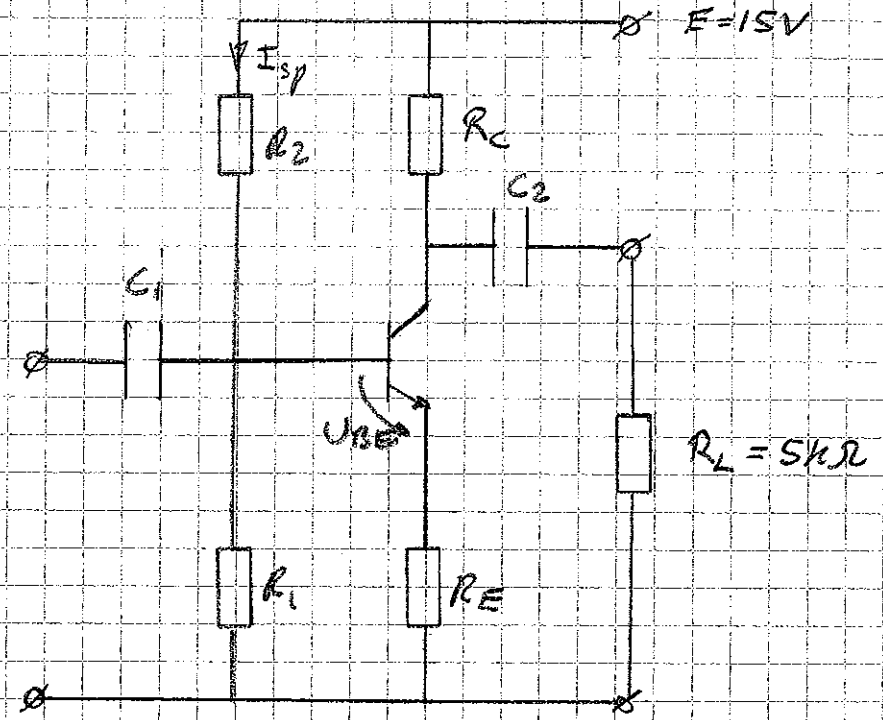


1) a)



$I_C = 1 \text{ mA}$ $U_{RE} = 1 \text{ V}$ $U_{BE} = 0.65 \text{ V}$

$I_{sp} = I_C / 10 = 0.1 \text{ mA}$

$R_C = \frac{7.5}{0.001} = 7.5 \text{ k}\Omega$

$R_1 = \frac{1.65}{0.11 \cdot 10^{-3}} = 16.5 \text{ k}\Omega$

$R_E = \frac{1}{0.001} = 1 \text{ k}\Omega$

$R_2 = 133.5 \text{ k}\Omega$

b)

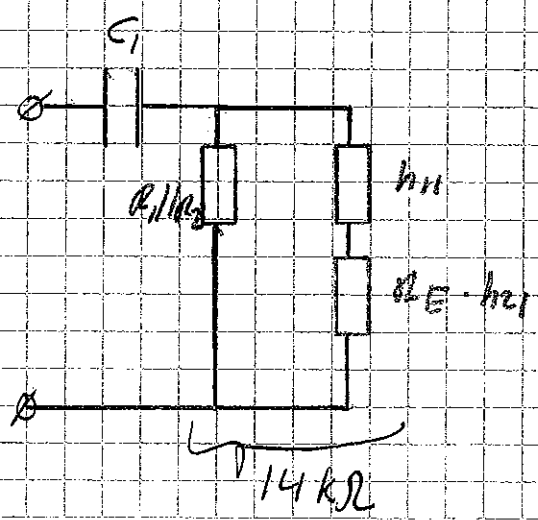
$h_{11} = 8 \text{ k}\Omega$

$h_{21} = 350$

$f_u = 35 \text{ Hz} \Rightarrow$

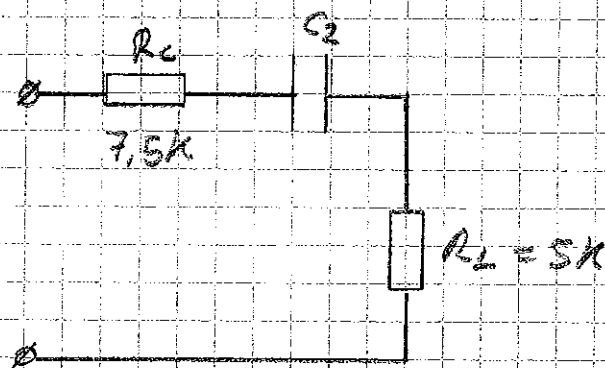
$f_p = \frac{35}{\sqrt{2}} = 25 \text{ Hz}$

↑
triplexer
(1 in, 1 out)



$C_i = \frac{1}{2\pi \cdot 14000 \cdot 25} = 0.45 \mu\text{F}$

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b)

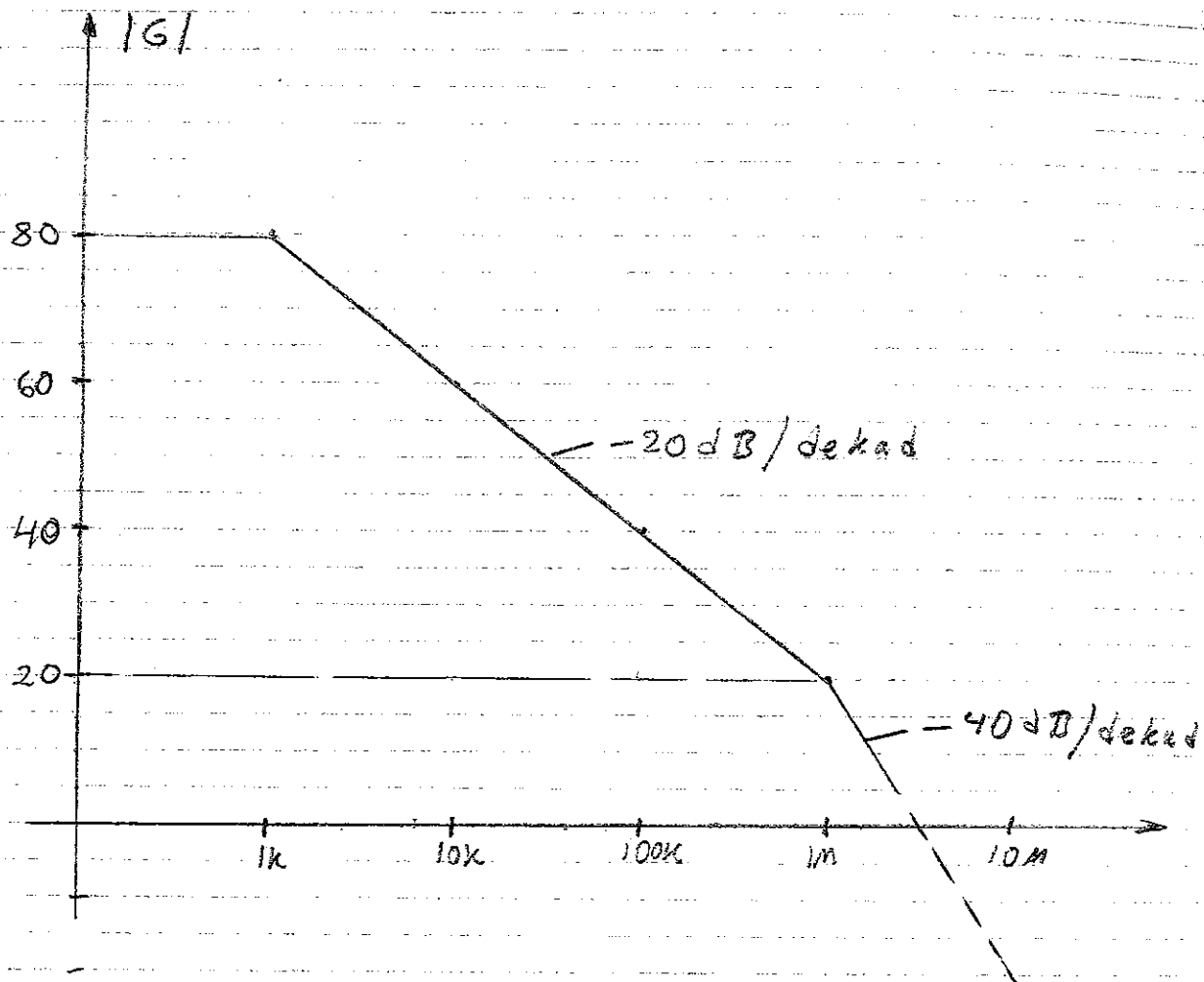


$$C_2 = \frac{1}{2\pi \cdot 25 (7,5k + 5k)} = 0,5 \mu F$$

g)

$$G = - \frac{h_{21} (R_C // R_L)}{h_{11} + R_E + R_E h_{21}} \approx - \frac{R_C // R_L}{R_E}$$
$$= - 3$$

2)

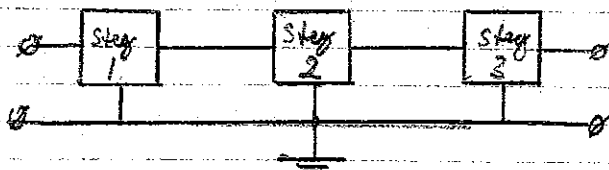


$$f_p = \frac{1}{2\pi RC}$$

$$f_{p1} = \frac{1}{2\pi \cdot 10k \cdot 16nF} = 995 \text{ Hz}$$

kaskad kopplad tre stegs-
förstärkare.

$$f_{p2} = \frac{1}{2\pi \cdot 100 \cdot 16nF} = 995 \text{ kHz}$$



$$f_{p3} = \frac{1}{2\pi \cdot 100 \cdot 160pF} = 9,95 \text{ MHz}$$

$$80 \text{ dB} = 20 \log |G|$$

$$a) \quad |G| = |A| \cdot 20 \cdot 10 = 10000$$

$$|A| = 50$$

2b) sökt f då $|U_T/I_N| = 0 \text{ dB}$

vid $f_2 = 995 \text{ kHz}$ är $|U_T/I_N| = 20 \text{ dB}$

$$|A| = \frac{10000}{\sqrt{\left(1^2 + \frac{f^2}{995^2}\right)} \cdot \sqrt{\left(1^2 + \frac{f^2}{0,995 \text{ MHz}^2}\right)} \cdot \sqrt{\left(1^2 + \frac{f^2}{995 \text{ MHz}^2}\right)}}$$

$$\left|\frac{U_T}{I_N}\right| = |A| = 0 \text{ dB} \Rightarrow f = 3 \text{ MHz} \quad (\text{prövning})$$

$$\vartheta = -\arctan\left(\frac{f}{f_1}\right) - \arctan\left(\frac{f}{f_2}\right) - \arctan\left(\frac{f}{f_3}\right)$$

$$\vartheta = -90 - 71,6 - 16,78$$

$$\vartheta \sim -178,4^\circ \quad \vartheta_m \sim 1,6^\circ \quad (\text{dåris fas marginen})$$

c)

$$|\beta \cdot A| = 1 \quad \beta = \frac{1}{|A|} \quad \text{då } \vartheta = -180^\circ$$

$$f = 3,0 \text{ MHz}$$

$$|A| = \frac{10000}{\sqrt{\left(1^2 + \frac{f^2}{f_1^2}\right)} \cdot \sqrt{\left(1^2 + \frac{f^2}{f_2^2}\right)} \cdot \sqrt{\left(1^2 + \frac{f^2}{f_3^2}\right)}}$$

$$1 + \beta \cdot A = 0 \quad \text{då } \vartheta = -180^\circ$$

$$\Rightarrow \beta \cdot |A| = 1 \quad \beta = \frac{1}{|A|} \quad \text{Då } \vartheta = -178,4^\circ$$

$$\text{f} \ddot{\text{a}}r |A| - 0 \text{ dB} = 1 \Rightarrow \beta \text{ n} \ddot{\text{a}}r > 1 \text{ d} \ddot{\text{a}} \vartheta = -180^\circ$$

dvs. Systemet är stabilt för alla värden av resistiv motkoppling

3)

$$a) \text{ Brusband bredd} = \frac{1}{2\pi \cdot 1000 \cdot 1,6 \cdot 10^{-9}} \cdot \frac{\pi}{2} \cdot 100$$

$$B = 156 \text{ kHz}$$

enligt bilagan.

ekvivalent injäms brus

$$e_N = \sqrt{e_n^2 + 4kT(R_s + R_i \parallel R_2) + \overline{i_n^2} (R_s + R_i \parallel R_2)^2}$$

$$e_n = 4,5 \text{ nV} / \sqrt{\text{Hz}}$$

$$i_n = 0,4 \text{ pA} / \sqrt{\text{Hz}}$$

$$4kT = 4 \cdot 1,38 \cdot 10^{-23} \cdot 300 = 16,6 \cdot 10^{-21}$$

$$R_s + R_i \parallel R_2 = 11 \text{ k}\Omega$$

$$\overline{e_n^2} = 20,2 \cdot 10^{-18}$$

$$4kT(R_s + R_i \parallel R_2) = 182 \cdot 10^{-18}$$

$$\overline{i_n^2} \cdot (R_s + R_i \parallel R_2)^2 = 19,4 \cdot 10^{-18}$$

$$e_N = 14,9 \cdot 10^{-9} \text{ V} / \sqrt{\text{Hz}}$$

$$e_{N_{ut}} = e_N \cdot 100 \cdot \sqrt{B} = 590 \text{ }\mu\text{V}$$

b) termiska bidragen från resistorer

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4) a)

$$G = - \frac{Z_2}{Z_1} \quad Z_1 = R_1$$

$$Z_2 = R_2 // C_2$$

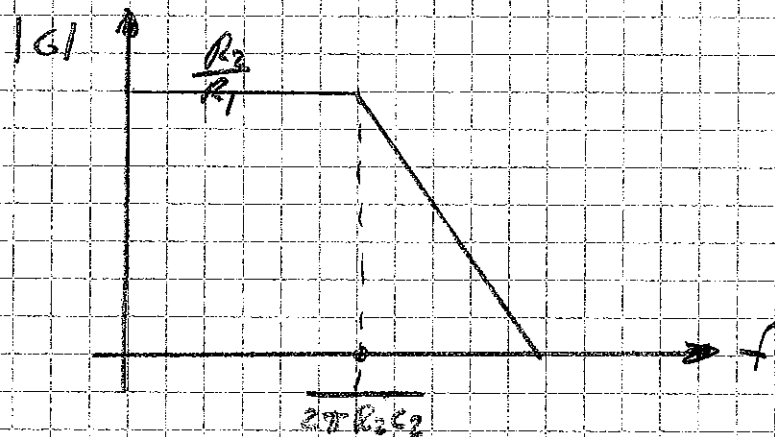
$$\frac{1}{R_2} + j\omega C_2 = \frac{1}{Z_2}$$

$$\frac{1 + j\omega R_2 C_2}{R_2}$$

$$Z_2 = \frac{R_2}{1 + j\omega R_2 C_2}$$

$$G = - \frac{R_2}{R_1} \cdot \frac{1}{1 + j\omega R_2 C_2}$$

b)



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- 5) a) boken sid 387 - 389
b) boken sid 493
c) boken sid 379