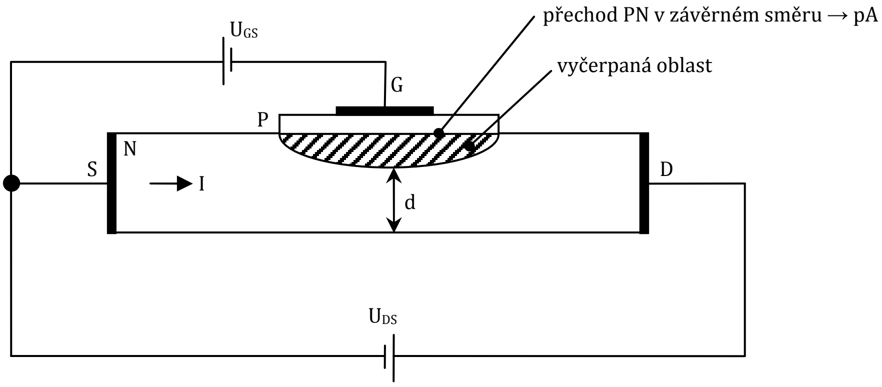
Tranzistory řízené polem

- bipolární – na vedení proudu se podílejí majoritní i minoritní nosiče náboje
  unipolární – jen jeden druh nosiče náboje
- výhody – vysoký vstupní odpor



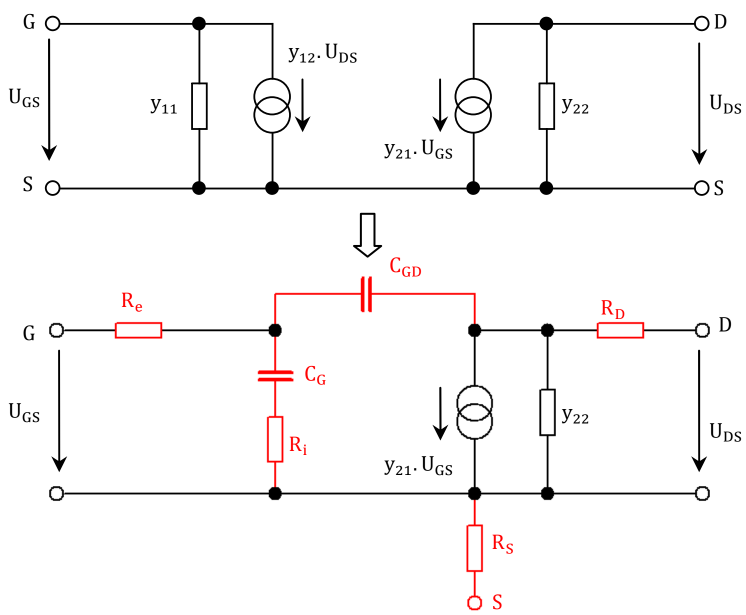
- ovládání napětím na G

$$U_{po} = \frac{e}{2\varepsilon}.N_p a^2.\left(1+\frac{N_D}{N_A}\right)$$

Náhradní schéma JFETu

$I_G = y_{11}.U_{GS} + y_{12}.U_{DS} \doteq pA \Rightarrow = 0$

$I_D = y_{21}.U_{GS} + y_{22}.U_{DS}$



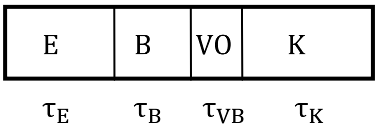
$y_{22} = \frac{I_D}{U_{DS}}$ pro $U_{GS} = 0$

$y_{22} = \frac{\partial I_D}{\partial U_{DS}}$ pro $U_{GS} = konst.$

$y_{21} = \frac{I_D}{U_{GS}}$ pro $U_{DS} = 0$

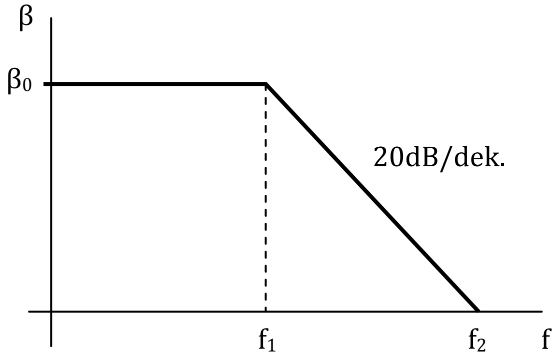
$y_{21} = \frac{\partial I_D}{\partial U_{GS}}$ pro $U_{DS} = konst.$

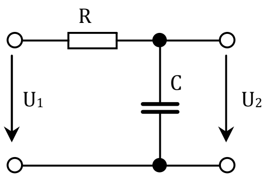
Mezní kmitočet bipolárního tranzistoru



VO – vyčerpaná oblast

$\tau_c = \tau_E + \tau_B + \tau_{VO} + \tau_K$





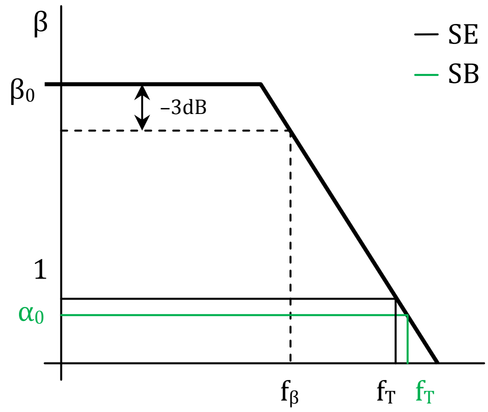
$$A_U = \frac{U_2}{U_1} = \frac{\frac{1}{j\omega C}}{R + \frac{1}{j\omega C}} = \frac{\frac{1}{j\omega C}}{\frac{1 + j\omega CR}{j\omega C}} = \frac{1}{1 + j\omega CR} = \frac{1}{1 + j\omega\tau_C} = \frac{1}{1 + j.\frac{f}{f_T}}$$

$$\tau_c = CR, f_T = \frac{1}{2\pi\tau_C} \Rightarrow \tau_c = \frac{1}{2\pi f_T}$$

$$\alpha = \frac{\alpha}{1 + j\omega\tau_C} = \frac{\alpha_0}{1 + j.\frac{f}{f_T}}$$

$$\beta = \frac{\alpha}{1-\alpha} = \frac{\frac{\alpha_0}{1 + j.\frac{f}{f_T}}}{1 - \frac{\alpha_0}{1 + j.\frac{f}{f_T}}} = \frac{\frac{\alpha_0}{1 + j.\frac{f}{f_T}}}{\frac{1 + j.\frac{f}{f_T} - \alpha_0}{1 + j.\frac{f}{f_T}}} = \frac{\alpha_0}{1 - \alpha_0 + j.\frac{f}{f_T}} = \underbrace{\frac{\alpha_0}{1-\alpha_0}}_{\beta_0}.\frac{1}{1 + \frac{j.\frac{f}{f_T}}{1-\alpha_0}} = \frac{\beta_0}{1 + \frac{j.\frac{f}{f_T}}{1-\alpha_0}} =$$

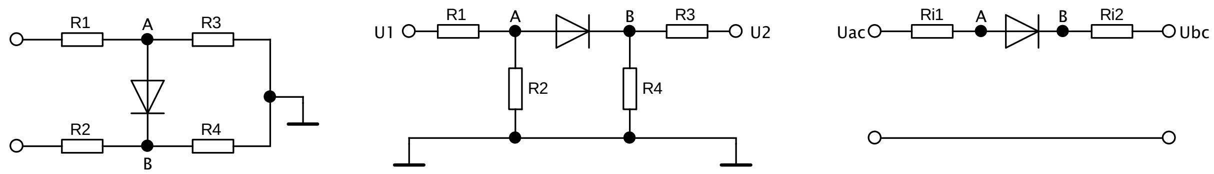
$$= \frac{\beta_0.(1-\alpha_0)}{1 - \underbrace{\alpha_0}_{\to 1} + j.\frac{f}{f_T}} = \frac{\frac{\alpha_0}{1-\alpha_0}.(1-\alpha_0)}{j.\frac{f}{f_T}} = \frac{\alpha_0}{j.\frac{f}{f_T}} = \frac{1}{j.\frac{f}{f_T}}$$



f_T – kmitočet, kdy β klesne na hodnotu 1

Závěr: pro vyšší frekvence je lepší SB

<u>Příklad:</u>



$R1 = R2 = R3 = R4 = 10k\Omega$

$U1 = 15V$

$U2 = 10V$

$U_D = 0{,}7V$

$U_{AB} = ?$

$I_D = ?$

$$Uac = U1.\frac{R2}{R1 + R2} = 15.\frac{10.10^3}{10.10^3 + 10.10^3} = = 7{,}5V$$

$Ri1 = R2||R1 = 5k\Omega$

$Ri1 = R2||R1 = 5k\Omega$

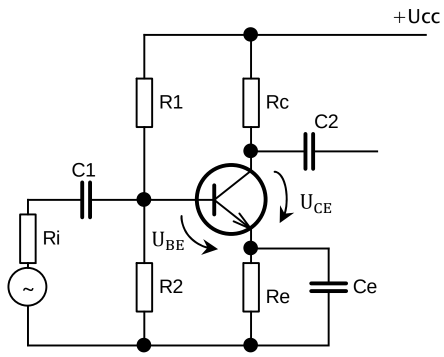
$$Ubc = U2.\frac{R4}{R4 + R3} = 10.\frac{10.10^3}{10.10^3 + 10.10^3} = = 5V$$

$Ri2 = R4||R3 = 5k\Omega$

$U_{AB} = Uac - U_D - Ubc = 7{,}5 - 0{,}7 - 5 = 1{,}8V$

$$I_D = \frac{U_{AB}}{Ri1 + Ri2} = \frac{1{,}8}{10.10^3} = 180\mu A$$

<u>Příklad:</u> můstkové zapojení pro stabilizaci pracovního bodu tranzistoru



$Ucc = 15V$

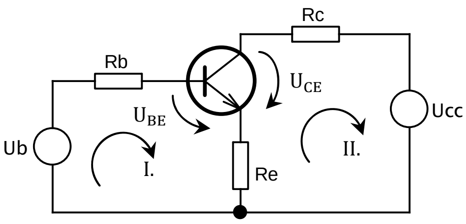
$R1 = 22k\Omega$

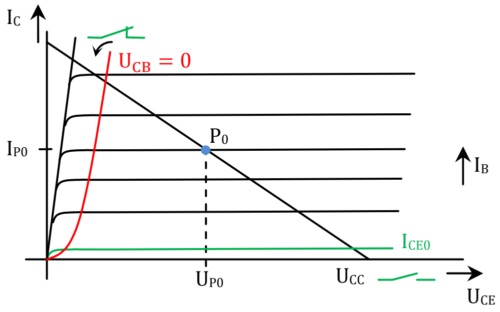
$R2 = 5{,}6k\Omega$

$Re = 1k\Omega$

$Rc = 2{,}3k\Omega$

$\beta = 220$





P_0 – nastavíme stejnosměr. veličinami

I. – bázový (vstupní) obvod
II. – kolektorový (výstupní) obvod

$$Ub = Ucc.\frac{R2}{R1 + R2} = 3{,}04V$$

$$Rb = R1||R2 = \frac{R_1.R_2}{R_1 + R_2} = 4{,}46k\Omega$$

I.:

$$-Ub + Rb.Ib + U_{BE} + Re.Ie = 0$$

$$Ub = Rb.Ib + U_{BE} + Re.Ie$$

$$Ub = Rb.Ib + U_{BE} + Re.(Ib + Ic)$$

$$Ub = Rb.Ib + U_{BE} + Re.(\beta.Ib + Ib)$$

$$Ub = Ib.[Rb + Re.(\beta + 1)] + U_{BE}$$

- obvod lze řešit pomocí VA charakteristiky nebo empiricky. Přechod BE v otevřeném směru Si = 0,7V a Ge = 0,3V.

II.:

$$Ucc - Re.Ie - U_{CE} - Rc.Ic = 0$$

$$Ucc = Re.Ie + U_{CE} + Rc.Ic$$

$$Ucc = Re.(Ic + Ib) + U_{CE} + Rc.Ic$$

$$Ucc = Re.\left(Ic + \frac{Ic}{\beta}\right) + U_{CE} + Rc.Ic$$

$$Ucc = Ic.\left[Re.\left(1 + \frac{1}{\beta}\right) + Rc\right] + U_{CE}$$

$$P_0 = [U_{BE}; U_{CE}; I_C]$$