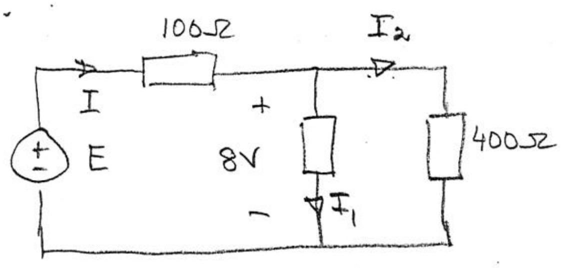
Lösningar Elektriska kretsar dec 2011

(1a) $V_p = 0 - 100\Omega \cdot I_1 = 0 - 100\Omega \cdot 80mA = \underline{\underline{-8V}}$

(1b)



$$I_2 = \frac{8V}{400\Omega} = 20mA \Rightarrow I = I_1 + I_2 = 100mA$$

$$E = R_{TOT} \cdot I \ ; \ R_{TOT} = 100\Omega + 100\Omega // 400\Omega = 180\Omega \Rightarrow$$

$$E = 180\Omega \cdot 100mA = \underline{\underline{18V}}$$

(2a) Läge 2, då är $U_{BE} = 0$ så att transistorn är strypt.

(2b) $I_C = \frac{6W}{12V} = 0{,}5A \Rightarrow I_B = \frac{0{,}5A}{40} = 12{,}5mA \Rightarrow$

$$R_B + 220\Omega = \frac{12V - 0{,}7V}{12{,}5mA} = 904\Omega \Rightarrow \underline{\underline{R_B < 684\Omega}}$$

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(3) Icke-inverterande koppling $\Rightarrow$

$$U_2 = \frac{12k\Omega + 1{,}2k\Omega}{1{,}2k\Omega} \cdot 0{,}85V = \underline{\underline{9{,}35V}}$$

$$I = I_{6,8} + I_{12} . \quad I_{6,8} = \frac{9{,}35V}{6{,}8k\Omega} = \underline{1{,}375mA}$$

$$I_{12} = \frac{U_2 - 0{,}85V}{12k\Omega} = \frac{9{,}35V - 0{,}85V}{12k\Omega} = \underline{0{,}708mA} \Rightarrow$$

$$\underline{\underline{I = 2{,}08mA}}$$

(4a.) Komplext.

$$u(t) \leftrightarrow U = 10 \cdot e^{j(\omega t + 23^\circ)}$$ ✓

$$i(t) \leftrightarrow I = |I| \cdot e^{j(\omega t + \beta)}$$

$$330\,\Omega \leftrightarrow 330\,\Omega$$

$$680\,mH \leftrightarrow j\omega L = j\,544.$$

$$I = \frac{U}{Z} \; ; \quad Z = 330 + j\,544 = 636{,}3 \cdot e^{j\,58{,}76^\circ}\ \Omega \Rightarrow$$

$$I = \frac{10\,e^{j(\omega t + 23^\circ)}}{636\,e^{j\,58{,}76^\circ}} = 15{,}7 \cdot e^{j(\omega t - 35{,}8^\circ)}\ mA \Rightarrow$$

$$|I| = 15{,}7\,mA \quad \beta = -35{,}8^\circ \Rightarrow$$

$$\underline{\underline{i(t) = 15{,}7 \cdot \sin(800t - 35{,}8^\circ)\ mA}}$$

(4b.) $\arg Z = 60^\circ \Rightarrow \arctan \frac{\omega L}{R} = 60^\circ$

$$\arctan \frac{\omega \cdot 0{,}68}{330} = 60^\circ \Leftrightarrow \frac{\omega \cdot 0{,}68}{330} = \tan 60^\circ = \sqrt{3}$$

$$\Rightarrow \underline{\underline{\omega = 840{,}6\ rad/s}}$$

(5.) Belastningsresistans $R_b = 20\,\Omega$ ger maxeffekt.

$$P_{max} = \frac{(12V)^2}{4 \cdot 20\,\Omega} = \underline{\underline{1{,}8\,W}}$$

(6a) $P = U_e \cdot I_e \cdot \cos\phi$.

$$U_e = \frac{|U|}{\sqrt{2}} = \frac{100V}{\sqrt{2}} \qquad I_e = \frac{|I|}{\sqrt{2}} = \frac{150mA}{\sqrt{2}}$$

$$\phi = \frac{1}{3} \cdot 180^\circ = 60^\circ \Rightarrow P = \frac{100V}{\sqrt{2}} \cdot \frac{150mA}{\sqrt{2}} \cdot \cos 60^\circ = \underline{\underline{3{,}75W}}$$

(6b.) $T = 20ms \Rightarrow f = \frac{1}{20ms} = \underline{\underline{50\,Hz}} \Rightarrow$

$$\omega = 2\pi f = \underline{\underline{314\,rad/s}}$$

(6c.) Strömmen ligger före spänningen.

(6d.) Kapacitiv krets $\Rightarrow$ $Z = R + \frac{1}{j\omega C} = R - j\frac{1}{\omega C}$

$$Z = |Z| \cdot e^{-j\phi} = |Z| \cdot \cos\phi - j|Z| \cdot \sin\phi =$$

$$= |Z| \cdot \cos 60^\circ - j|Z| \cdot \sin 60^\circ \Rightarrow$$

$$R = |Z| \cdot \cos 60^\circ \qquad \frac{1}{\omega C} = |Z| \cdot \sin 60^\circ$$

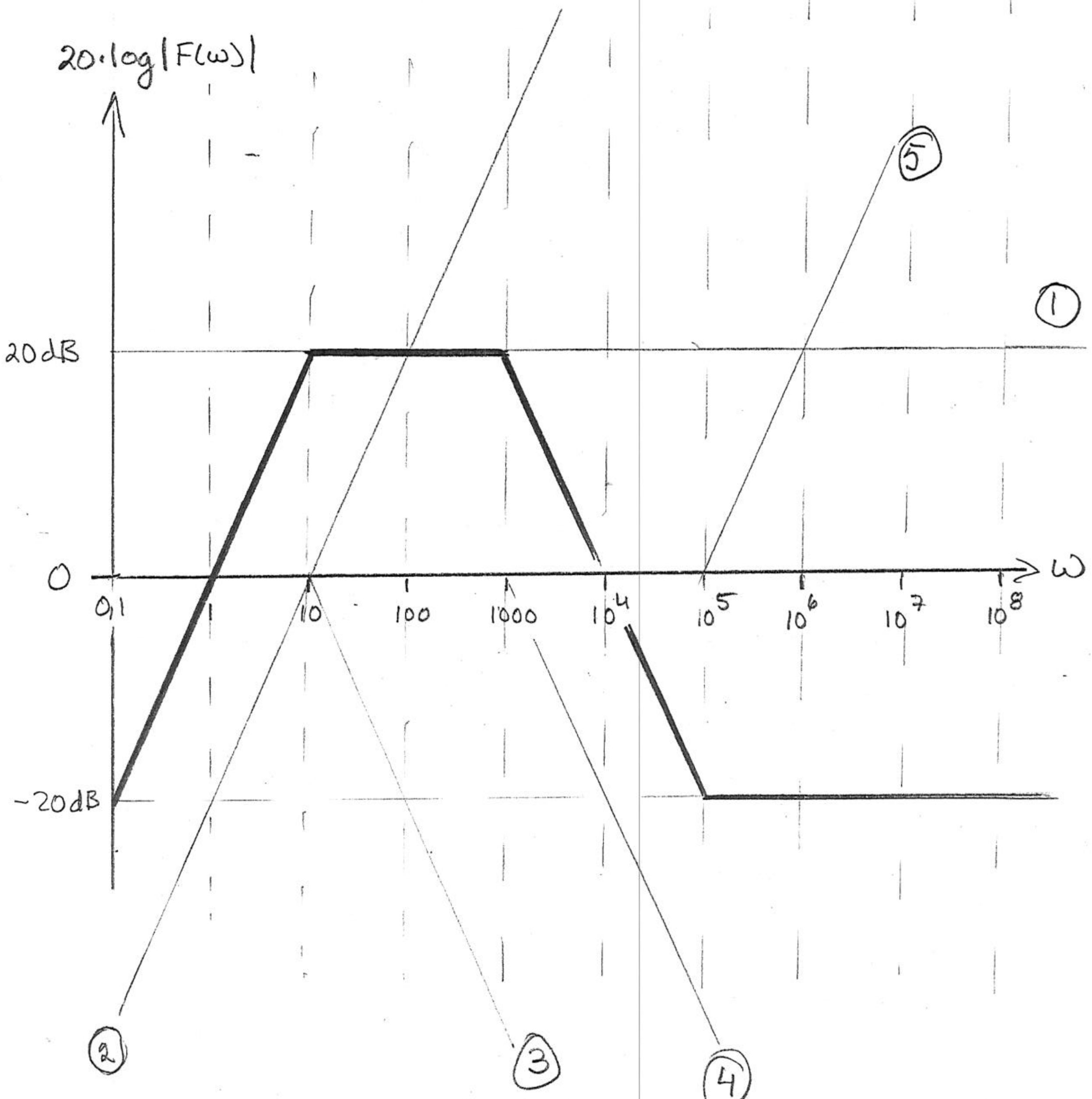
$$|Z| = \frac{|U|}{|I|} = \frac{100V}{150mA} = 666{,}7\Omega \Rightarrow$$

$$R = 666{,}7\Omega \cdot \cos 60^\circ = \underline{\underline{333\Omega}}$$

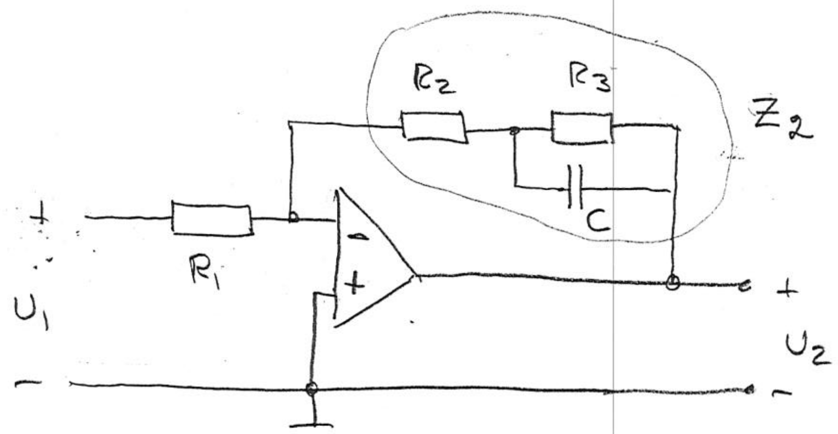
$$\frac{1}{\omega C} = 666{,}7 \cdot \sin 60^\circ \Rightarrow C = \frac{1}{314 \cdot 666{,}7 \cdot \sin 60^\circ} F = \underline{\underline{5{,}52\mu F}}$$

7.

$$F(\omega) = 10^4 \cdot \frac{j\frac{\omega}{10}\cdot\left(1+j\frac{\omega}{10^5}\right)}{\left(1+j\frac{\omega}{10}\right)\cdot 10^3\cdot\left(1+j\frac{\omega}{10^3}\right)} = \underset{1}{10}\cdot\frac{\overset{2}{j\frac{\omega}{10}}\cdot\overset{5}{\left(1+j\frac{\omega}{10^5}\right)}}{\underset{3}{\left(1+j\frac{\omega}{10}\right)}\underset{4}{\left(1+j\frac{\omega}{10^3}\right)}}$$



8.



$R_1 = 2{,}2\,k\Omega$

$R_2 = 18\,k\Omega$

$R_3 = 390\,k\Omega$

$C = 47\,nF$

Inverterande koppling $\Rightarrow$

$$F(\omega) = -\frac{Z_2}{R_1} \; ; \quad Z_2 = R_2 + R_3 /\!/ \frac{1}{j\omega C} =$$

$$= R_2 + \frac{R_3 \cdot \frac{1}{j\omega C}}{R_3 + \frac{1}{j\omega C}} = R_2 + \frac{R_3}{1 + j\omega R_3 C} =$$

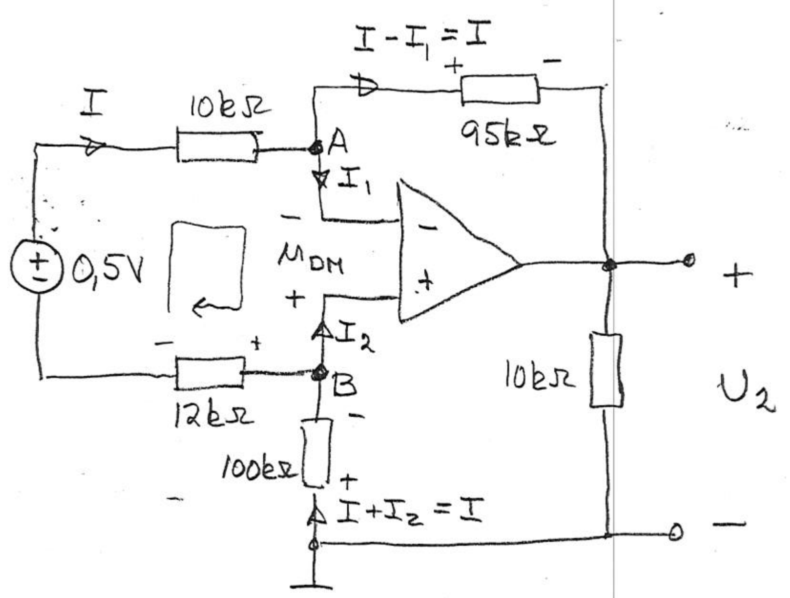
$$= \frac{R_2 + R_3 + j\omega R_2 R_3 C}{1 + j\omega R_3 C} = (R_2 + R_3) \cdot \frac{1 + j\omega \frac{R_2 R_3}{R_2 + R_3} \cdot C}{1 + j\omega R_3 C}$$

Alltså

$$F(\omega) = -\frac{R_2 + R_3}{R_1} \cdot \frac{1 + j\omega \frac{R_2 R_3}{R_2 + R_3} \cdot C}{1 + j\omega R_3 C} \Rightarrow$$

$\underline{\underline{A = -185}}$, $\underline{\underline{\omega_1 = 1237\ \text{rad/s}}}$, $\underline{\underline{\omega_2 = 54{,}6\ \text{rad/s}}}$

9.



Ideal motkopplad OP $\Rightarrow$ $I_1 = I_2 = 0$, $u_{DM} = 0$.

- $U_2 = V_A - 95k\Omega \cdot I$
- I ges av Kirchhoff:

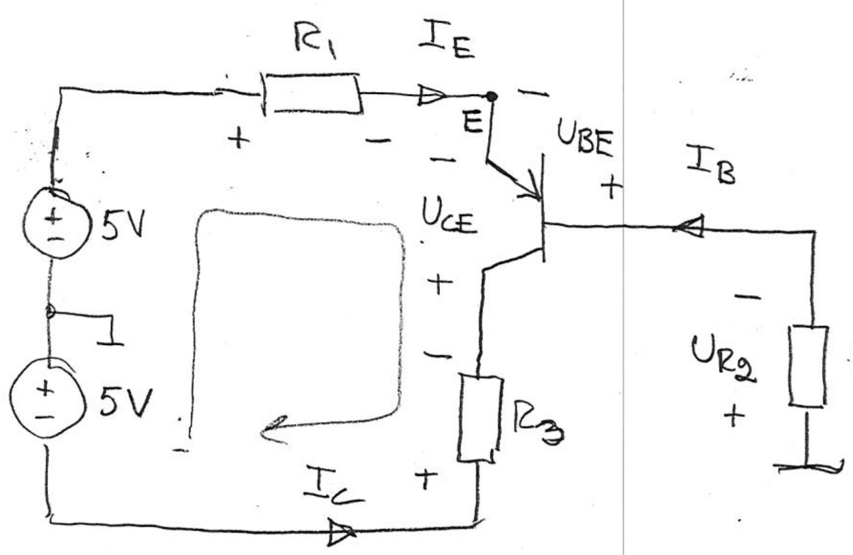
$$+0{,}5V - 10k\Omega \cdot I + u_{DM} - 12k\Omega \cdot I = 0, \quad u_{DM} = 0 \Rightarrow$$

$$I = \frac{0{,}5V}{12k\Omega + 10k\Omega} = 22{,}73\mu A$$

- $V_A = V_B - u_{DM} = V_B = 0 - 100k\Omega \cdot I = -2{,}273V \Rightarrow$

$$U_2 = -2{,}273V - 95k\Omega \cdot 22{,}73\mu A = \underline{\underline{-4{,}432\,V}}$$

(10.)



$U_{CE} = -5V$

$U_{BE\,led} = -0{,}7V$

$R_1 = 1{,}2k\Omega$

$R_3 = 1{,}2k\Omega$

$I_C = h_{FE} \cdot I_B = 20\, I_B \qquad I_E = -(I_C + I_B) = -21 \cdot I_B$

Kirchhoff ger

$+5V + 5V - R_1 \cdot I_E + U_{CE} + R_3 \cdot I_C = 0 \Rightarrow$

$10V - R_1(-21 I_B) - 5V + R_3 \cdot 20 I_B = 0$

$10V + 1{,}2k\Omega \cdot 21\, I_B - 5V + 1{,}2k\Omega \cdot 20\, I_B = 0 \Rightarrow$

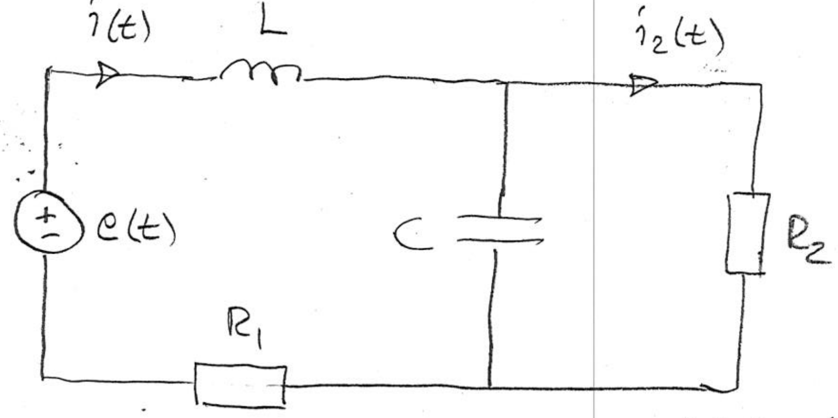
$$I_B = \frac{5V - 10V}{1{,}2k\Omega \cdot 21 + 1{,}2k\Omega \cdot 20} = -101{,}63\,\mu A$$

$$R_2 = \frac{U_{R2}}{I_B} \; ; \; U_{R2} = -(V_E + U_{BE}) = -V_E + 0{,}7V$$

$$V_E = 5V - R_1 \cdot I_E = 5V - 1{,}2k\Omega \cdot (-21 \cdot (-101{,}63\mu A)) = 2{,}439V$$

$$\Rightarrow R_2 = \frac{-2{,}439V + 0{,}7V}{-101{,}63\mu A} = \underline{\underline{17{,}11\,k\Omega}}$$

11a.



$$e(t) = 10\sin(\omega t + 20^\circ)\,\mathrm{V} \iff E = 10e^{j(\omega t + 20^\circ)}\,\mathrm{V}$$

$$i_1(t) = |I_1|\sin(\omega t + \beta_1) \iff I_1 = |I_1|\,e^{j(\omega t + \beta_1)}$$

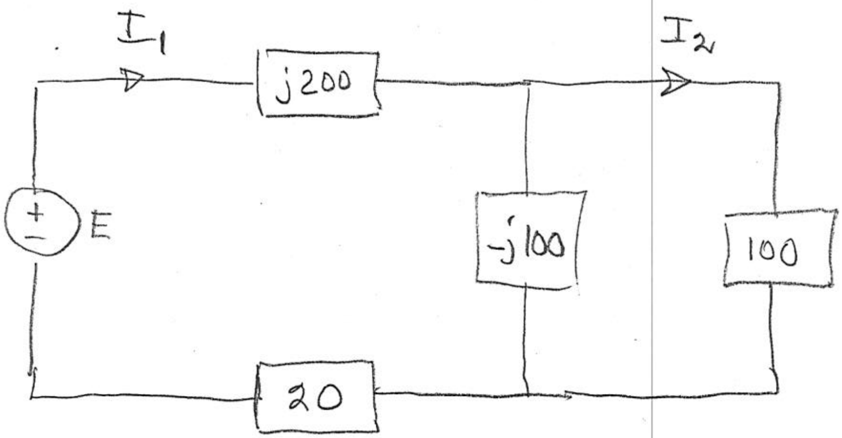
$$i_2(t) = |I_2|\sin(\omega t + \beta_2) \iff I_2 = |I_2|\,e^{j(\omega t + \beta_2)}$$

$$R_1 \iff R_1 = 20\,\Omega$$

$$R_2 \iff R_2 = 100\,\Omega$$

$$L \iff j\omega L = j200$$

$$C \iff \frac{1}{j\omega C} = -j100$$



Strömdelning: $I_2 = \dfrac{\frac{1}{100}}{\frac{1}{100} + \frac{1}{-j100}} \cdot I_1 = \dfrac{1}{1+j} \cdot I_1 =$

$= \dfrac{1}{\sqrt{2}}\, e^{-j45^\circ} \cdot I_1.$

$$I = \frac{E}{Z_{TOT}} \quad , \quad Z_{TOT} = R_1 + j\omega L + R_2 // \frac{1}{j\omega C} =$$

$$= R_1 + j\omega L + \frac{R_2 \cdot \frac{1}{j\omega C}}{R_2 + \frac{1}{j\omega C}} = R_1 + j\omega L + \frac{R_2}{1 + j\omega R_2 C} =$$

$$= 20 + j\,200 + \frac{100}{1 + j\,10^4 \cdot 100 \cdot 1 \cdot 10^{-6}} = 20 + j200 + \frac{100}{1+j} =$$

$$= 20 + j200 + \frac{100(1-j)}{(1+j)(1-j)} = 20 + j200 + 50 - j50 =$$

$$= 70 + j150 = 165{,}53 \cdot e^{j64{,}98^\circ} \; \Omega \implies$$

$$I_1 = \frac{E}{Z_{TOT}} = \frac{10\,e^{j(\omega t + 20^\circ)} \; V}{165{,}53\,e^{j64{,}98^\circ} \; \Omega} = 60{,}4 \; e^{j(\omega t - 44{,}98^\circ)} \; mA$$

$$\implies I_2 = \frac{1}{\sqrt{2}} e^{-j45^\circ} \cdot 60{,}4 \cdot e^{j(\omega t - 44{,}98^\circ)} \; mA \approx$$

$$\approx 42{,}7 \cdot e^{j(\omega t - 90^\circ)} \; mA \implies$$

$$\underline{\underline{i_2(t) = 42{,}7 \sin(10^4 t - 90^\circ) \; mA}}$$