7.8 Dinamički parametri i model bipolarnog tranzistora

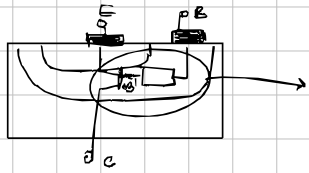
Nelinearni modeli => za režim velikog signala

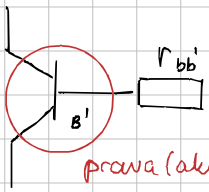
linearni modeli → režim malog signala

Dinamički otpor

Ulazni dinamički otpor $r_{be} = \left.\frac{du_{BE}}{di_B}\right|_{u_{CE}=konst.} = \left.\frac{u_{be}}{i_b}\right|_{u_{ce}=0}$

- $r_{be} = r_{bb'} + r_{b'e}$



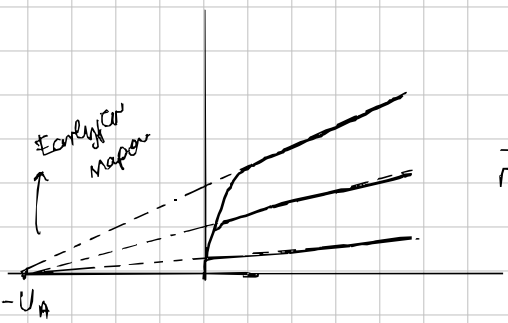


prava (aktivna) baza

din otpor spoja EB

↳ $r_{b'e} = \frac{U_T}{I_B}$

izlazni dinamički otpor $r_{ce} = \left.\frac{du_{CE}}{di_C}\right|_{i_B=konst} = \left.\frac{u_{ce}}{i_c}\right|_{i_b=0}$



$$I_C = \beta I_B \left(1 + \frac{u_{CE}}{U_A}\right)$$

$$\frac{1}{r_{ce}} = \frac{di_C}{du_{CE}} = \frac{i_c}{u_{CE} + U_A}$$

$$r_{CE} = \frac{u_{CE} + U_A}{i_c} \approx \frac{U_A}{i_c}$$

Pojačanja → dinamički faktor strujnog pojačanja

$$h_{fe} = \left.\frac{di_C}{di_B}\right|_{u_{CE}=konst.} = \left.\frac{i_c}{i_b}\right|_{u_{ce}=0} \rightarrow h_{fe} \approx \beta$$

$$\Rightarrow h_{fe} = \left.\frac{\Delta i_C}{\Delta i_B}\right|_{u_{CE}=konst} = \left.\frac{\Delta i_C}{I_{B_2} - I_{B_1}}\right|_{u_{CE}=konst.}$$

Strmina bipolarnog tranzistora

– drugi parametar koji opisuje pojačanje tranzistora

$$g_m = \frac{di_C}{du_{B'E}}\bigg|_{u_{CE}=konst} = \frac{i_c}{u_{b'e}}\bigg|_{u_{ce}=0} \quad \} \text{SZE}$$

$$g_m = \frac{di_C}{du_{B'E}} = \frac{di_C}{di_B} \cdot \frac{di_B}{du_{B'E}} = \frac{h_{fe}}{r_{b'e}}$$

u radnoj točki:

$$g_m \approx \frac{\beta}{\frac{U_T}{I_B}} = \frac{I_C}{U_T}$$

Primjer 7.8.)

$I_{BA} = 50\mu A \longrightarrow$ –||–

$r_{b'e}, r_{ce}, h_{fe}, g_m = ?$ u točki A

$I_{CA} = 8mA$ $\quad I_{CB} = 8.1mA$ $\quad U_A = ?$

$U_{CEA} = 5V$ $\quad U_{CEB} = 10V$ $\quad U_T = 25mV$

$$r_{b'e} = \frac{U_T}{I_{BA}} = \boxed{500\Omega}$$

$$g_m = \frac{I_{CA}}{U_T} = \frac{8 \cdot 10^{-3}}{25 \times 10^{-3}} = \boxed{320mA/V}$$

* za razliku od FET-ova gdje je oko 5mA/V

$$h_{fe} = g_m \cdot r_{b'e} = 320 \cdot 10^{-3} \cdot 500 = \boxed{160}$$

$h_{fe} \approx \beta$

▸ faktor β je $\frac{I_{CA}}{I_{BA}} = \frac{8 \cdot 10^{-3}}{50 \cdot 10^{-6}} \longrightarrow \boxed{\beta = 160}$

$$r_{ce} = \frac{\Delta U_{CE}}{\Delta i_C}\bigg|_{i_B=konst.} = \frac{U_{CEB} - U_{EA}}{I_{CB} - I_{CA}} = \frac{10-5}{(8.1-8)\cdot 10^{-3}} = 50k\Omega$$

$$r_{ce} = \frac{U_{CEA} + U_A}{I_{CA}} = \frac{U_{CEB} + U_A}{I_{CB}} \Longrightarrow U_A = \frac{I_{CA} \cdot U_{CB} - I_{CB} \cdot U_{EA}}{I_{CB} - I_{CA}}$$

$$= \frac{8 \cdot 10 - 8{,}1 \cdot 5}{8.1 - 8} \Rightarrow \boxed{U_A = 395V}$$