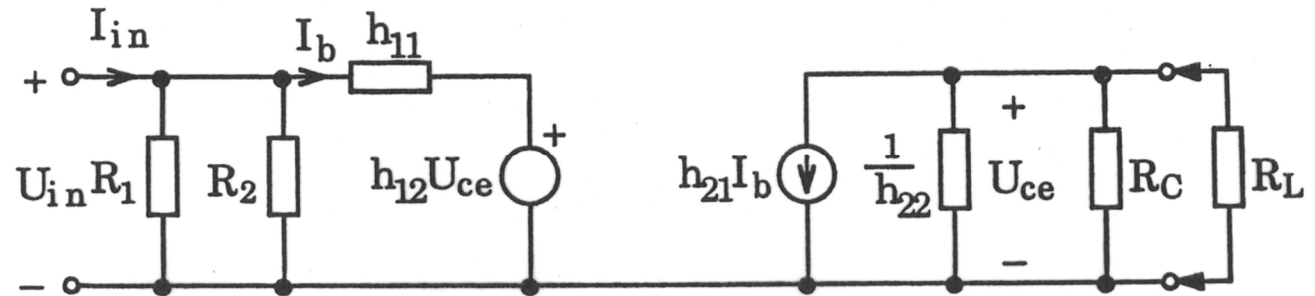


Inimpedans, utimpedans, förstärkning

Bestämning av Z_{in}

(Inimpedans)

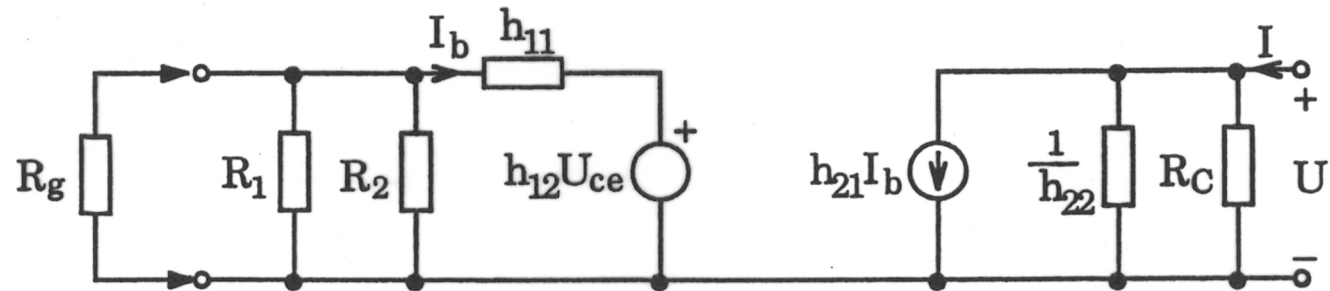
$$Z_{in} = \frac{U_{in}}{I_{in}}$$



Bestämning av Z_{ut}

(Utimpedans)

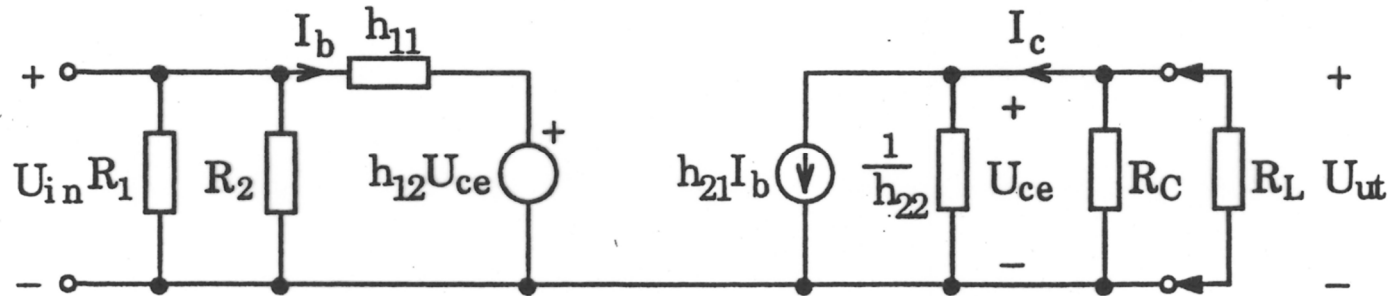
$$Z_{ut} = \frac{U}{I}$$



Bestämning av F

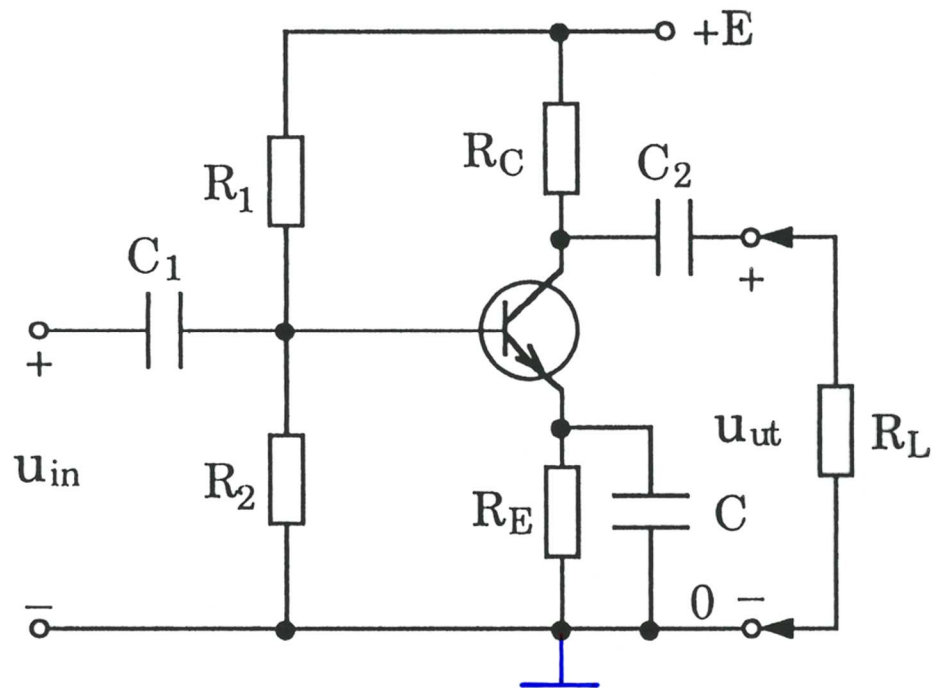
(Förstärkning)

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

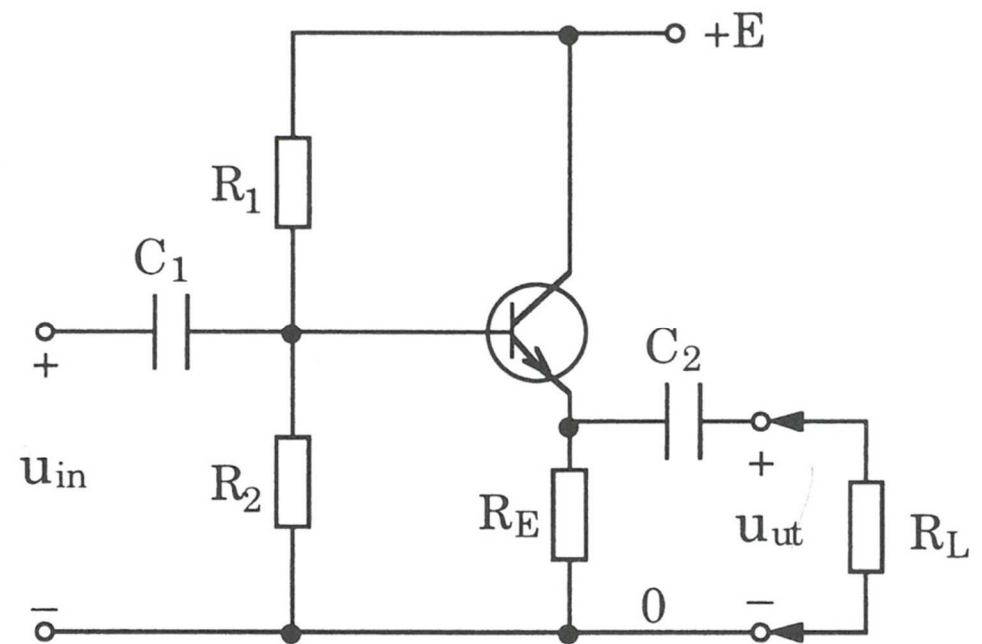


GE-steget vs EF-steget (emitterföljare)

GE-steget

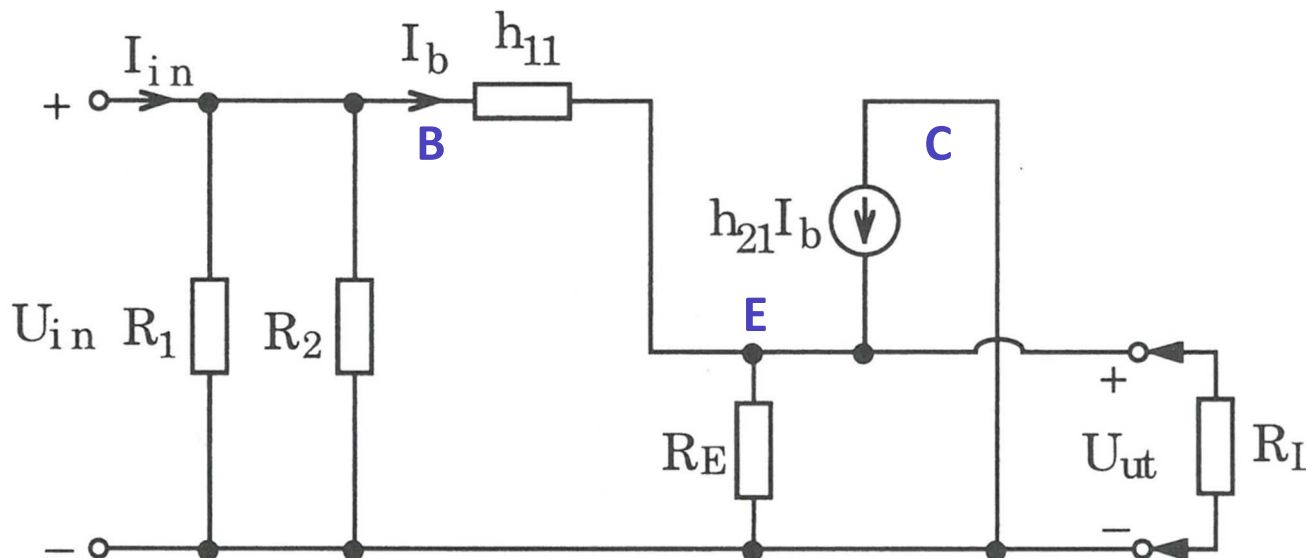


EF-steget



EF-steget

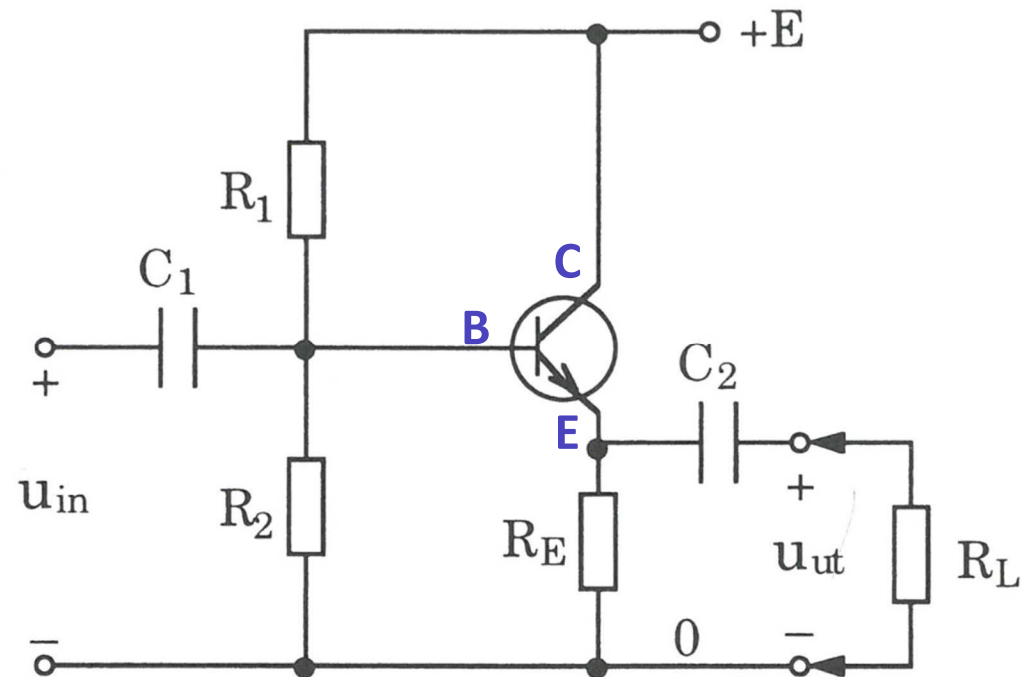
Ekvivalent
småsignalschema



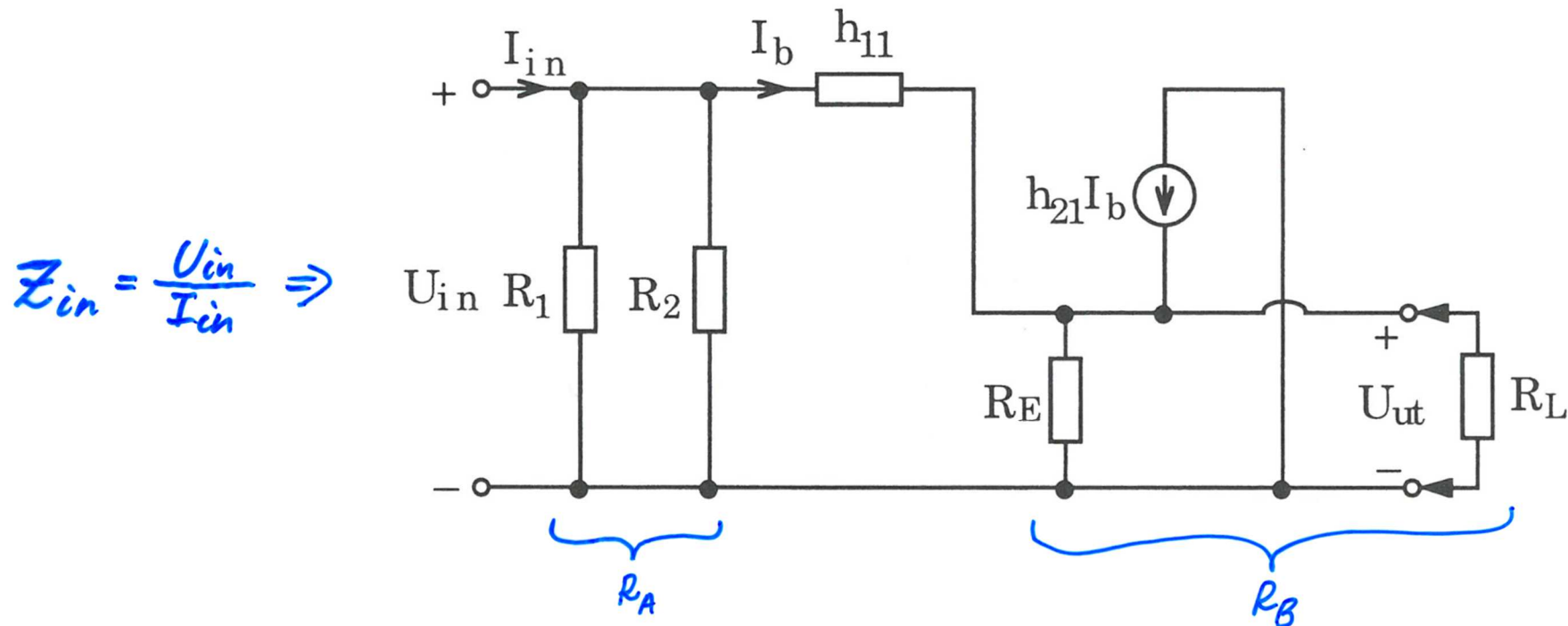
Förenklad
transistormodell

$$h_{12} \approx 0$$

$$h_{22} \approx 0$$



EF-stegets inimpedans

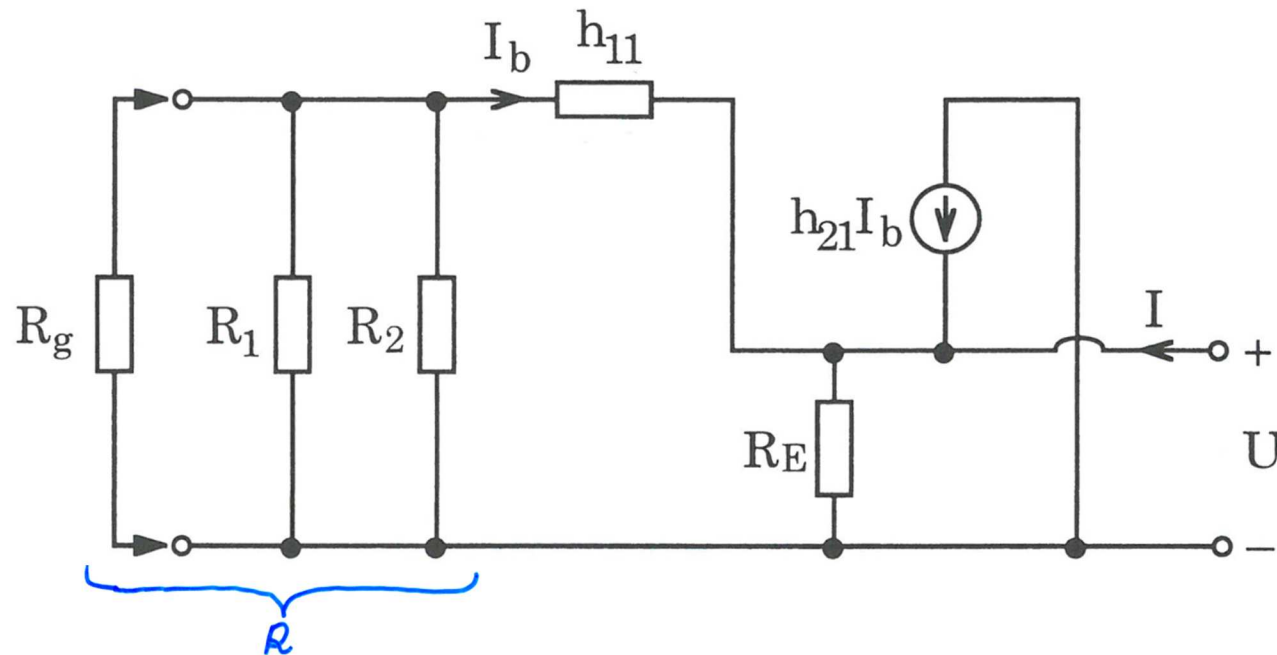


KVL: $U_{in} - h_{11}I_b - R_B(1 + h_{21})I_b = 0$

KCL: $I_{in} - I_b - \frac{U_{in}}{R_A} = 0 \Rightarrow I_b = I_{in} - \frac{U_{in}}{R_A}$

$\Rightarrow Z_{in} = \frac{U_{in}}{I_{in}} = R_1 \parallel R_2 \parallel (h_{11} + (1 + h_{21})(R_E \parallel R_L)) \approx \overset{h_{21} \text{ stor}}{\downarrow} R_1 \parallel R_2$

EF-stegets utimpedans



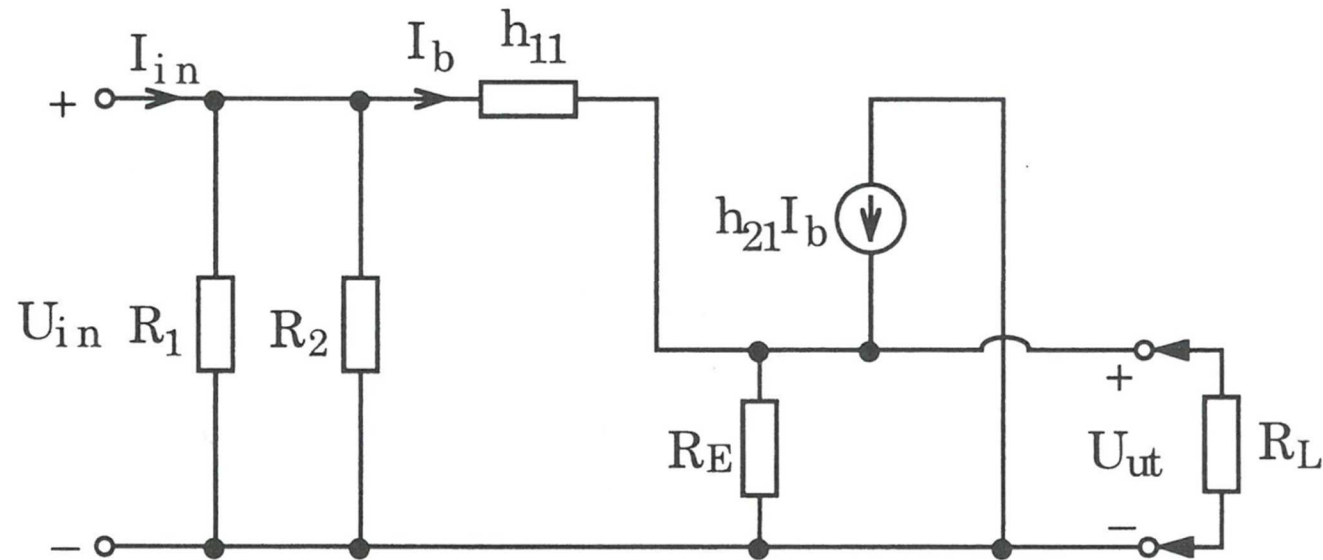
Ohms lag: $U = R_E \cdot (I_b + h_{21}I_b + I)$

Ohms lag: $U = -I_b \cdot (h_{11} + R) \Rightarrow I_b = -\frac{U}{h_{11} + R}$ } $\Rightarrow$

$$\Rightarrow Z_{ut} = \frac{U}{I} = R_E \parallel \frac{h_{11} + R_g \parallel R_1 \parallel R_2}{1 + h_{21}} \approx \frac{h_{11} + R_g \parallel R_1 \parallel R_2}{h_{21}} \approx \frac{R_g \parallel R_1 \parallel R_2}{h_{21}}$$

$\uparrow$ h_{21} stor $\uparrow$ h_{11} liten

EF-stegets förstärkning



$$\left. \begin{array}{l} \text{KVL: } U_{in} - h_{11}I_b - (R_E // R_L) \cdot (h_{21} + 1)I_b = 0 \\ \text{Ohms lag: } U_{ut} = (R_E // R_L) \cdot (h_{21} + 1) \cdot I_b \end{array} \right\} \Rightarrow$$

$$\Rightarrow F = \frac{U_{ut}}{U_{in}} = \frac{(R_E // R_L) \cdot (h_{21} + 1)}{h_{11} + (R_E // R_L) \cdot (h_{21} + 1)} \approx 1$$

$\uparrow$
 $h_{21} \text{ stor}$

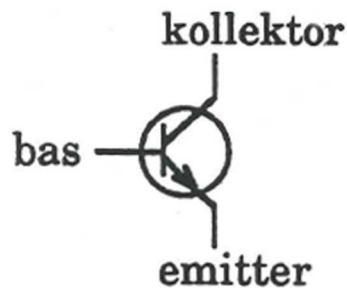
Sammanställning EF-steget

$$Z_{in} = \frac{U_{in}}{I_{in}} = R_1 // R_2 // (h_{11} + (1 + h_{21})(R_E // R_L)) \approx \overset{h_{21} \text{ stor}}{\downarrow} R_1 // R_2$$

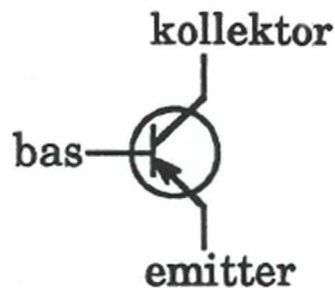
$$Z_{ut} = \frac{U}{I} = R_E // \frac{h_{11} + R_g // R_1 // R_2}{1 + h_{21}} \approx \underset{h_{21} \text{ stor}}{\uparrow} \frac{h_{11} + R_g // R_1 // R_2}{h_{21}} \approx \underset{h_{11} \text{ liten}}{\uparrow} \frac{R_g // R_1 // R_2}{h_{21}}$$

$$F = \frac{U_{ut}}{U_{in}} = \frac{(R_E // R_L) \cdot (h_{21} + 1)}{h_{11} + (R_E // R_L) \cdot (h_{21} + 1)} \approx \underset{h_{21} \text{ stor}}{\uparrow} 1$$

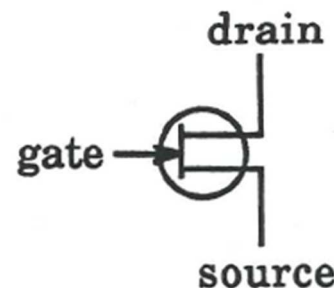
Några transistortyper



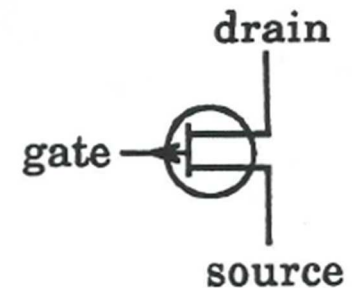
a) *NPN-bipolar-transistor*



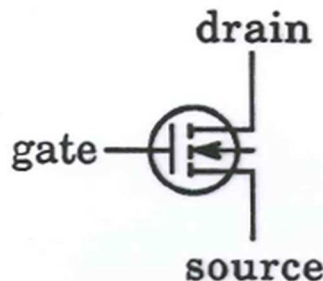
b) *PNP-bipolar-transistor*



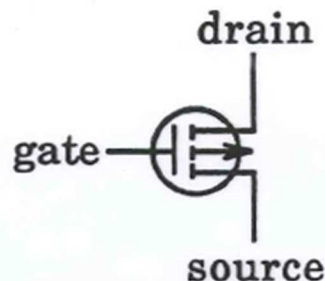
c) *N-kanal FET-transistor*



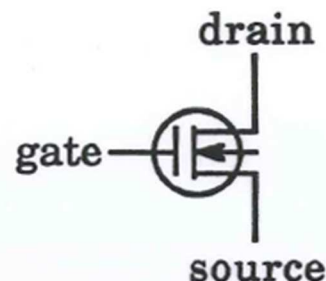
d) *P-kanal FET-transistor*



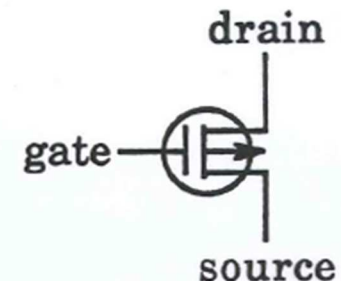
e) *N-kanal MOS-transistor
anrikningstyp*



f) *P-kanal MOS-transistor
anrikningstyp*



g) *N-kanal MOS-transistor
utarmningstyp*

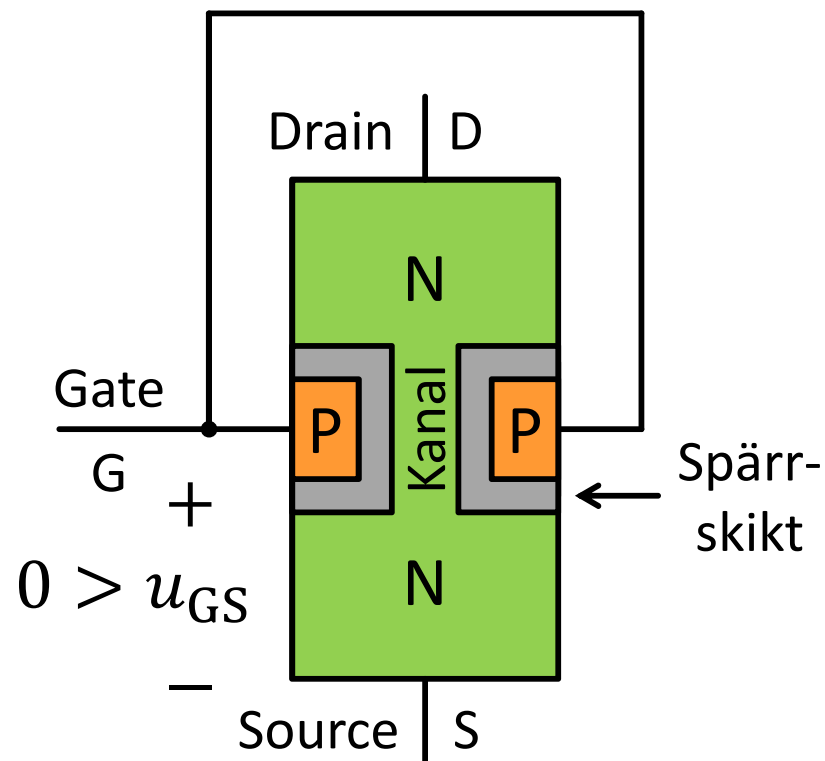


h) *P-kanal MOS-transistor
utarmningstyp*

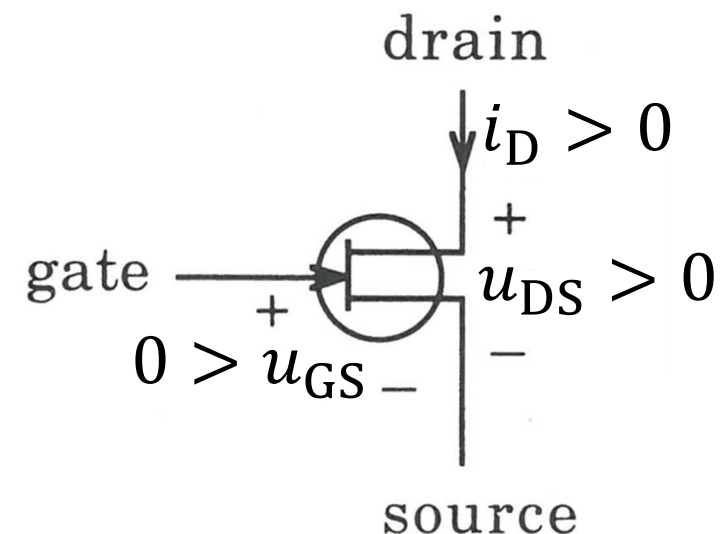
N-kanal JFET-transistor

Junction – Field Effect Transistor

Konstruktion



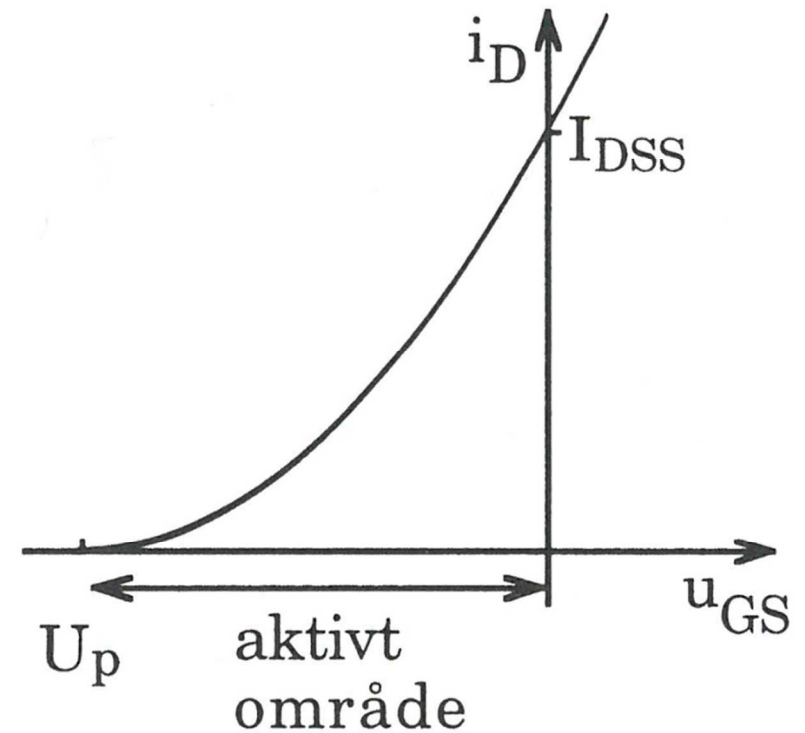
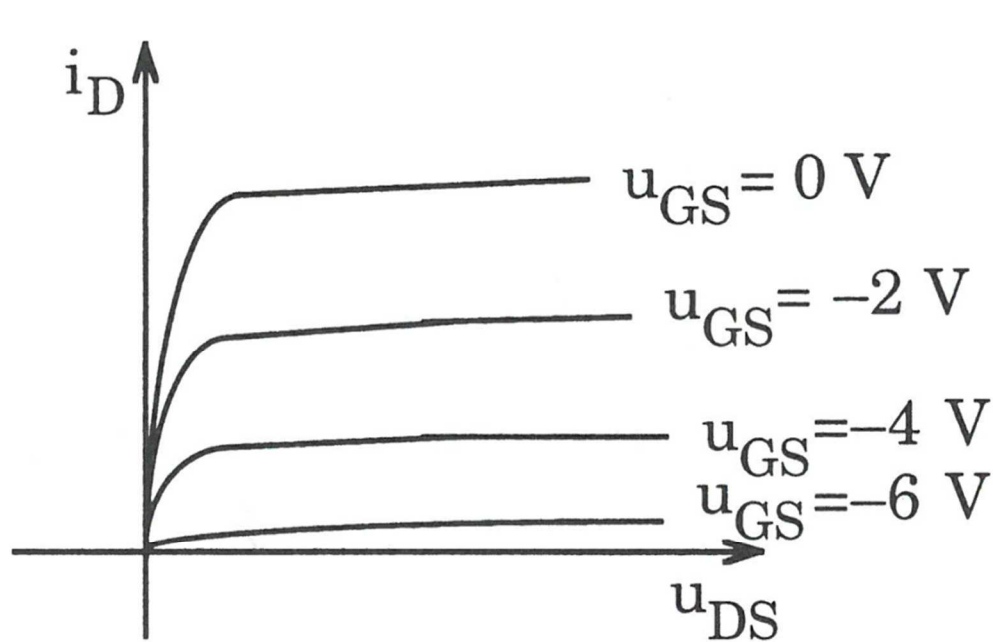
Symbol



*Ju mer negativ u_{GS} görs,
desto smalare blir kanalen.*

N-kanal JFET-transistor

Karakteristika

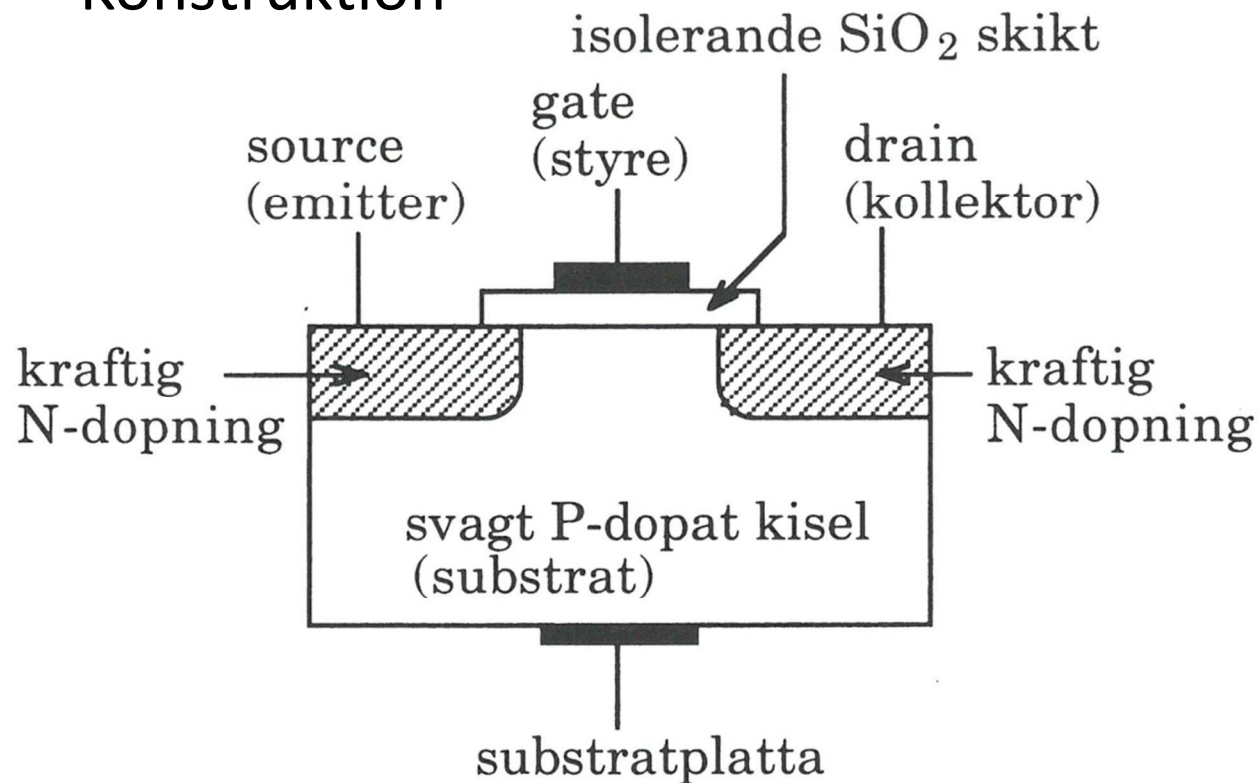


$$i_D \approx I_{DSS} \left(1 - \frac{u_{GS}}{U_p}\right)^2$$

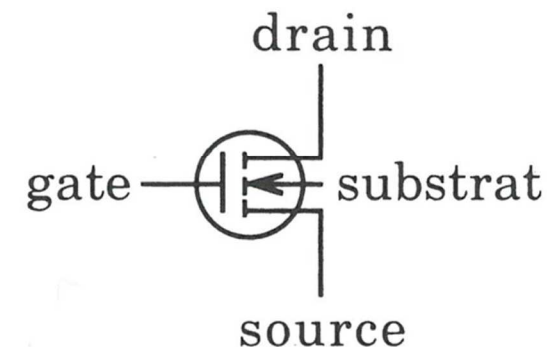
N-kanal MOSFET av anrikningstyp

Metal Oxid Semiconductor

Konstruktion



Symbol

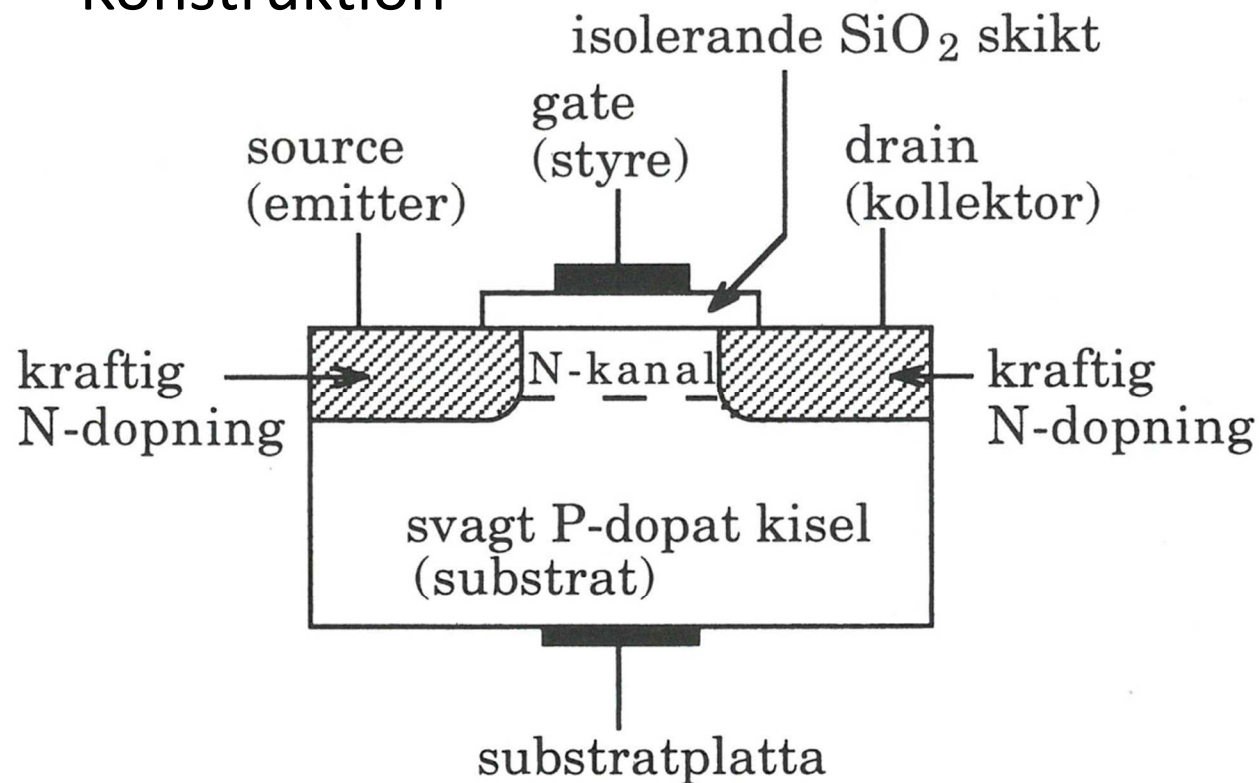


Ju mindre positiv u_{GS} görs, desto smalare blir kanalen.

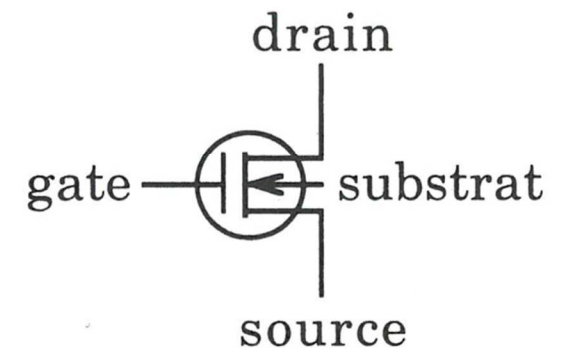
N-kanal MOSFET av utarmningstyp

Metal Oxid Semiconductor

Konstruktion



Symbol

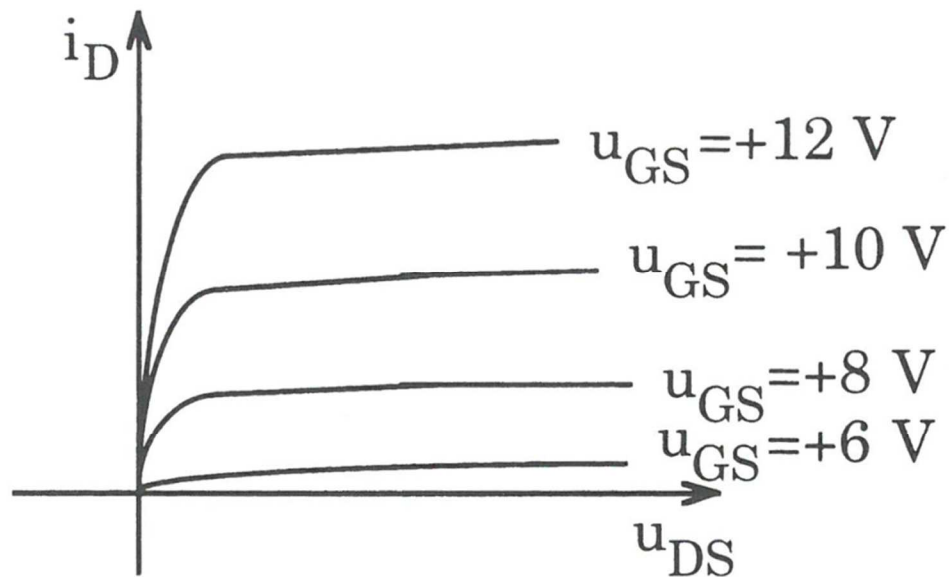


Ju mer negativ u_{GS} görs, desto smalare blir kanalen.

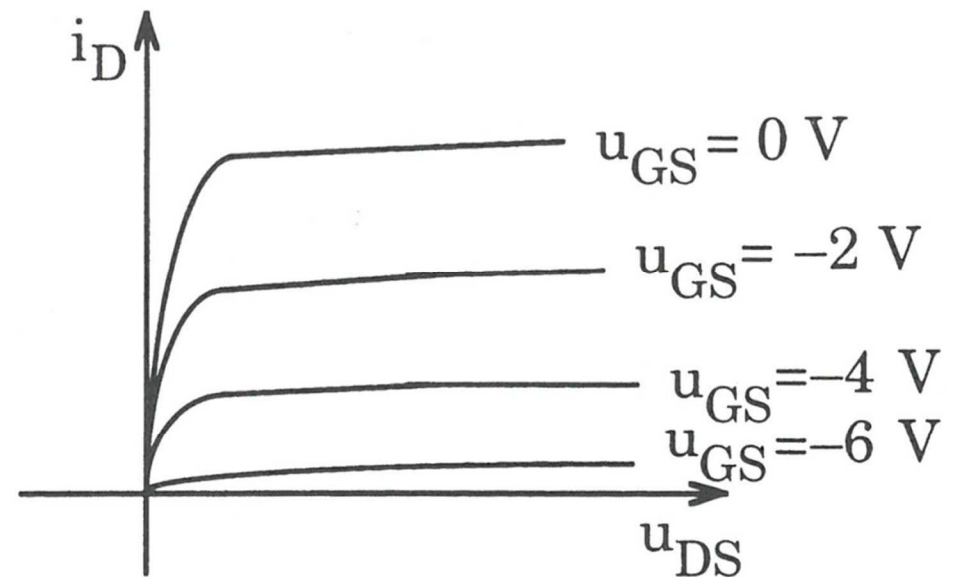
Draindiagram för N-kanal MOSFET

– skillnad mellan anrikning och utarmning

Anrikning

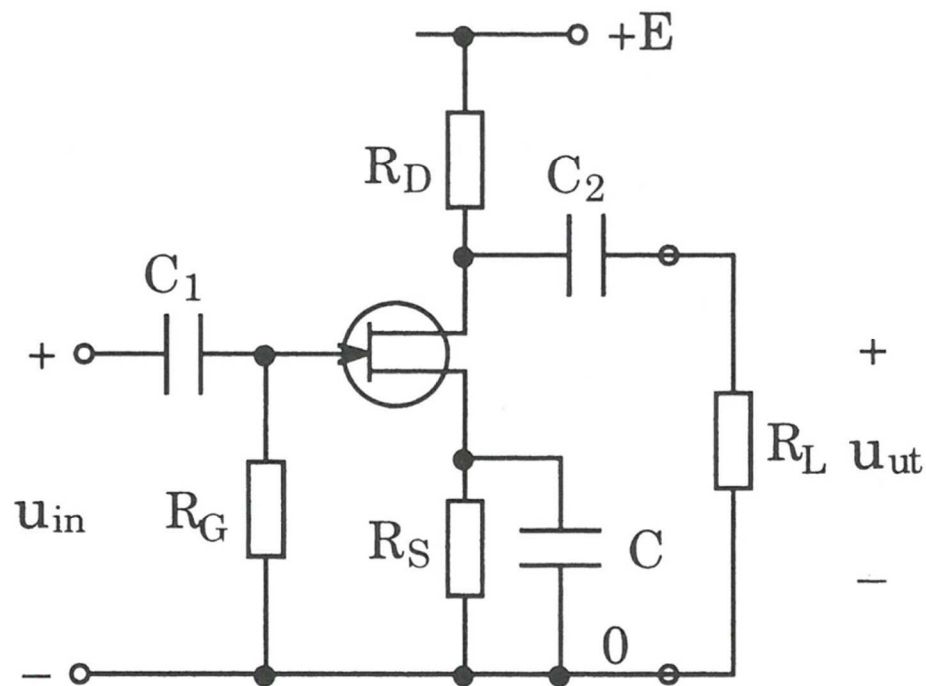


Utarmning

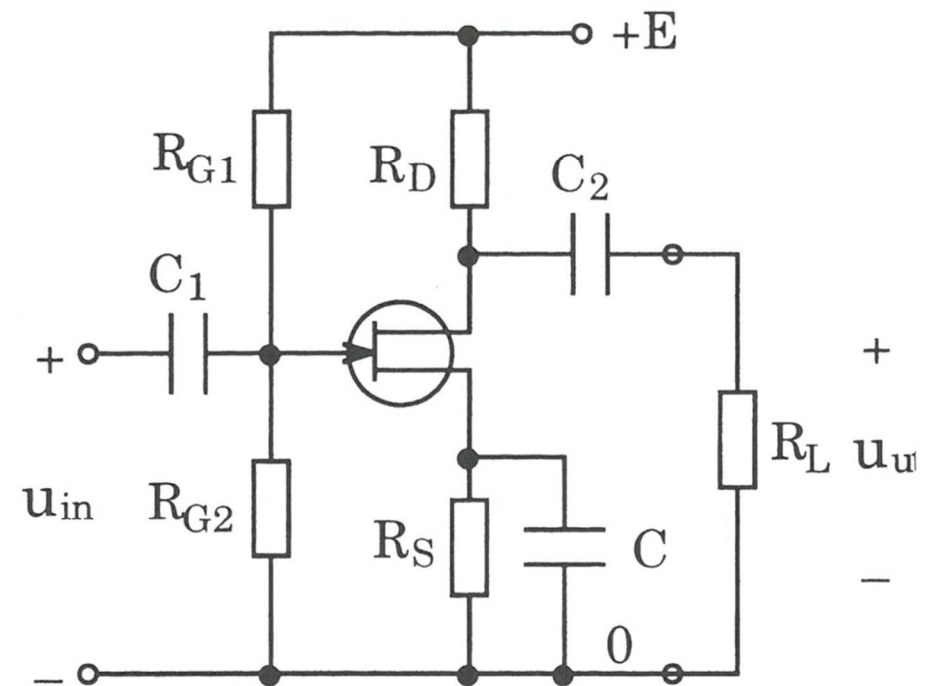


GS-steg – Gemensam Source (N-kanal)

Self-biased

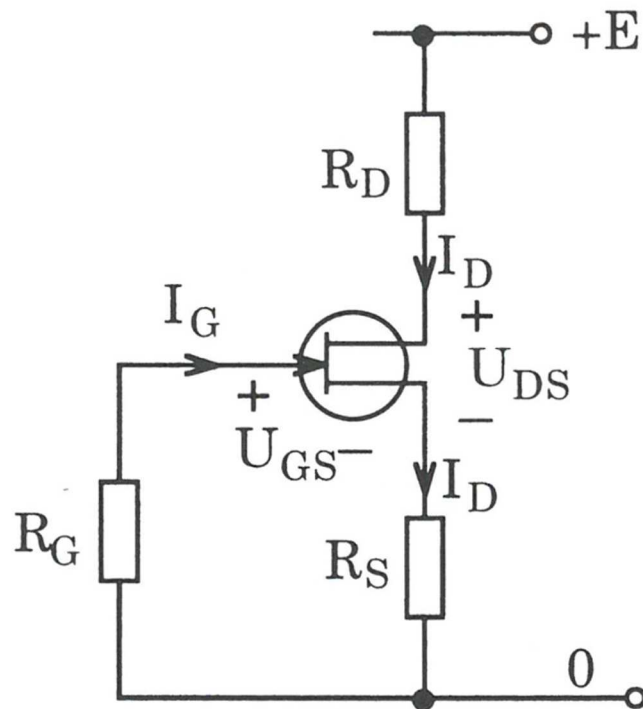


Fixed-biased



Self-biased GS-steg – likströmsschema

Likströmsschema

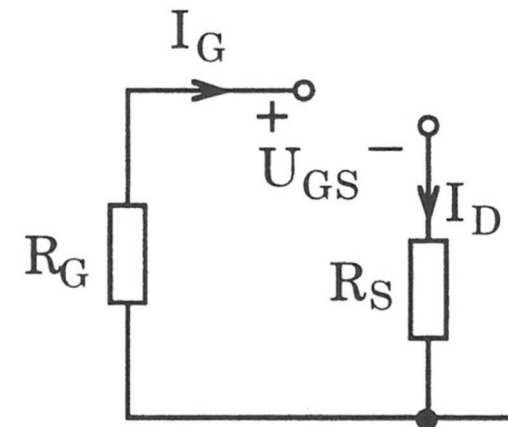


$$E - R_D I_D - U_{DS} - R_S I_D = 0$$

$$I_G \approx 0$$

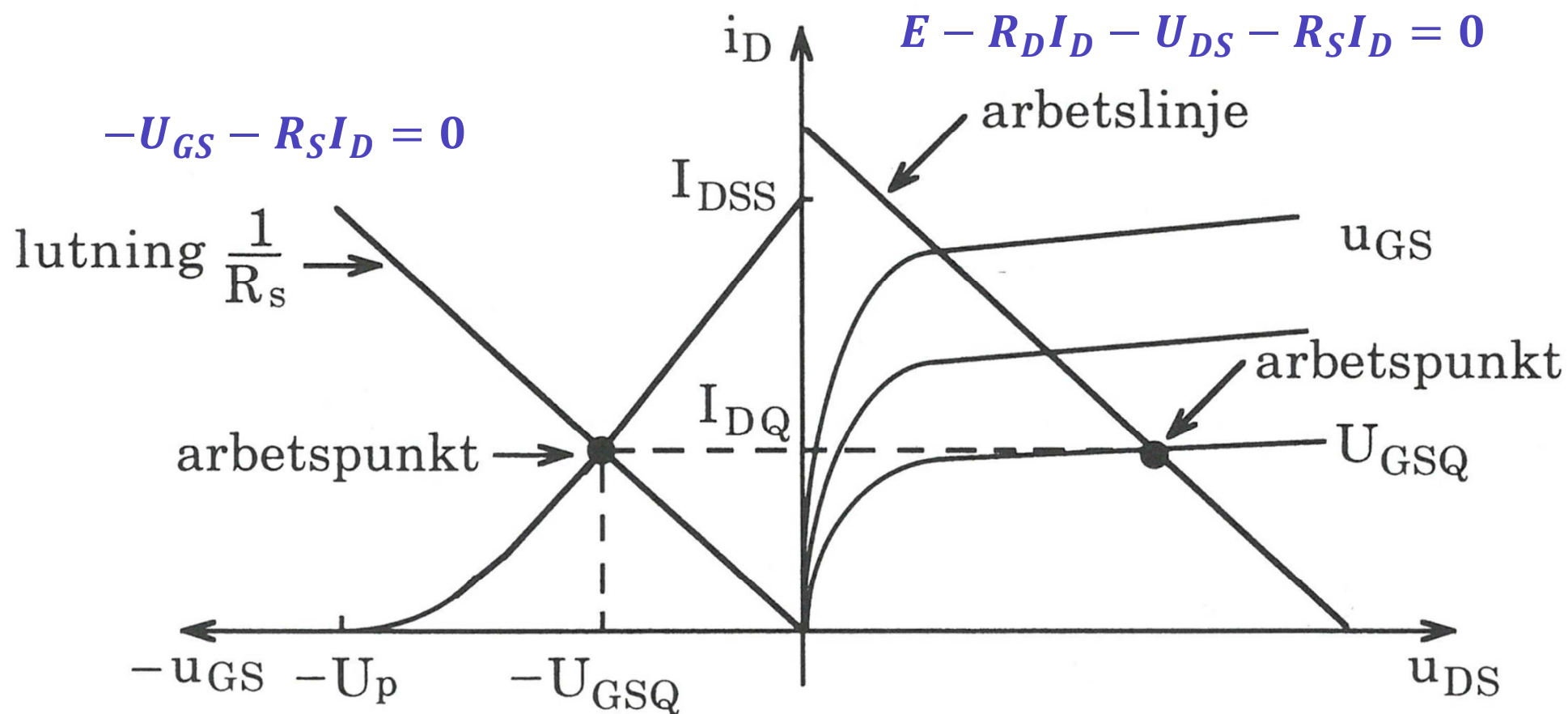
Gate-source-kretsen

$$-R_G I_G - U_{GS} - R_S I_D = 0$$

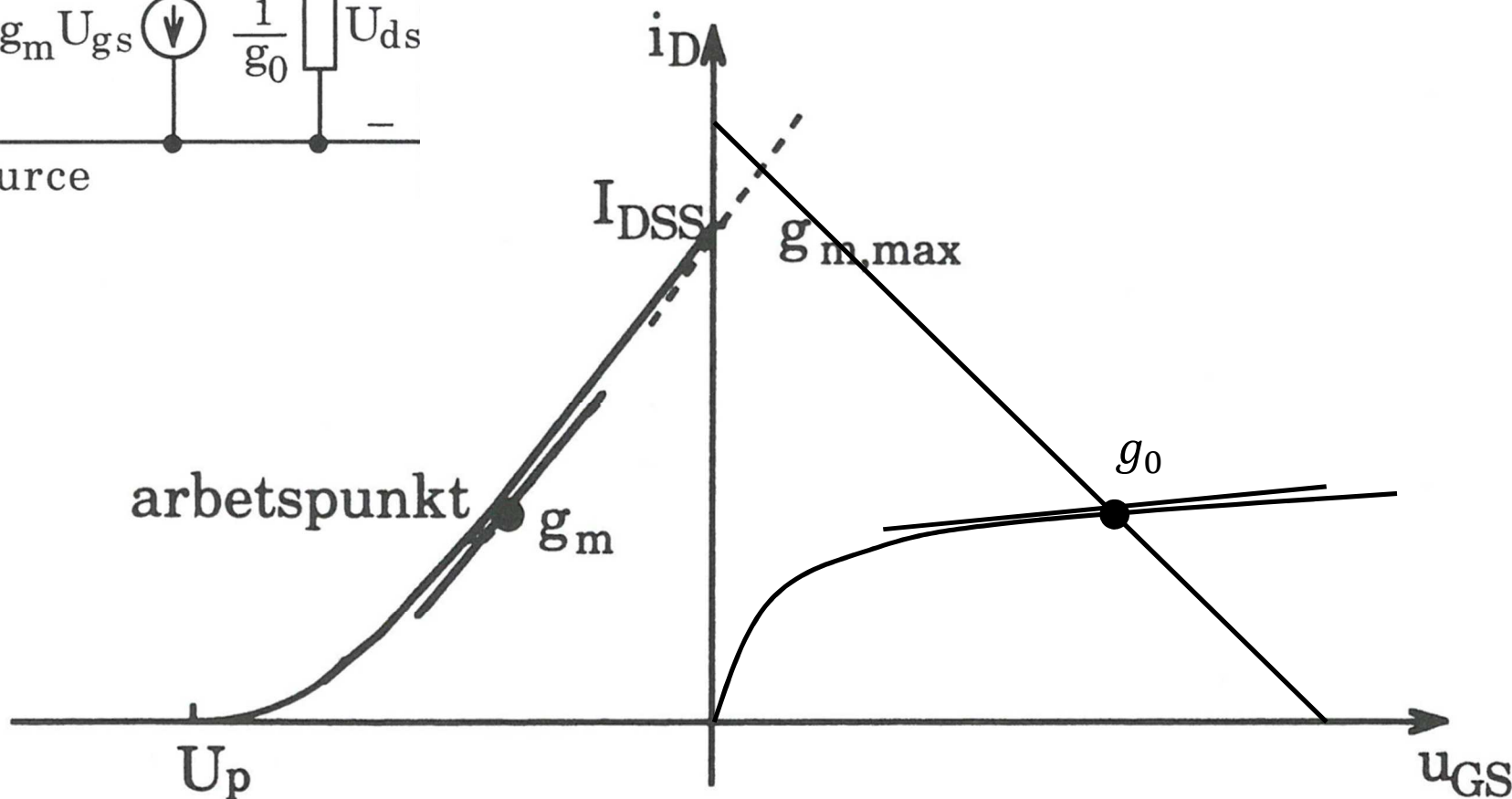
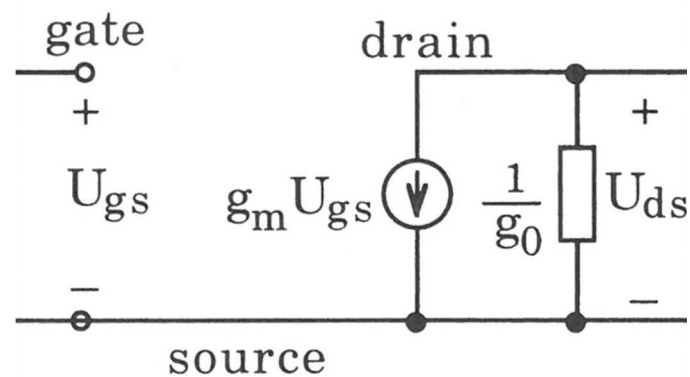


$$-U_{GS} - R_S I_D = 0$$

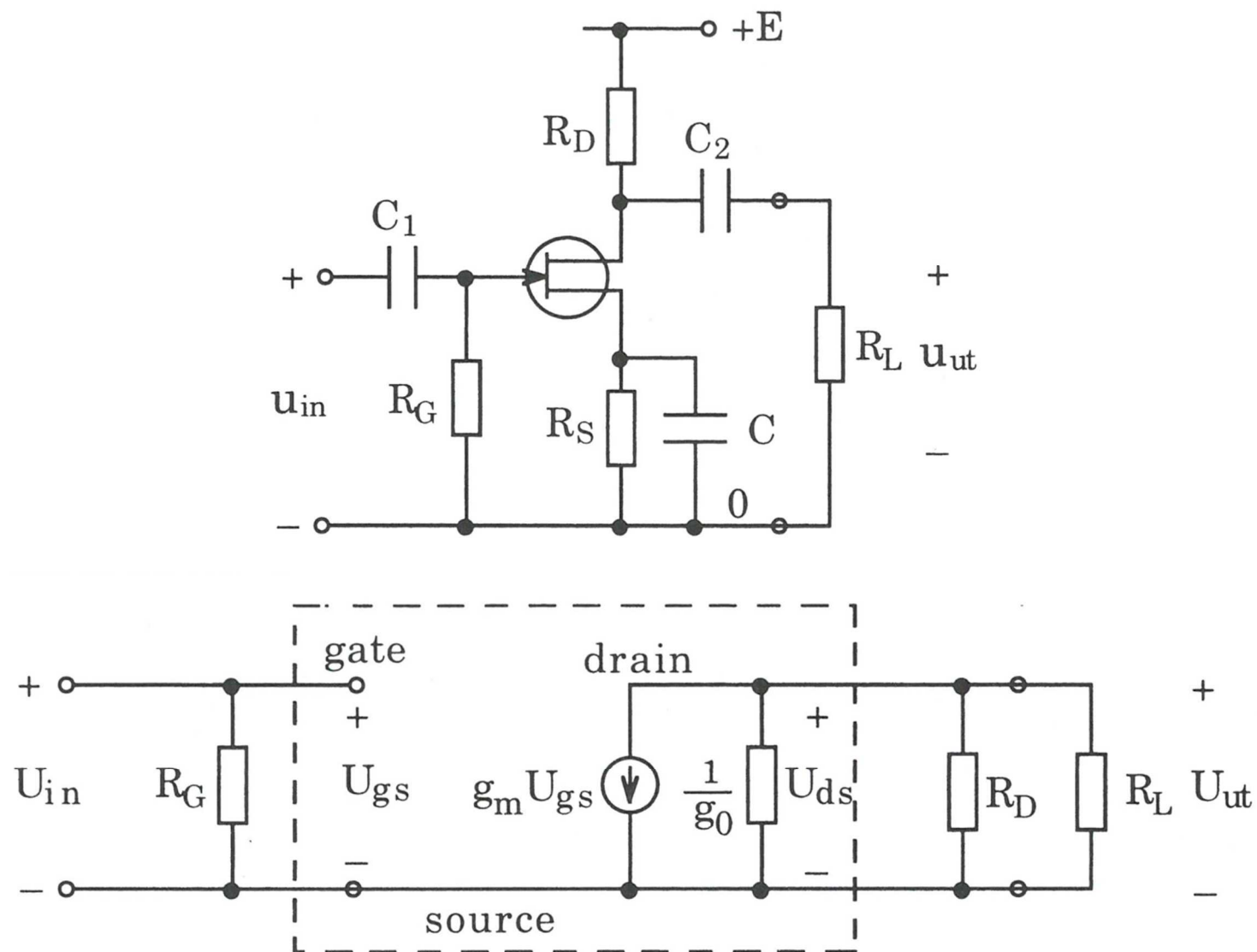
Arbetspunkten för en FET-transistor



FET – småsignaler – g-parameterschema



GS-steget – Ekvivalent småsignalschema



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