

TSTE05 Elektronik & mätteknik

Föreläsning 15

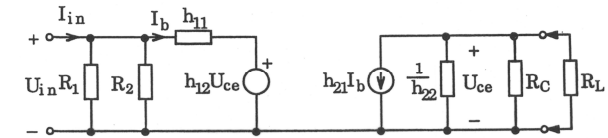
Emitterföljare och fälteffekt-transistorer

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Inimpedans, utimpedans, förstärkning

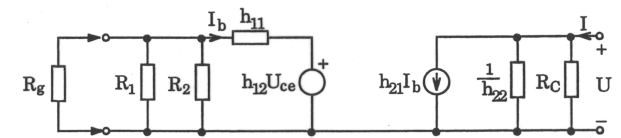
Bestämning av Z_{in}
 (Inimpedans)

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



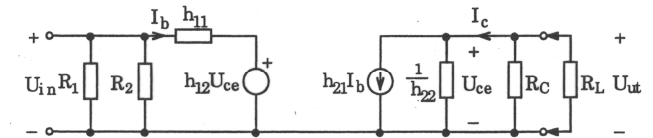
Bestämning av Z_{ut}
 (Utimpedans)

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

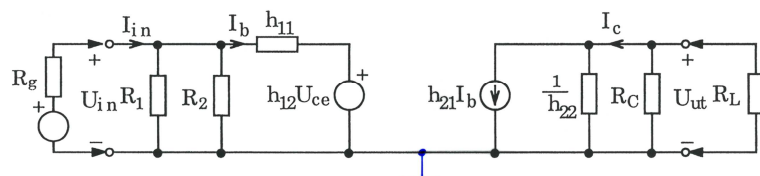
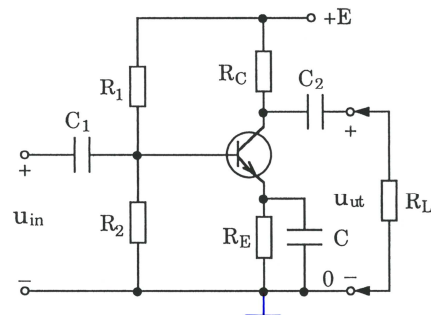


Bestämning av F
 (Förstärkning)

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

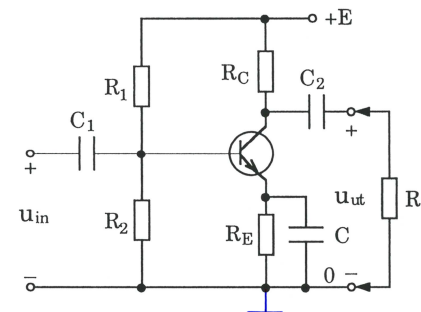


GE-steget (Gemensam emitter)

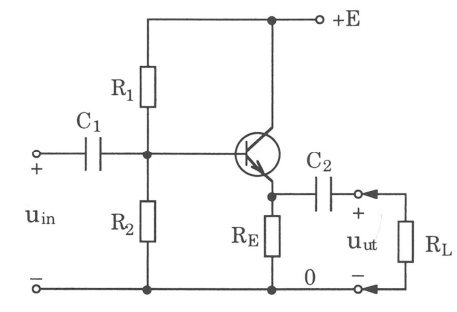


GE-steget vs EF-steget (emitterföljare)

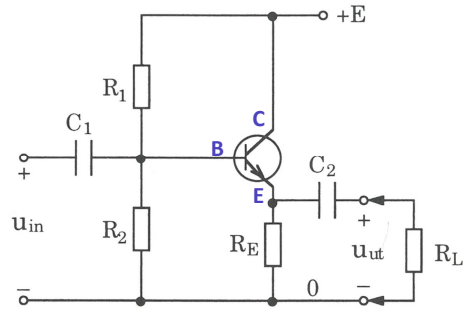
GE-steget



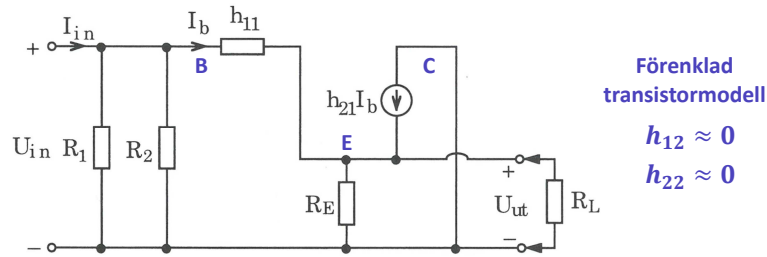
EF-steget



EF-steget

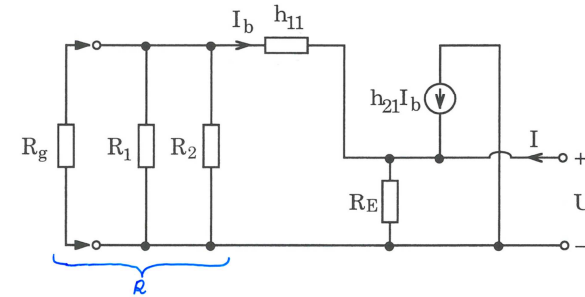


Ekvivalent småsignalschema



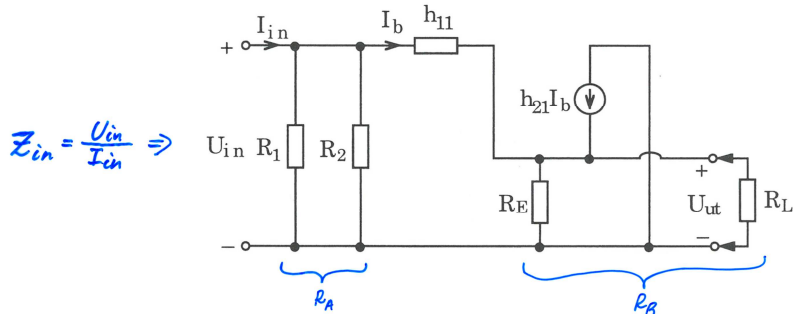
Förenklad transistormodell
 $h_{12} \approx 0$
 $h_{22} \approx 0$

EF-stegets utimpedans



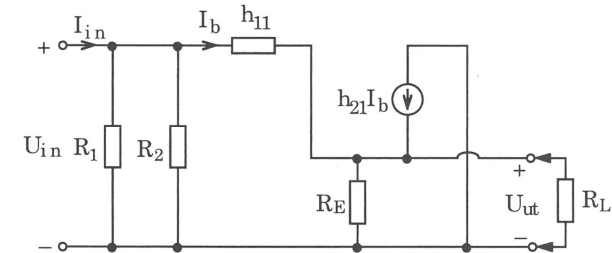
Ohms lag: $U = R_E \cdot (I_b + h_{21} I_b + I)$
 Ohms lag: $U = -I_b \cdot (h_{11} + R)$ $\Rightarrow I_b = -\frac{U}{h_{11} + R}$ \Rightarrow
 $\Rightarrow Z_{ut} = \frac{U}{I} = R_E \parallel \frac{h_{11} + R_E \parallel R_L / R_1 / R_2}{1 + h_{21}} \approx \frac{h_{11} + R_E \parallel R_L / R_1 / R_2}{h_{21}}$
(Notes: h21 stor, h11 liten)

EF-stegets inimpedans



$Z_{in} = \frac{U_{in}}{I_{in}} \Rightarrow$
 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
 $\Rightarrow Z_{in} = \frac{U_{in}}{I_{in}} = R_1 \parallel R_2 \parallel (h_{11} + (1 + h_{21})(R_E \parallel R_L)) \approx R_1 \parallel R_2$
(Note: h21 stor)

EF-stegets förstärkning



KVL: $U_{in} - h_{11} I_b - (R_E \parallel R_L) \cdot (h_{21} + 1) I_b = 0$
 Ohms lag: $U_{ut} = (R_E \parallel R_L) \cdot (h_{21} + 1) \cdot I_b$ \Rightarrow
 $\Rightarrow F = \frac{U_{ut}}{U_{in}} = \frac{(R_E \parallel R_L) \cdot (h_{21} + 1)}{h_{11} + (R_E \parallel R_L) \cdot (h_{21} + 1)} \approx 1$
(Note: h21 stor)

Sammanställning EF-steget

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

h₂₁ stor

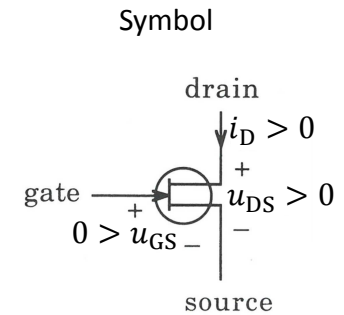
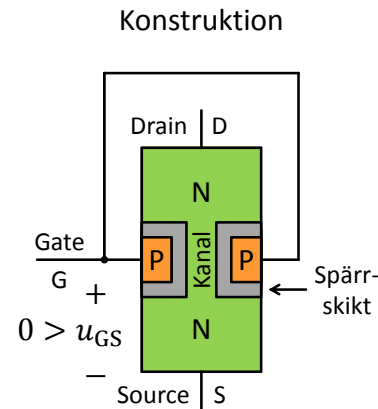
$$Z_{out} = \frac{U}{I} = R_E // \frac{h_{11} + R_3 // R_1 // R_2}{1+h_{21}} \approx \frac{h_{11} + R_3 // R_1 // R_2}{h_{21}} \approx \frac{R_3 // R_1 // R_2}{h_{21}}$$

h₂₁ stor *h₁₁ liten*

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

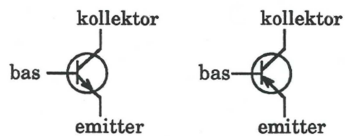
h₂₁ stor

N-kanal JFET-transistor Junction – Field Effect Transistor

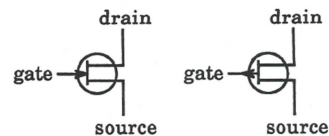


Ju mer negativ u_{GS} görs, desto smalare blir kanalen.

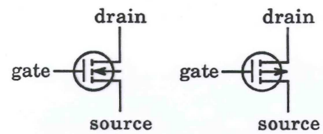
Några transistortyper



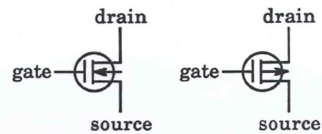
a) NPN-bipolar-transistor b) PNP-bipolar-transistor



c) N-kanal FET-transistor d) P-kanal FET-transistor

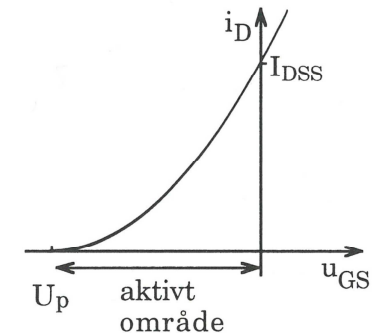
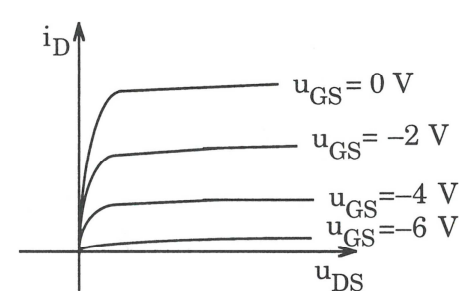


e) N-kanal MOS-transistor anrikningstyp f) P-kanal MOS-transistor anrikningstyp



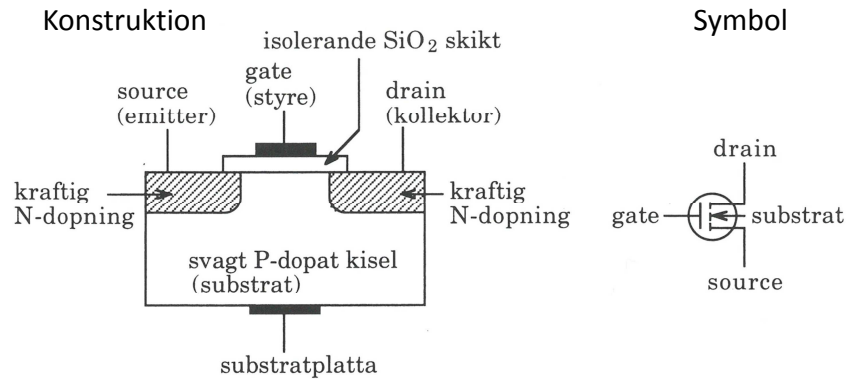
g) N-kanal MOS-transistor utarmningstyp h) P-kanal MOS-transistor utarmningstyp

N-kanal JFET-transistor Karaktistika



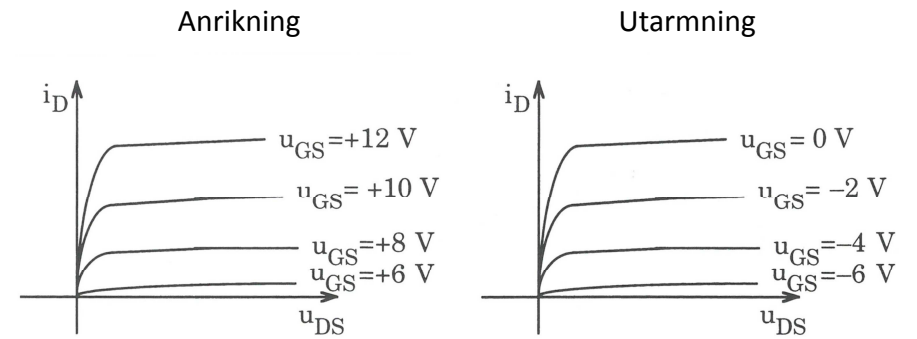
$$i_D \approx I_{DSS} \left(1 - \frac{u_{GS}}{U_p}\right)^2$$

N-kanal MOSFET av anrikningstyp Metal Oxid Semiconductor

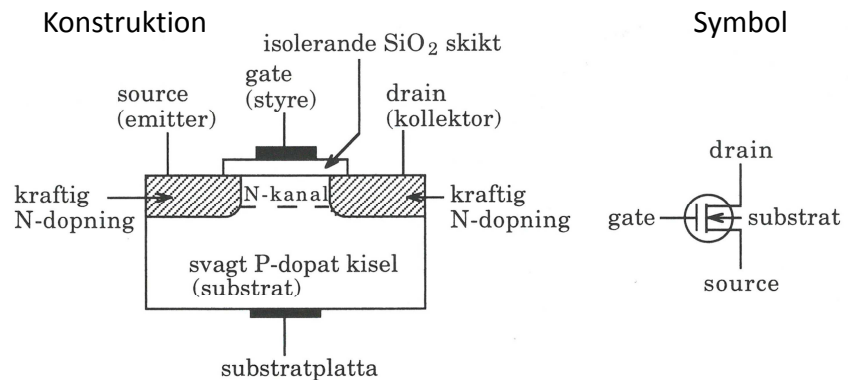


Ju mindre positiv u_{GS} görs, desto smalare blir kanalen.

Draindiagram för N-kanal MOSFET – skillnad mellan anrikning och utarmning

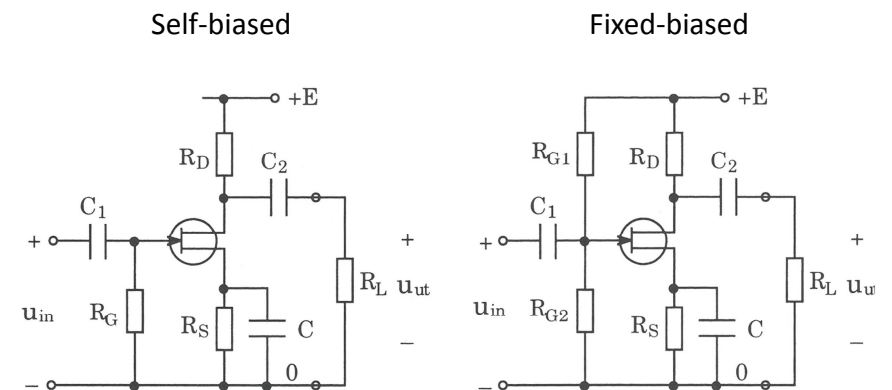


N-kanal MOSFET av utarmningstyp Metal Oxid Semiconductor



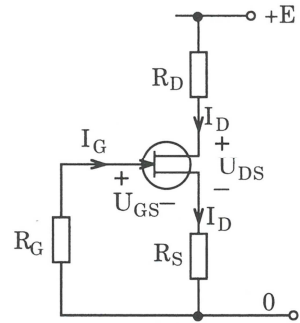
Ju mer negativ u_{GS} görs, desto smalare blir kanalen.

GS-steg – Gemensam Source (N-kanal)



Self-biased GS-steg – likströmsschema

Likströmsschema

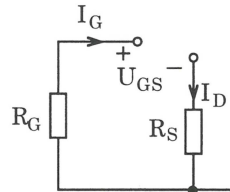


$$E - R_D I_D - U_{DS} - R_S I_D = 0$$

Gate-source-kretsen

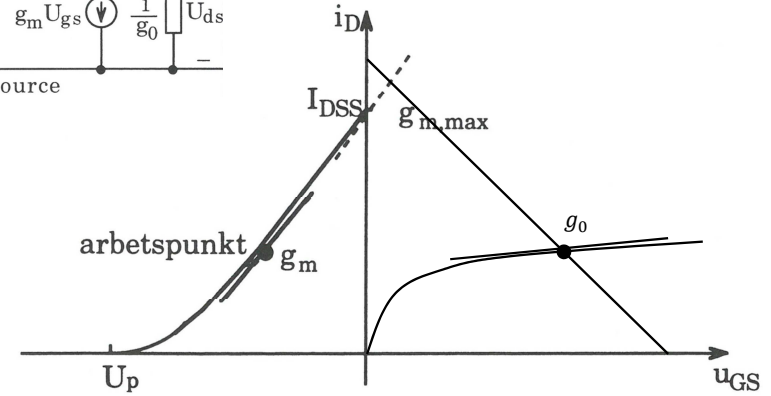
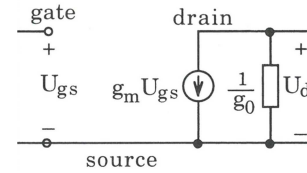
$$-R_G I_G - U_{GS} - R_S I_D = 0$$

$$I_G \approx 0$$

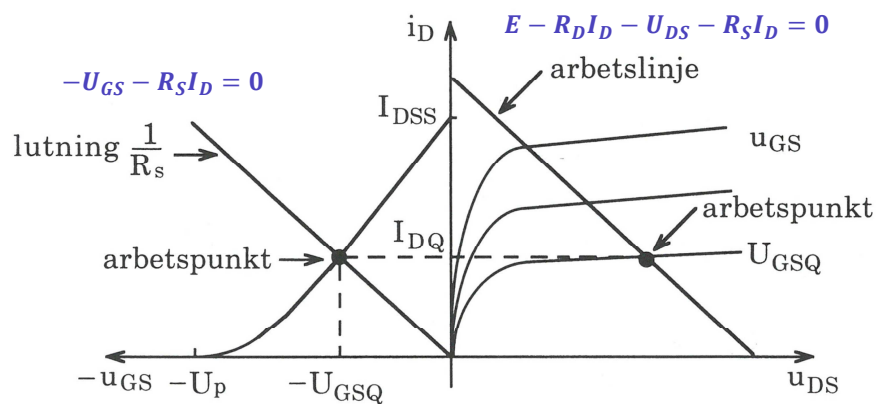


$$-U_{GS} - R_S I_D = 0$$

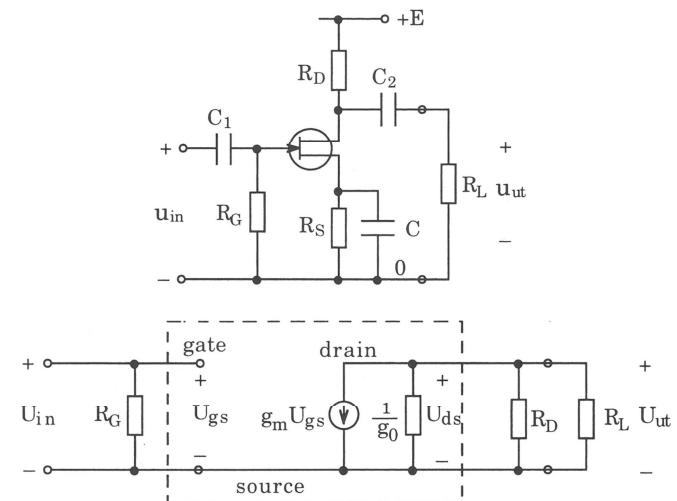
FET – småsignaler – g-parameterschema



Arbetspunkten för en FET-transistor



GS-steget – Ekvivalent småsignalschema



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