

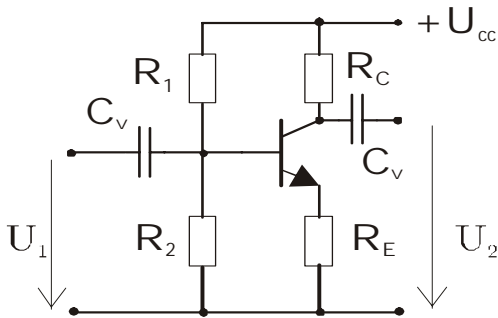
KOMUNIKACIJSKA VEZJA

IZPIT 24.januar 2005

Rešitve nalog

1. Izračunajte ojačenje in spodnjo mejno frekvenco ojačevalnika!

□ Upor R1 nastavite tako, da bo mirovni kolektorski tok transistorja 1mA!



$$\text{Par}(R1, R2) := \frac{R1 \cdot R2}{R1 + R2}$$

$$U_{cc} := 20 \quad U_{be0} := 0.6$$

$$R2 := 2000 \quad R_E := 1000$$

$$R_C := 10000 \quad C_v := 10 \cdot 10^{-6}$$

$$\beta := 100$$

$$I_{e0} := 10^{-3}$$

$$U_B := U_{be0} + I_{e0} \cdot R_E \quad U_B = 1.6$$

$$R1 := \frac{U_{cc} - U_B}{U_B} \cdot R2 \quad R1 = 2.3 \cdot 10^4 \quad R_B := \text{Par}(R1, R2) \quad R_B = 1.84 \cdot 10^3$$

napaka zaradi zanemaritve baznega toka, zato je napetost U_B malenkost manjša:

$$U_{cc} \cdot \frac{R2}{R1 + R2} - R_B \cdot \frac{I_{e0}}{\beta + 1} = 1.582$$

potencial kolektorja: $U_{cc} - R_C \cdot I_{e0} = 10$

parametri NF modela
bipolarnega transistorja:

$$g_m := 40 \cdot I_{e0} \quad r_{be} := \frac{\beta}{g_m}$$

$$g_m = 0.04 \quad r_{be} = 2.5 \cdot 10^3$$

ojačenje :

$$A_{sf} := -g_m \cdot R_C \cdot \frac{r_{be}}{r_{be} + R_E \cdot (\beta + 1)} \quad A_{sf} = -9.662$$

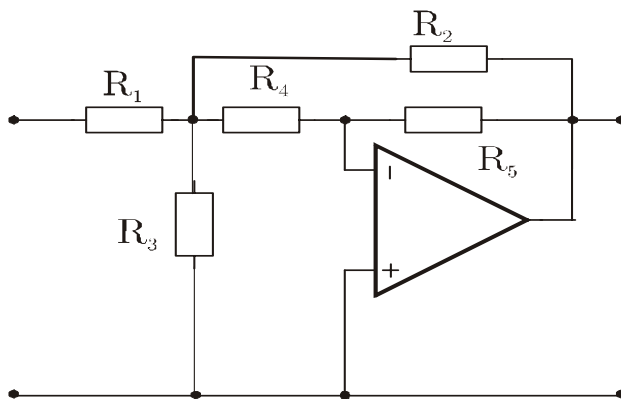
$$20 \cdot \log(|A_{sf}|) = 19.701$$

spodnja mejna frekvenca:

$$R_{nv} := \text{Par}(R_B, R_E \cdot (\beta + 1) + r_{be}) \quad R_{nv} = 1.808 \cdot 10^3$$

$$f_{sp} := \frac{1}{2 \cdot \pi \cdot C_v \cdot R_{nv}} \quad f_{sp} = 8.803$$

2. Izračunajte natančno napetostno ojačenje vezave na sliki !



$R1 := 1000$
 $R2 := 50000$
 $R3 := 10000$
 $R4 := 2000$
 $R5 := 500000$
 $A0 := 1000$

ojačenje in vhodna upornost sklopa R4,R5, A:

$$RM5 := \frac{R5}{1 + A0} \quad A\beta1 := -\frac{RM5}{R4 + RM5} \cdot A0 \quad A\beta1 = -199.84$$

$$Rvh1 := R4 + RM5 \quad Rvh1 = 2.5 \cdot 10^3$$

ojačenje sklopa R1, R2, R3, Rvh1, Aβ1:

$$Rnad3 := \text{Par}(R3, Rvh1)$$

$$Aoz := \frac{\text{Par}(R2, Rnad3)}{R1 + \text{Par}(R2, Rnad3)} \cdot A\beta1 \quad Aoz = -131.467$$

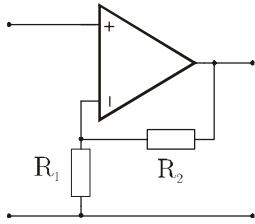
$$T := -\left[\frac{\text{Par}(R1, Rnad3)}{(R2 + \text{Par}(R1, Rnad3))} \cdot A\beta1 \right] \quad T = 2.629 \quad A\beta := \frac{Aoz}{1 + T} \quad A\beta = -36.223$$

rešitev z uporabo Millerjeve transformacije R2:

$$RM2 := \frac{R2}{1 - A\beta1} \quad RM2 = 248.954$$

$$A\beta := \frac{\text{Par}(RM2, Rnad3)}{(R1 + \text{Par}(RM2, Rnad3))} \cdot A\beta1 \quad A\beta = -36.223$$

3. Izračunajte fazno varnost in pasovno širino ojačevalnika !



$$A_0 := 10^5 \quad 20 \cdot \log(A_0) = 100$$

$$f_{p1} := 300 \quad f_{p2} := 10^6 \quad R_1 := 10000 \quad R_2 := 90000$$

$$T_0 := A_0 \cdot \frac{R_1}{R_1 + R_2} \quad T_0 = 1 \cdot 10^4$$

mejna frekvenca je v 3. segmentu, $f_{zg} > f_{p2}$: $T_0 \cdot f_{p1} = 3 \cdot 10^6$

$$f_{zg} := \sqrt{T_0 \cdot f_{p1} \cdot f_{p2}} \quad f_{zg} = 1.732 \cdot 10^6 \quad B := f_{zg} \quad B = 1.732 \cdot 10^6$$

natančni zasuk faze zančnega ojačenja T:

$$\arg T := - \left(\frac{180}{\pi} \cdot \operatorname{atan} \left(\frac{f_{zg}}{f_{p1}} \right) + \frac{180}{\pi} \cdot \operatorname{atan} \left(\frac{f_{zg}}{f_{p2}} \right) \right) \quad \arg T = -149.99$$

približek:

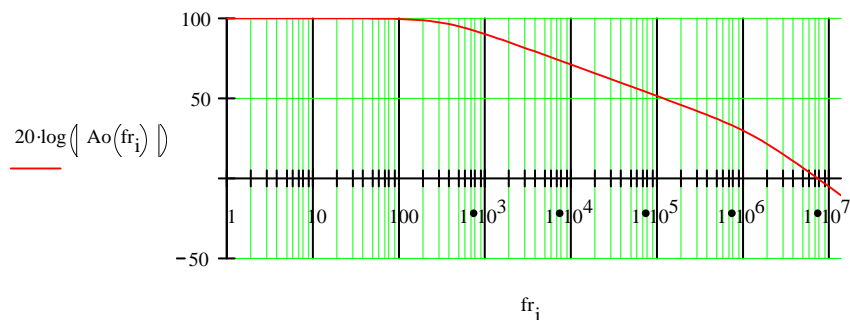
$$\arg T := -90 - \frac{180}{\pi} \cdot \operatorname{atan} \left(\frac{f_{zg}}{f_{p2}} \right) \quad \arg T = -150$$

fazna varnost, fazni razloček: $\Phi_M := 180 + \arg T$ $\Phi_M = 30$

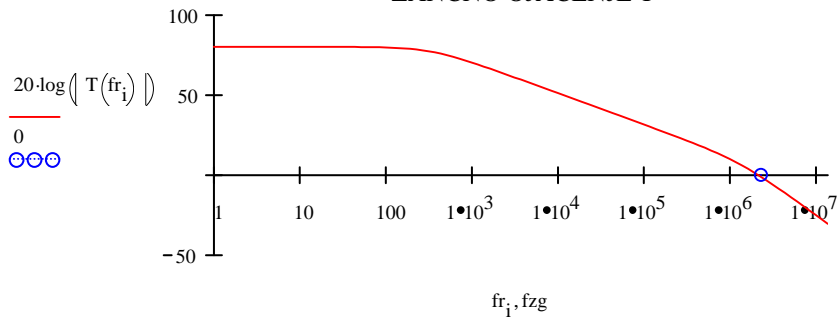
DODATEK : frekvenčni poteki zančnega ojačenja T in ojačenja $A\beta$:

$$A_o(f) := A_0 \cdot \frac{1}{1 + j \cdot \frac{f}{f_{p1}}} \cdot \frac{1}{1 + j \cdot \frac{f}{f_{p2}}} \quad A_{oz}(f) := A_o(f) \quad T(f) := A_o(f) \cdot \frac{R_1}{R_1 + R_2}$$

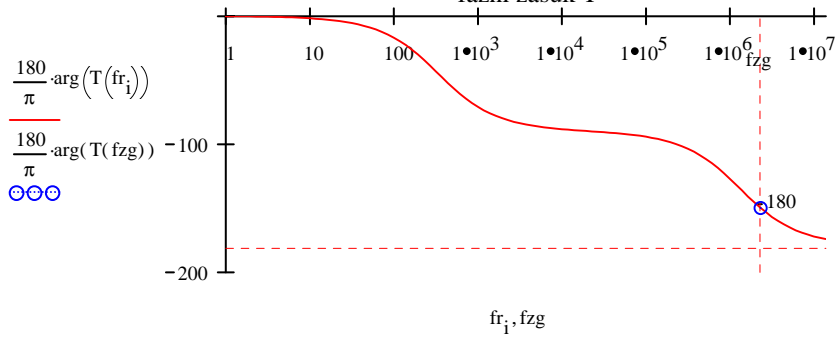
$$i := 0..100 \quad f_{r_i} := 10^{\frac{i}{100} \cdot 7}$$



ZANCNO OJACENJE T

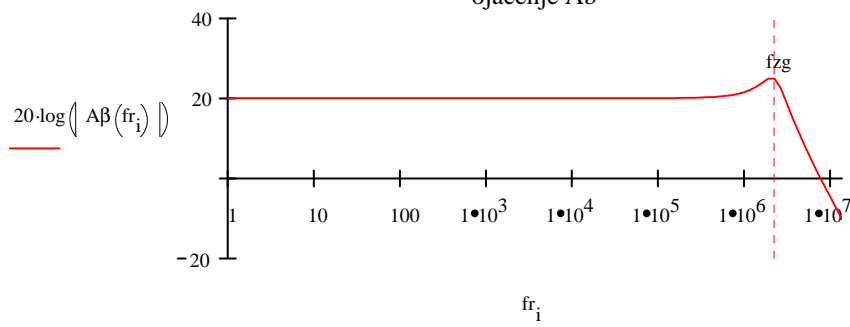


fazni zasuk T



dejanski potek ojačenja $A\beta$ kaže prevzpon: $A\beta(f) := \frac{A_{oz}(f)}{1 + T(f)}$

ojacenje Ab



prevzpon ojačenja $A\beta$ se zmanjša, če povečamo fazno varnost!