HW #08

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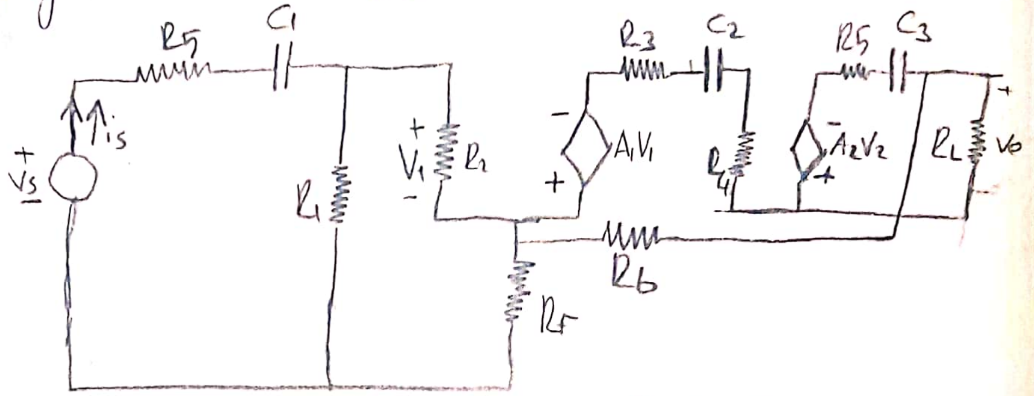
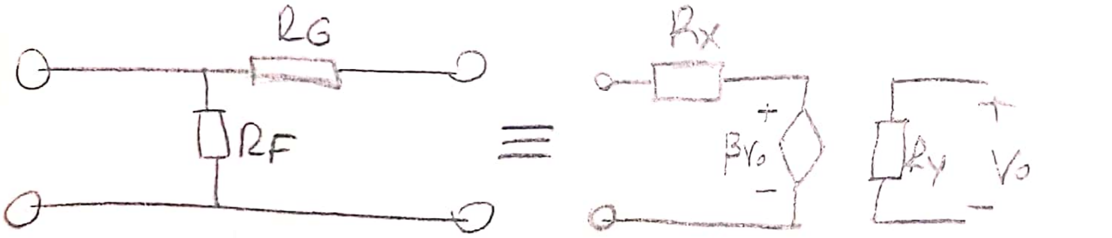
Q1 : The feedback amplifier in Fig P.10.13 has $A_1 = 50$ $A_2 = 60$, $R_s = 500\Omega$, $R_1 = 15k\Omega$, $R_2 = 1.5k\Omega$, $R_3 = 250\Omega$, $R_4 = 1.5k\Omega$, $R_5 = 250\Omega$, $R_6 = 2k\Omega$, $R_L = 4.7k\Omega$, $R_F = 500\Omega$ $C_1 = C_2 = C_3 = 0.1\mu F$ and $V_s = 100mV$. Determine (a) the input resistance $R_{if} = V_s/i_s$ (b) the output resistance R_{of}, and (c) the overall voltage gain of $A_f = V_o/V_s$. Assume C_1, C_2 and C_3 are shorted at the operating frequency



Öncelikle bu bir voltage amplifier olduğundan voltage-series feedback yapılacak

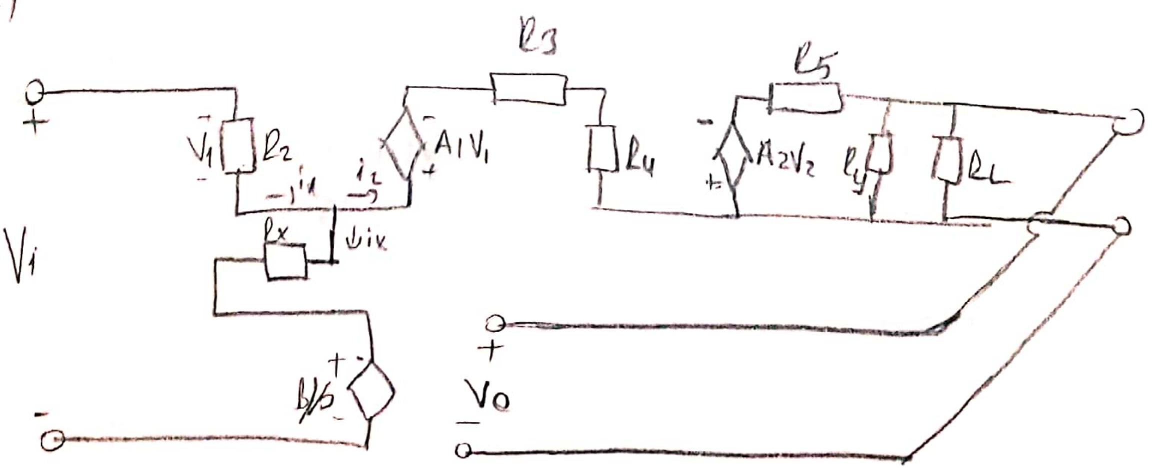


$R_x = R_F \parallel R_G$

$R_y = R_F + R_G$

$\beta = \dfrac{R_F}{R_F + R_G}$

V.A.fl Şematiği (Feedback-Loaded voltage Amplifier and the idealized feedback network)



VA.fl analizi $\beta = 0$ için (Amaç: $\frac{V_1}{V_i} = ?$ $\frac{V_2}{V_i} = ?$ $\frac{V_i}{i_1} = ?$)

Mesh analysis

$$V_i - V_1 - A_1 V_1 - (R_3 + R_4) i_2 = 0$$
$$V_i - V_1 - i_x R_x = 0$$

Node Analysis

$$i_1 = i_2 + i_x$$
$$V_1 = i_1 . R_2$$
$$V_2 = i_2 . R_4$$

$$V_i = (1 + A_1) V_1 + (R_3 + R_4) i_2$$

$$\frac{V_1}{R_2} = i_2 + i_x \qquad \frac{V_i - V_1}{R_x} = i_x$$

$$V_i \left[1 + \frac{R_3 + R_4}{R_x} \right] = V_1 \left[1 + A_1 + \frac{R_3 R_4}{R_2 \| R_x} \right]$$

$$\Rightarrow \boxed{\frac{V_1}{V_i} = \frac{\left[1 + \frac{R_3 + R_4}{R_x} \right]}{\left[(1 + A_1) + \left(\frac{R_3 + R_4}{R_2 \| R_x} \right) \right]}} \;\star$$

$$\frac{V_1}{V_i} = \frac{i_1 R_2}{V_i} \longrightarrow \boxed{\frac{V_1}{i_1} = \frac{V_i}{V_i} . R_2}$$

$$\frac{V_i}{V_1} = \left(\frac{V_1}{V_i} \right)^{-1} \longrightarrow \boxed{\frac{V_i}{i_1} = R_2 . \frac{\left[(1 + A_1) + \left(\frac{R_3 + R_4}{R_2 \| R_x} \right) \right]}{\left[1 + \frac{R_3 + R_4}{R_x} \right]}} \;\star$$

$$\frac{V_2}{V_i} = \frac{R_4 i_2}{V_i} = \frac{R_4}{V_i} \left[\frac{V_1}{R_2} - \frac{V_i - V_1}{R_x} \right] \longleftarrow \quad i_2 = \left[\frac{V_1}{R_2} - \frac{V_i - V_1}{R_x} \right]$$

$$= \frac{R_4}{V_i} \left[\frac{V_1}{R_2 \| R_x} - \frac{V_i}{R_x} \right] \qquad \longrightarrow \underbrace{\frac{V_1}{R_2} + \frac{V_1}{R_x}}_{} - \frac{V_i}{R_x}$$

$$= \frac{R_4}{V_i} . \frac{V_1}{R_2 \| R_x} - \frac{R_4 . \cancel{V_i}}{\cancel{V_i} . R_x} \qquad \boxed{\frac{V_1}{R_2 \| R_x} - \frac{V_i}{R_x}}$$

$$\frac{V_2}{V_i} = \frac{R_4}{R_2 \| R_x} \cdot \underbrace{\left[\frac{\left[1 + \frac{R_3 + R_4}{R_x}\right]}{\left[(1+A_1) + \left(\frac{R_3+R_4}{R_2 \| R_x}\right)\right]} \right]}_{\frac{V_1}{V_i}} - \frac{R_4}{R_x} < 0$$

$R_4 = 1{,}5k\Omega$

$R_2 = 1{,}5k\Omega$

$R_3 = 250\Omega$

$A_1 = 50$

R_x

$$\approx \frac{1.5k}{1.5k \| R_x} \cdot \left[\frac{1 + \frac{1750}{R_x}}{51 + \frac{1750}{1.5k \| R_x}} \right] < \frac{1.5k}{R_x} < 0$$

$$\Rightarrow \frac{\cancel{1500} \cdot (1500 + R_x)}{1500 \cancel{R_x}} \cdot \left[\frac{\frac{R_x + 1750}{R_x}}{51 + \frac{1750(1500 + R_x)}{1500 R_x}} \right] < \frac{\cancel{1500}}{\cancel{R_x}}$$

$$= \frac{(1500 + R_x)}{\cancel{1500}} \cdot \left[\frac{(R_x + 1750) \cdot \cancel{1500 R_x}}{\cancel{R_x} \cdot ((51 \cdot 1500 R_x) + 1750(1500 + R_x))} \right] < 1$$

$$= \frac{(1500 + R_x)(1750 + R_x)}{76500 R_x + 2{,}625 \times 10^6 + 1750 R_x} < 1$$

$$= (R_x)^2 + 3250 R_x + \cancel{2{,}625 \times 10^6} < \cancel{2{,}625 \times 10^6} + 78250 R_x$$

$$= (R_x)^2 - 75000 R_x < 0$$

$$(R_x) \cdot (R_x - 75000) < 0$$

$0 < R_x < 75k\Omega$ için

$\frac{V_2}{V_i} < 0$ olduğu belirlenmiştir.

$$\frac{V_o}{V_2} = (-A_2)\,\frac{R_y \| R_L}{R_y \| R_L + R_5} < 0 \text{ if } A_2 > 0$$

then

$$\frac{V_o}{V_i} = \frac{V_2}{V_i} \cdot \frac{V_o}{V_2} = A_{VA,fl}$$

$$A_{VA,fl} = \underbrace{\left[\frac{R_4}{R_2 \| R_x} \cdot \left[\frac{\left(1 + \frac{R_3+R_4}{R_x}\right)}{(1+A_1) + \left(\frac{R_3+R_4}{R_2 \| R_x}\right)} \right] - \frac{R_4}{R_x} \right]}_{<0} \cdot \underbrace{(-A_2)\,\frac{R_y \| R_L}{R_y \| R_L + R_5}}_{<0}$$

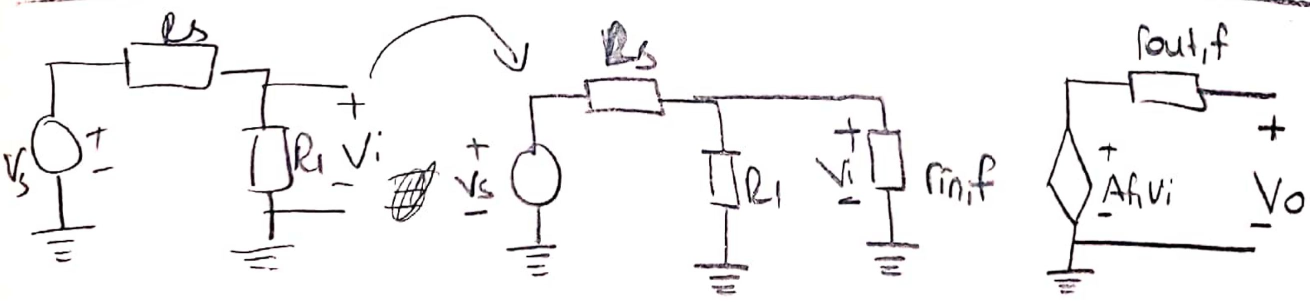
$$A_{VA,fl} > 0$$

$$r_{out,VA,fl} = R_5 \| R_y \| R_L$$

Teorik formüller

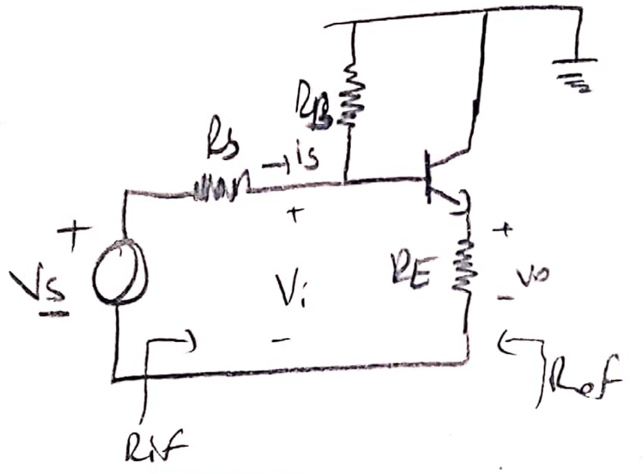
$$A_f = \frac{A_{VA,fl}}{1 + \beta A_{VA,fl}}, \quad r_{in,f} = (1 + \beta A_{VA,fl})\, r_{in,VA,fl}$$

$$r_{out,f} = \frac{r_{out,VA,fl}}{1 + \beta A_{VA,fl}}$$



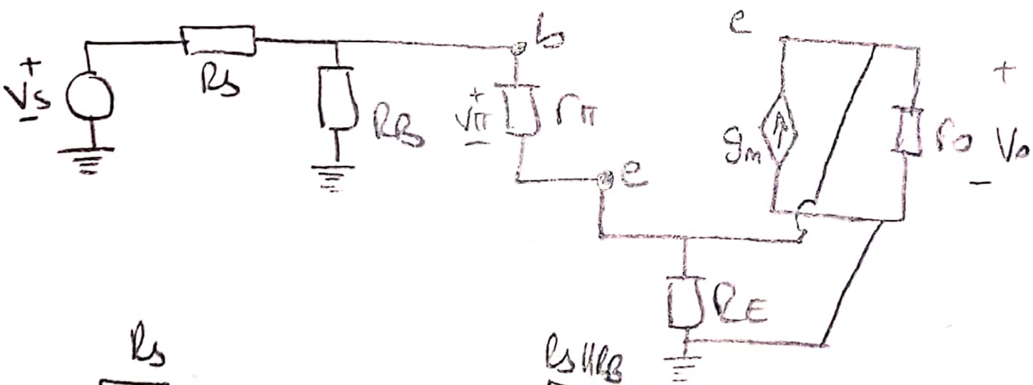
$$\frac{V_o}{V_s} = \frac{r_{in,f} \| R_1}{r_{in,f} \| R_1 + R_s} \cdot A_f$$

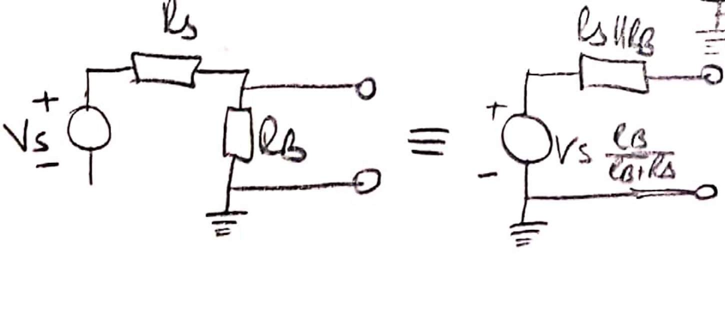
Q2) The emitter follower in Fig P.10.18 has $R_B = 75k\Omega$, $R_E = 750\Omega$, $R_L = 1k\Omega$ and $R_s = 250\Omega$. The transistor parameters are $h_{fe} = 150$, $r_\pi = 250$, and $r_o = +\infty$. Use the techniques of feedback analysis to calculate. Draw a block diagram of the feedback mechanism. (a) input resistance (b) the output resistance R_{of}, and (c) the close loop voltage gain A_f.



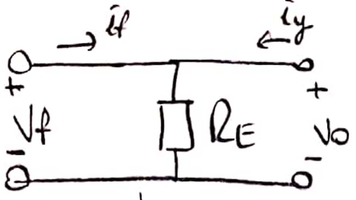
→ small signal eşdeğeri çiz.
→ Voltage amp. için voltage-series feedback. parametrelerini bul.
→ Feedback network olmadan analizi gerçekleştir. direct amplifier için sonuç bul.
→ feedback network ile parametreler bul.

Small signal, eşdeğeri





Feedback network analizi



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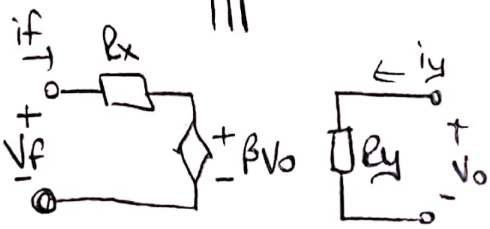
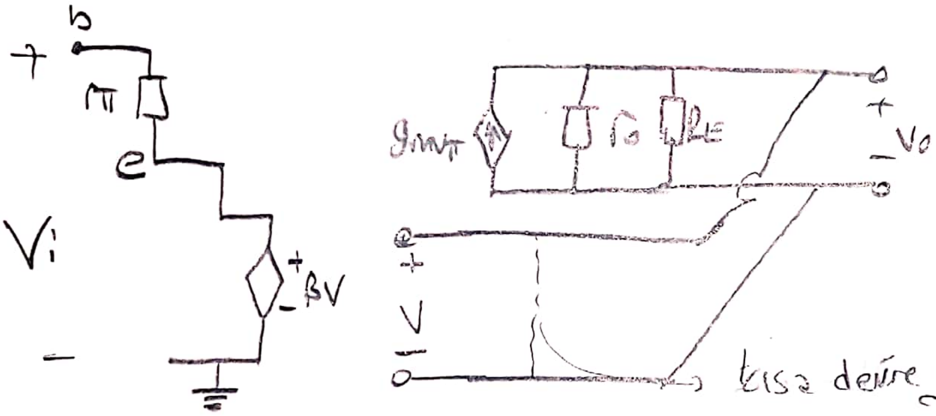


$$\beta = \frac{V_f}{V_o}\Big|_{i_f=0} = 1 \qquad R_y = \frac{V_o}{i_y}\Big|_{i_f=0} = R_E$$

$$R_x = \frac{V_F}{i_f}\Big|_{v_o=0} = 0$$



kısa devre yapılarak $v=0$ $\beta v=0$

(Analiz için) $v_i = v_\pi$ sağlanır

$$A_{VA,fl} = g_m(r_o \| R_E)$$

$$r_{in,VA,fl} = r_\pi$$

$$r_{out,VA,fl} = r_o \| R_E$$

$\beta = 1$ için

$$A_f = \frac{A_{VA,fl}}{1 + A_{VA,fl} \cdot \beta} \quad \text{eq.1}$$

$$r_{in,f} = r_{in,VA,fl}(1 + A_{VA,fl}\beta) \quad \text{eq.2}$$

$$r_{out,f} = \frac{r_{out,VA,fl}}{1 + A_{VA,fl} \cdot \beta} \quad \text{eq.3}$$

eq.1

$$A_f = \frac{g_m(r_o \| R_E)}{1 + g_m(r_o \| R_E)}$$

eq.2

$$r_{in,f} = r_\pi(1 + g_m(r_o \| R_E))$$

eq.3

$$r_{out,f} = \frac{r_o \| R_E}{1 + g_m(r_o \| R_E)}$$

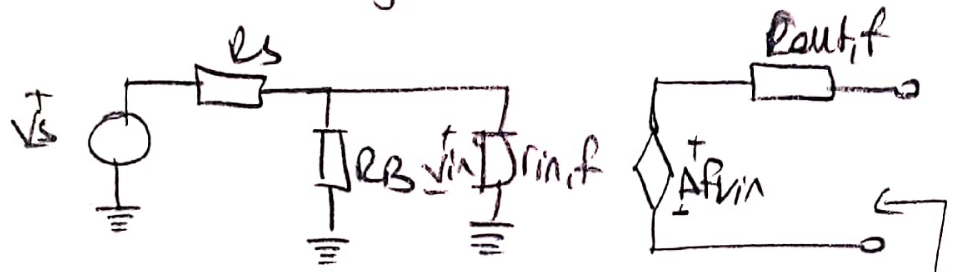
$r_o \gg R_E$ için

$$\boxed{A_f = \frac{g_m R_E}{1 + g_m R_E}}$$

$$\boxed{r_{in,f} = r_\pi(1 + g_m R_E)}$$

$$\boxed{r_{out,f} = \frac{R_E}{1 + g_m R_E}}$$

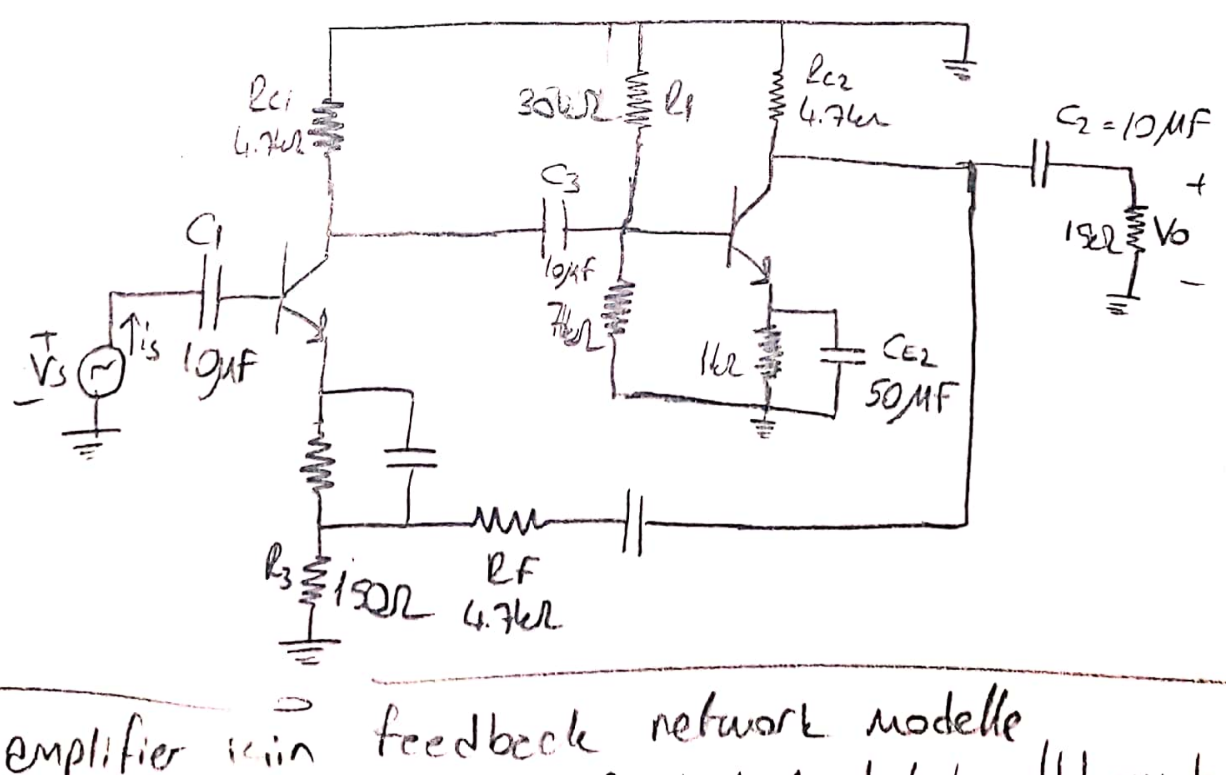
feedback başlı hali analizi



rout,f $V_s = 0$ için

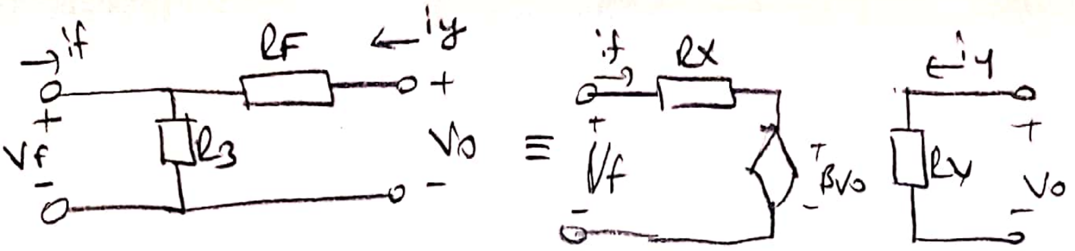
$$A_{realized} = \frac{r_{in,f} \parallel R_B}{r_{in,f} \parallel R_B + R_S} \cdot A_f$$

Q3: Use the techniques of feedback analysis to calculate the input resistance R_{if}, the output resistance R_{of}, and the closed loop voltage gain of A_f of the amplifier in Fig P 10.19. The transistor parameters are $h_{fe} = h_{fe1} = h_{fe2} = 104$, $r_{\pi 1} = r_{\pi 2} = 250\Omega$, $r_o = 1.5k\Omega$, $r_\mu = +\infty$



→ Voltage amplifier için feedback network modelle
→ direct amplifier parametrelerinin feedback loaded karşılıklarını bulmak için $V_{A,fl}$ kur.
→ Kurulan $V_{A,fl}$'yi analiz ederek $A_{VA,fl}$, $r_{inVA,fl}$ ve $r_{outVA,fl}$ bul.
→ Devrenin tümünü analiz et $A_f = \frac{A_{VA,fl}}{1+\beta A_{VA,fl}}$, $r_{in,f} = r_{in,VA,fl} \cdot (1+\beta A_{VA,fl})$

$$r_{out,f} = \frac{r_{out,VA,f}}{1+\beta A_{VA,fl}}$$



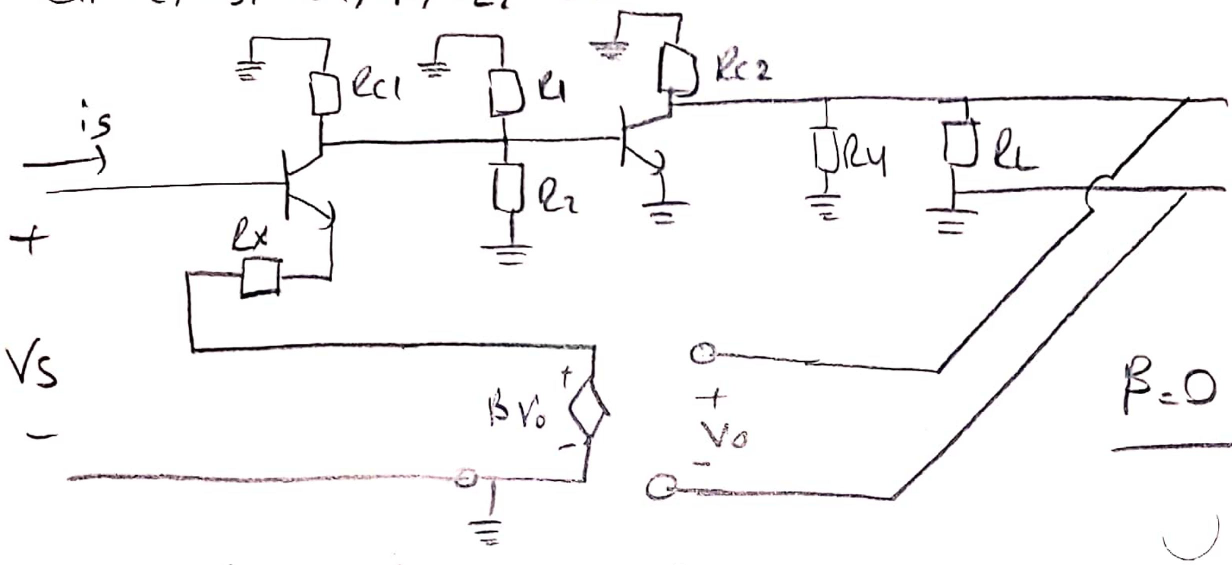
$R_y = R_3 + R_F$

$R_x = R_3 // R_F$

$\beta = \dfrac{R_3}{R_3 + R_F}$

feedback network Schematic

$C_1, C_2, C_3, C_{E1}, C_F, C_{E2}$ kısa devre



$\beta = 0$ zyark

$$r_{in,VA,fl} = \frac{V_s}{i_s}\Big|_{i_o=0} = r_{\pi 1}(1 + g_{m1} R_x)$$

$$A_{VA,fl} = \frac{V_o}{V_s}\Big|_{i_o=0} = \left[\frac{-g_{m1}}{1+g_{m1}R_x}\right]\left[R_{C1} // R_1 // R_2 // r_{\pi 2} // [r_{o1}(1+g_{m1}R_x]\right] \cdot$$

$$\cdot \left[-g_{m2}\right]\left[R_{C2} // r_{o2} // R_y // R_L\right]$$

$R_{in,C1} = (r_{\pi 1} // R_x)(1 + g_{m1} R_o)$

$R_{out,b2} = R_1 // R_2 // R_{C1} // R_{in,C1}$

$r_{out,VA,fl} = R_{C2} // R_y // R_L // r_o$

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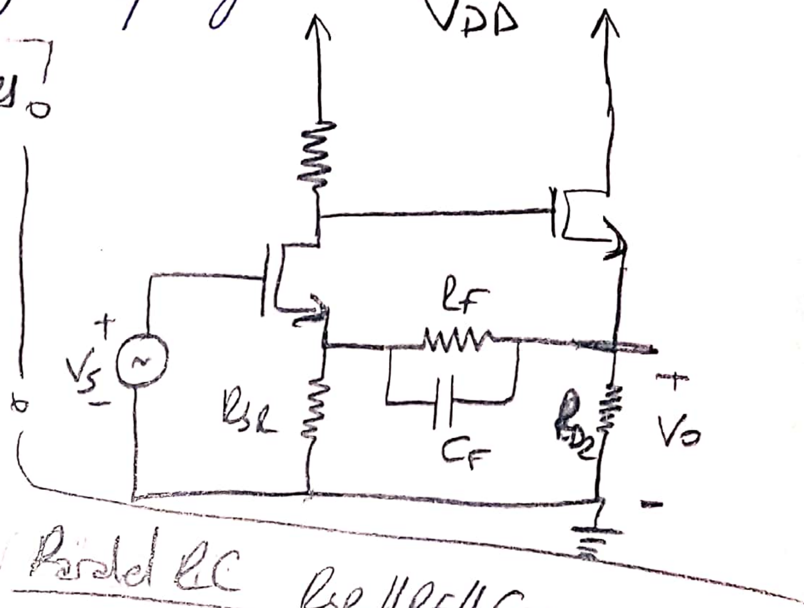
feedback network ile analiz

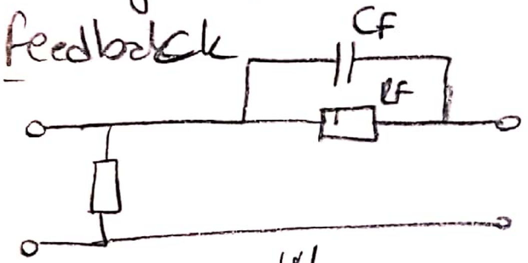
$\beta = \dfrac{R_3}{R_3 + R_F}$ $\quad A_f = \dfrac{A_{VA,fl}}{1 + \beta V_{A,fl}}$ $\quad , r_{in,f} = r_{in,VA,fl}(1 + \beta A_{VA,fl})$

$r_{out,f} = \dfrac{r_{out,VA,fl}}{1 + \beta A_{VA,fl}}$

Q4. The MOS Amplifier shown in fig P10.22 is biased to have the following small-signal MOS parameters: $g_{m1} = 1.2\,mA/V$, $r_{o1} = 25k\Omega$, $g_{m2} = 1.6\,mA/V$, and $r_{o1} = 25k\Omega$. If $R_{D1} = 1.5k\Omega$, then $R_{D2} = 1k\Omega$, $R_{SR} = 500\Omega$, $R_F = 5k\Omega$ and $C_F = 20pF$. Determine (a) the voltage gain without feedback $A = V_o/V_s$, (b) the voltage gain with feedback A_f and (c) the feedback capacitor C_F to limit the high frequency $f_H = 50kHz$



Voltage amp. ise voltage-series feedback



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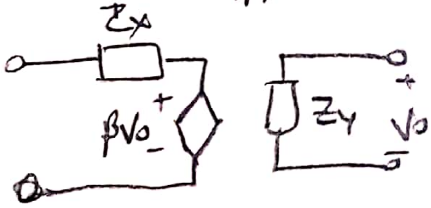


$Z_x =$ Paralel RC $R_{SR} \| R_F \| C_F$

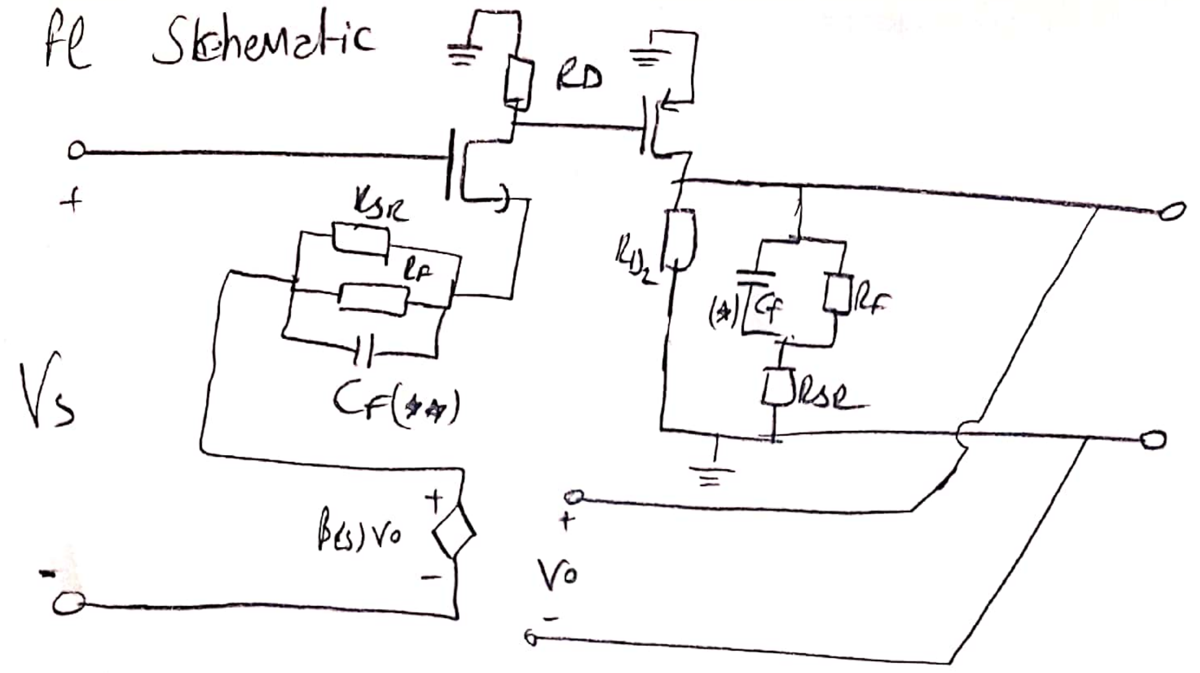
$Z_y =$ $\|$ $R_{SR} + (R_F \| C_F)$

$$\beta_S = \frac{R_{SR}}{R_{SR} + \dfrac{R_F \cdot \frac{1}{sC_F}}{R_F + \frac{1}{sC_F}}} = \frac{R_{SR}}{R_{SR} + \dfrac{R_F}{1 + sR_FC_F}} = \frac{R_{SR}(1 + sR_FC_F)}{R_F + R_{SR} + sR_FC_FR_{SR}}$$

$$= \underbrace{\frac{R_{SR}}{R_F + R_{SR}}}_{\beta} \cdot \left[\frac{1 + \dfrac{s}{1/R_FC_F \rightarrow W_z}}{1 + \dfrac{s}{\underbrace{1/C_FR_F \cdot \frac{R_{SR}}{R_F + R_{SR}}}_{W_p}}} \right]$$

$$\beta_S = \beta_o \left(\frac{1 + \frac{s}{W_z}}{1 + \frac{s}{1/W_p}} \right)$$

fl Skhematic



(**) $C_F = C_1$

$R_1 = R_{SR} \| R_F \| \left[\frac{R_{D1} + r_{o1}}{1 + g_{m1} r_{o1}} \right]$

$r_{o1} >> R_{D1}$

$g_{m} r_{o1} >> 1$

$\boxed{R_1 = \frac{r_{o1}}{g_{m1} r_{o1}} = \frac{1}{g_{m1}}}$

$\tau_1 = R_1 . C_1$

$\tau_1 = \left(\frac{1}{g_{m1}} \| R_{SR} \| R_F \right) . C_1 =$

$R_{SR} << R_F$

$\tau_1 = 71.43 . 20 \times 10^{-12} = 1.428 \times 10^{-9} F$

$\boxed{\tau_1 = 1.428 \times 10^{-9}}$

(*) $C_2 = C_F$

$R_2 = R_F \| [R_{SR} + r_{o2} \| R_{D2}]$

$r_{o2} >> R_{D2}$

$R_2 = R_F \| [R_{SR} + R_{D2}]$

$\tau_2 = R_2 . C_2$

$R_2 = 5k\Omega \| [500 + 1k\Omega]$

$\boxed{R_2 = 1153.84 \Omega}$

$\tau_2 = 1153.84 . \underbrace{20 \times 10^{-12}}_{C_2 = C_F}$

$R_F = 5k\Omega$

$R_{D2} = 1k\Omega$

$R_{SR} = 500\Omega$

$\boxed{\tau_2 = 2.307 \times 10^{-8}}$

$\boxed{W_H = \frac{1}{\tau_1 + \tau_2} = 40.935 \times 10^6}$

$\boxed{\tau_2 >> \tau_1}$ $23.07 >> 1.428$

$\beta(s)=0$ için $R_x = R_{SR} // R_F$ and $R_y = R_F + R_{SR}$

$$A_{VA,fl} = \left[\frac{-g_{m1}}{1+g_{m1}R_x}\right] \cdot \left[R_{D1} // \left[(1+g_{m1}R_x) \cdot r_{o1}\right]\right] \cdot \left[-g_{m2}\right] \cdot$$
$$\cdot \left[R_{D2} // R_y // r_{o2}\right]$$

$r_{in,VA,fl} = +\infty$

$$r_{out,VA,fl} = R_{D2} // R_y // \underbrace{r_{o2}}_{+\infty} = R_{D2} // R_y$$

$$r_{in,f} = r_{in,VA,fl} \cdot (1 + A_{VA,fl}\beta) = +\infty$$

$$r_{out,f} = \frac{r_{out,VA,fl}}{1 + A_{VA,fl} \cdot \beta} = \frac{R_{D2} // R_y}{1 + A_{VA,fl}\beta}$$

$$A_{VA,fl}(j\omega) = \frac{A_{VA,fl}}{1 + \frac{j\omega}{\omega_H}} \quad , \quad \omega_H = 40.93 \times 10^6$$

$$\beta(j\omega) = \beta \left[\frac{\left(1 + \frac{j\omega}{\omega_z}\right)}{1 + \frac{j\omega}{\omega_p}}\right]$$

$$A_f(j\omega) = \frac{A_{VA,fl}(j\omega)}{1 + \beta(j\omega) \cdot A_{VA,fl}(j\omega)} = \frac{\frac{A_{VA,fl}}{1 + \frac{j\omega}{\omega_H}}}{1 + \frac{A_{VA,fl}}{1 + \frac{j\omega}{\omega_H}} \cdot \beta \cdot \frac{1 + \frac{j\omega}{\omega_z}}{1 + \frac{j\omega}{\omega_p}}}$$

$$= \frac{A_{VA,fl}\left(1 + \frac{j\omega}{\omega_p}\right)}{1 + \frac{j\omega}{\omega_H} + \frac{j\omega}{\omega_p} + \beta A_{VA,fl} + \frac{\frac{j\omega}{\omega_z}}{\beta A_{VA,fl}}}$$

$$A_f(j\omega) = \frac{A_{VA,fl}}{1 + \beta A_{VA,fl}} \cdot \frac{1 + \frac{j\omega}{\omega_p}}{1 + \frac{j\omega}{\left(\omega_H // \omega_p // \frac{\omega_z}{A_{VA,fl} \cdot \beta}\right) \cdot \left(1 + A_{VA,fl}\beta\right)}}$$

Af(jw) has a zero and a pole approximately

$$W_P = \frac{1}{C_F R_F \frac{R_{SR}}{R_{SR}+R_F}} \qquad \frac{R_{SR}}{R_F} = \frac{1}{10} \qquad W_P = \frac{11}{C_F R_F} = 11 W_Z$$

$A_{VA,fl}\,\beta > 0$

$$A_{VA,fl} = \left[\frac{-1.2mS}{1+(1.2mS).(0.5k//5k)}\right] \cdot \left[1.5k // \left[25k(1+(1.2mS).(0.5k//5k)\right]\right]$$

$\approx 1.5k\Omega$

$$\cdot\,[-1.6mS] \cdot [1k // 5.5k // +\infty]$$

$\approx 0.9k$

$$A_{VA,fl} = (-0.75mS).(1.5k).(-1.6mS).0.5k = 1.620$$

$$A_{VA,fl}.\beta = 0.15 \qquad \frac{0.15}{\beta} = 1.620 \qquad \beta = 0.092 \approx \frac{1}{11}$$

$$\frac{W_Z}{A_{VA,fl}\beta} = \frac{W_Z}{0.15} = \frac{W_P}{11.(0.15)} = \frac{W_P}{1.65}$$

$$W_P = \frac{1}{C_F.5k.\frac{1}{11}} = \frac{1}{454.5 \times C_F} = \frac{1}{110.01 \times 10^6}$$

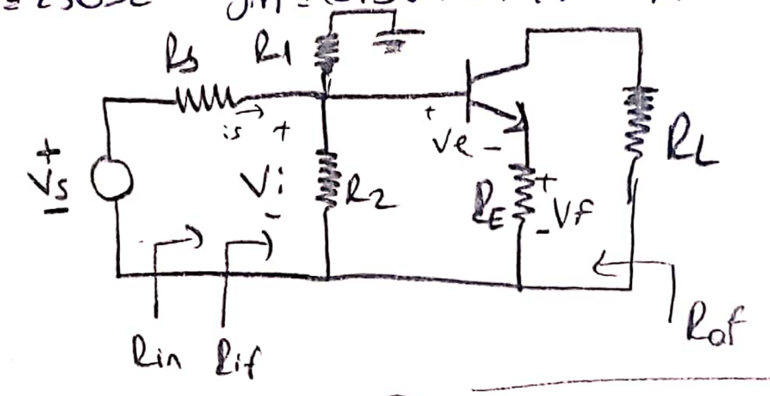
$$\frac{W_Z}{A_{VA,fl}.\beta} = \frac{W_P}{1.65} = 66.673 \times 10^6 = \frac{W_Z}{A_{VA,fl}.\beta}$$

$$A_f(jw) = \frac{1.62}{1.15} \cdot \frac{1 + \frac{jw}{\frac{1}{C_F(454.5)}}}{1 + \frac{jw}{\left[\frac{1}{(C_F.1454.5)} // \frac{1}{C_F.454.5} // \frac{1}{C_F.720}\right]}}$$

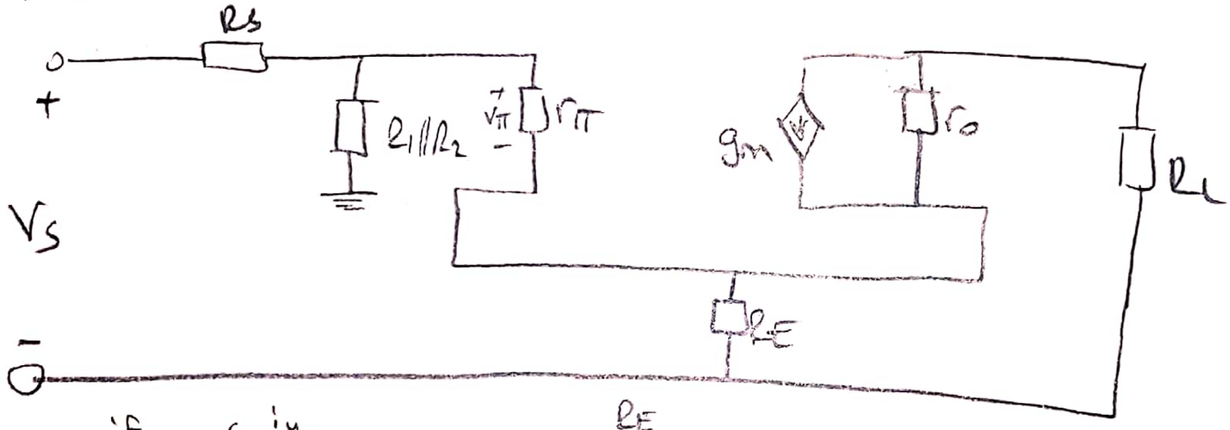
$$W_{H,f} = \frac{1.15}{C_F.(2.62)} = \frac{1}{C_F.2.28k} = 2\pi\,(50kHz)$$

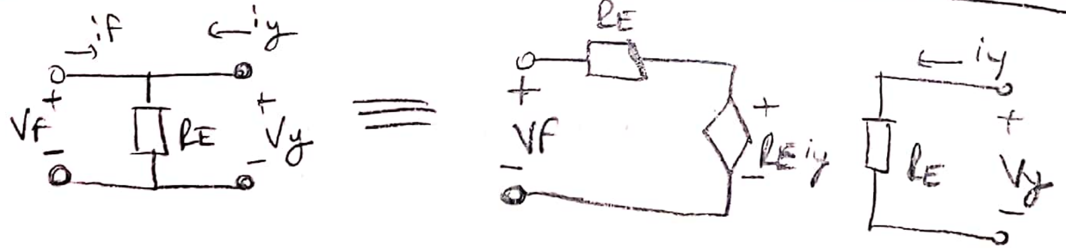
Q5. Use the techniques of feedback analysis to determine the input and output resistance of the CE transistor amplifier in Fig P10.26

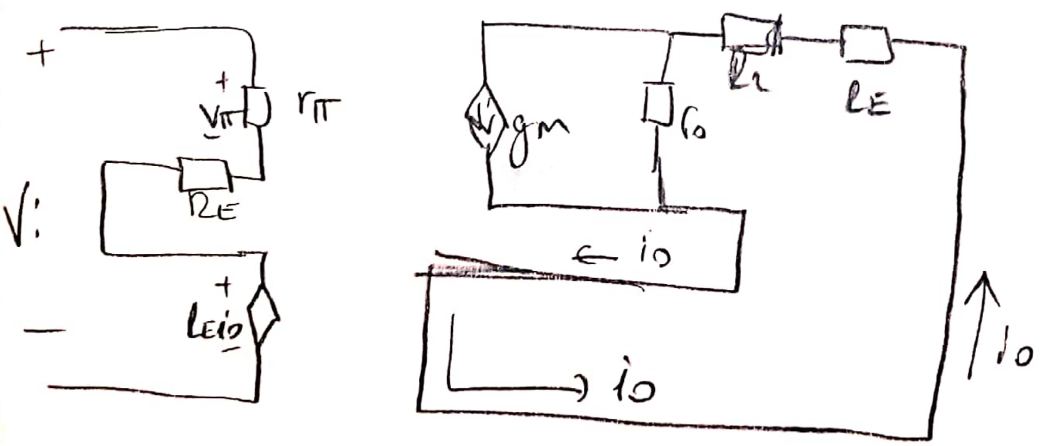
The circuit parameters are $R_S = 500\Omega$, $R_E = 250\Omega$, $R_2 = 15k\Omega$, $R_1 = 5k\Omega$, $R_C = 5k\Omega$ and $R_L = 10k\Omega$. The π model parameters are $r_o = 25k\Omega$, $h_{fe} = 150$, $r_\pi = 250\Omega$, $g_m = 0.3876\ A/V$, $r_M = \infty$



feedback network schematic







$\beta = 0$

$r_{in,TCA,fl} = r_\pi + R_E$

$$A_{TCA,fl} = \frac{r_\pi}{r_\pi + R_E} \cdot g_m \cdot \frac{r_o}{r_o + R_L + R_E}$$

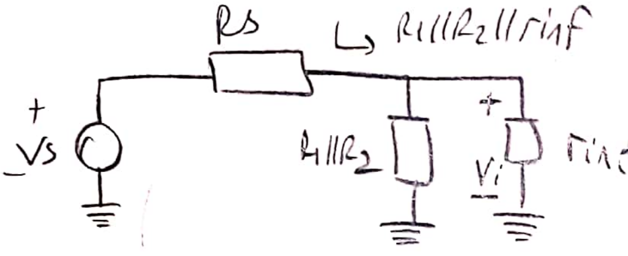
$$r_{out,TCA,fl} = r_o + R_L + R_E \qquad r_{in,TCA} = r_\pi + R_E$$

Tüm devre analizi:

$$r_{in,f} = r_{in,TCA,fl}\left(1 + \beta A_{TCA,fl}\right)$$

$$r_{out,f} = r_{out,TCA,fl}\left(1 + \beta A_{TCA,fl}\right)$$

$$A_f = \frac{A_{TCA,fl}}{1 + \beta A_{TCA,fl}}$$



$$\boxed{r_{in,TCA} = 250\Omega + 250 = 0.5k\Omega}$$

$$r_{out,TCA} = r_o + R_L + R_E = 25k + 10k + \cancel{250}$$

$$\boxed{r_{out,TCA} = 35k\Omega}$$

$$A_{TCA} = \frac{250}{250+250} \cdot 0.3876 \cdot \frac{25k}{25k+10k}$$

$$\boxed{A_{TCA} = 0.1384}$$

$$\boxed{\beta = R_E = 250}$$

$$\frac{V_o}{V_s} = \frac{R_1 \| R_2 \| r_{in,f}}{R_1 \| R_2 \| r_{in,f} + R_s} \cdot \left[-A_f\right] r_{out,f}$$

$$r_{in,f} = 500 \cdot (1 + 34.6)$$

$$\boxed{r_{in,f} = 17.803k\Omega}$$

$$r_{out,f} = 35k\Omega \cdot 35 =$$

$$\boxed{r_{out,f} = 1225k\Omega}$$

$$A_f = \frac{0.138}{1 + 34.6}$$

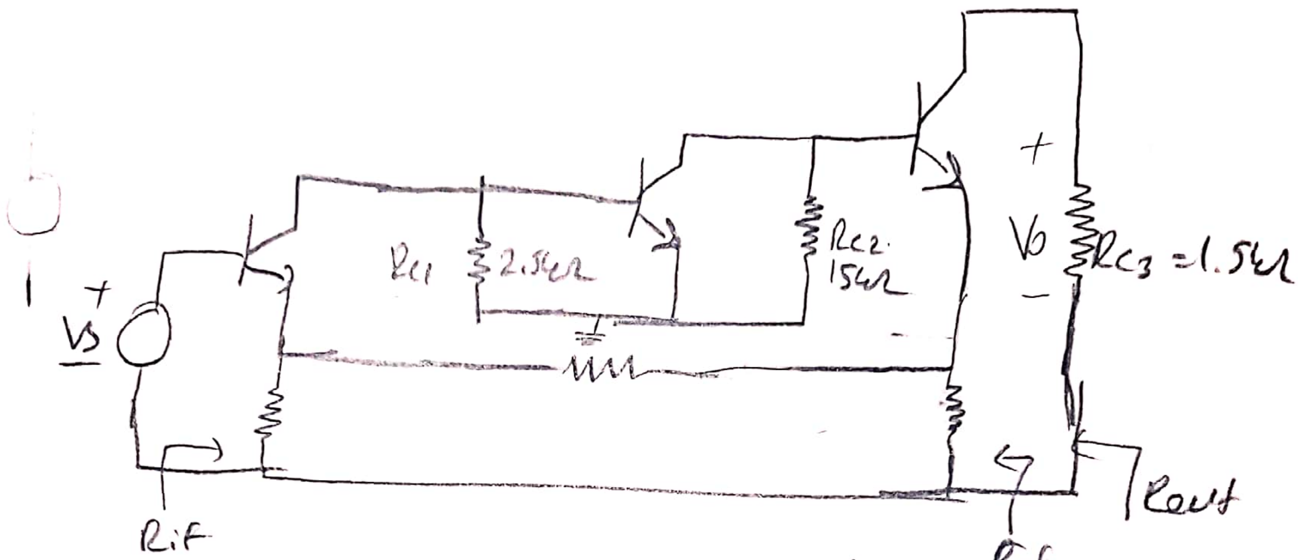
$$\boxed{A_f = 3.94 \times 10^{-3}}$$

$$\frac{V_o}{V_s} = \frac{5k\Omega \| 15k\Omega \| 17.803k\Omega}{5k\Omega \| 15k\Omega \| 17.803k\Omega + 500} \cdot \left[-3.94 \times 10^{-3}\right] \cdot (1225k\Omega)$$

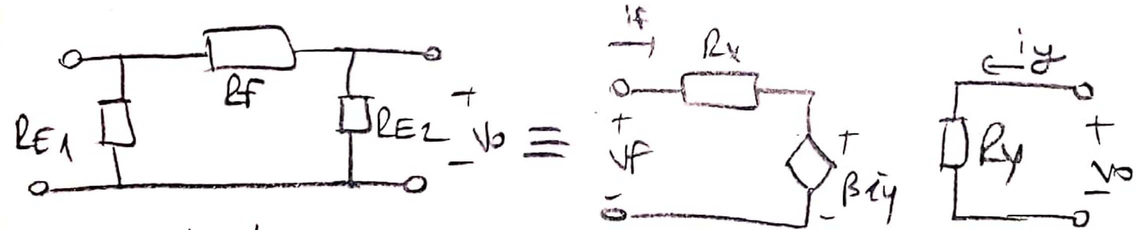
$$\frac{V_o}{V_s} = \frac{3.09k\Omega}{3590} \cdot (-3.94 \times 10^{-3}) \cdot 1225k\Omega$$

$$\frac{V_o}{V_s} = -4154.285$$

Q6. The AC equivalent circuit of a feedback amplifier is shown in fig P.10.28. The circuit values $R_{C1} = 2.5k\Omega$, $R_{C2} = 5k\Omega$, $R_{C3} = 1.5k\Omega$, $R_{E1} = 100\Omega$, $R_{E2} = 100\Omega$; $R_F = 750\Omega$. $R_s = 0$. The transistor parameters are $h_{fe} = 100$, $r_\pi = 2.5k\Omega$, $r_o = 25k\Omega$ and $r_\mu = \infty$. Use techniques of feedback analysis to calculate (a) the input resistance R_{if}, (b) the output resistance R_{of}, the closed-loop voltage gain A_f.



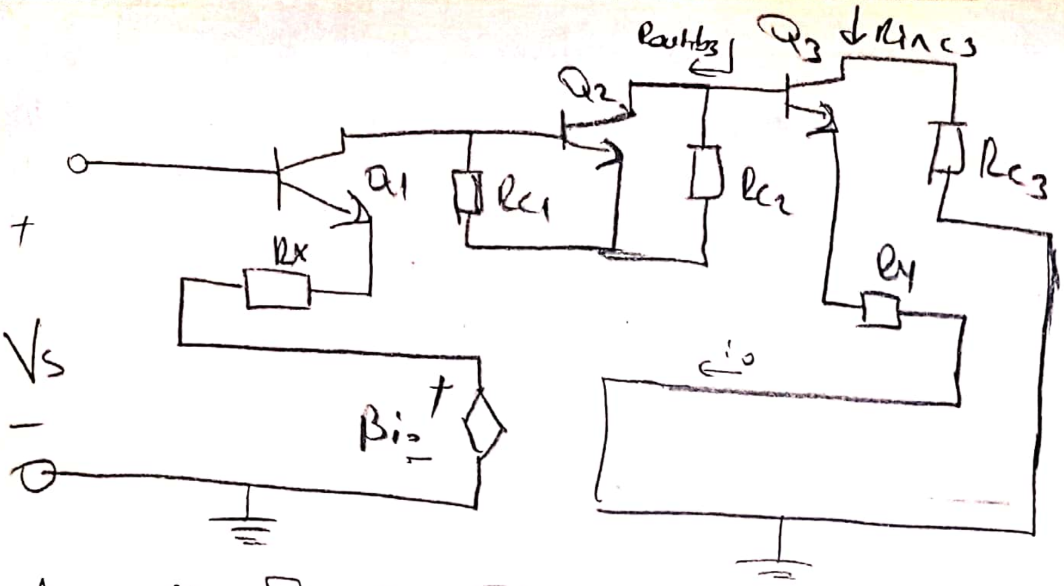
Transconductance Amp. için current series feedback yok.



$$R_x = \frac{V_f}{i_f}\Big|_{i_y=0} = R_{E1} \parallel [R_F + R_{E2}]$$

$$R_y = \frac{V_o}{i_y}\Big|_{i_f=0} = R_{E2} \parallel [R_{E1} + R_F]$$

$$\beta = \frac{V_f}{i_y}\Big|_{i_f=0} = \frac{R_E}{R_{E2} + R_{E1} + R_F} \cdot R_{E1}$$



$$A_{TCA,fl} = \left[\frac{-g_{m1}}{1+g_{m1}R_x}\right]\left[\left[(1+g_{m1}R_x)r_{o1}\right] \parallel R_{c1} \parallel r_{\pi 1}\right]\cdot\left[-g_{m2}\right]\cdot$$

$$\left[r_{o2} \parallel R_{c2} \parallel \left[r_{\pi 3}(1+g_{m3}R_y)\right]\right]\cdot\left[\frac{g_{m3}}{1+g_{m3}R_y}\right]$$

$$r_{in,TCA,fl} = r_\pi(1+g_{m1}R_x)$$

$$r_{out,TCA,fl} = R_{c3}+R_{in,c3} \qquad R_{out,b3} = R_{c2} \parallel r_{o2}$$

$$R_{in,c3} = (1+g_{m3}r_{o3})\left[\frac{R_y r_{\pi 3}}{R_y+r_{\pi 3}+R_{out,b3}} + \frac{r_o + R_y R_{out,b3}}{R_y+r_{\pi 3}+R_{out,b3}}\right]$$

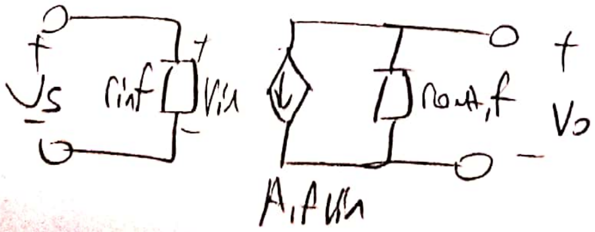
$$\cong (1+g_{m3}r_{o3})\left[\frac{R_y r_{\pi 3}}{R_y\, r_{\pi 3}+R_{out,b3}}\right]$$

Tüm devre analizi

$$A_f = \frac{A_{TCA,fl}}{1+\beta A_{TCA,fl}}$$

$$r_{in,f} = r_{in,TCA,fl}(1+\beta A_{TCA,fl})$$

$$r_{out,f} = r_{out,TCA,fl}(1+\beta A_{TCA,fl})$$



CamScanner ile tarandı