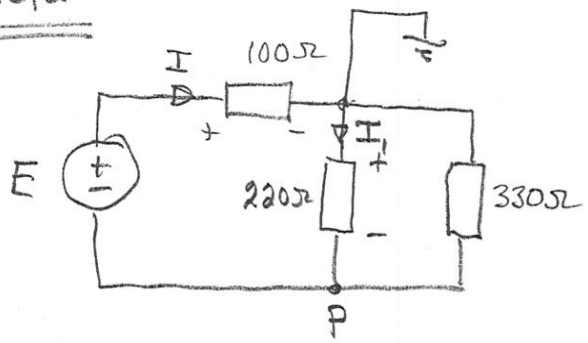
# Lösningar Elektriska kretsar dec 2010

**1a** $V_p = 0 - 220\Omega \cdot I_1 = \underline{\underline{-13{,}2\,V}}$

**1b**




$E = 100\Omega \cdot I + 220\Omega \cdot I_1$

$$I_1 = \frac{\frac{1}{220\Omega}}{\frac{1}{220\Omega} + \frac{1}{330\Omega}} \cdot I$$

$I_1 = 60\,mA \Rightarrow I = 100\,mA \Rightarrow$

$E = 100\Omega \cdot 100\,mA + 220\Omega \cdot 60\,mA = \underline{\underline{23{,}2\,V}}$

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**2a** • $U_{CE} = E - R_C I_C = 5V - 1{,}8k\Omega \cdot I_C$

• $I_C = h_{FE} \cdot I_B$ ; $I_B = \frac{U - 0{,}7V}{R_b} = \frac{1{,}5V - 0{,}7V}{47k} = 17{,}02\,\mu A$

$\Rightarrow I_C = 120 \cdot 17{,}02\,\mu A = 2{,}04\,mA \Rightarrow$

$U_{CE} = 5V - 1{,}8k\Omega \cdot 2{,}04\,mA = \underline{\underline{1{,}32\,V}}$

**2b** Räkna på $h_{FE} = h_{FE\,min} = 50$ !

• $R_b = \frac{U - U_{BE}}{I_b} = \frac{4{,}5V - 0{,}7V}{I_B} = \frac{3{,}8V}{I_B}$

• $I_B = \frac{I_C}{h_{FE}} = \frac{I_C}{50}$ ; $I_C = \frac{E - U_{CE}}{R_C} = \frac{5V - 0{,}1V}{1{,}8k\Omega} = 2{,}72\,mA$

$\Rightarrow I_B = \frac{2{,}72\,mA}{50} = 54{,}4\,\mu A \Rightarrow$

$R_b = \frac{3{,}8V}{54{,}4\,\mu A} = \underline{\underline{69{,}8k\Omega}}$

Transistorn bottnar säkert för $\underline{\underline{R_b < 69{,}8k\Omega}}$

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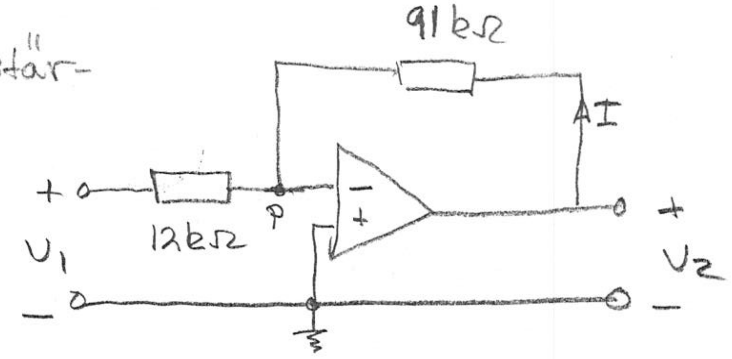
(3.) Inverterande förstärkarkoppling!




$$\Rightarrow \frac{U_2}{U_1} = -\frac{91\,k\Omega}{12\,k\Omega} = -7{,}583$$

$$\Rightarrow U_1 = \frac{U_2}{-7{,}583} = \frac{-10{,}5\,V}{-7{,}583} = \underline{\underline{1{,}385\,V}}$$

$$V_p = 0 \Rightarrow I = \frac{U_2}{91k\Omega} = \frac{10{,}5\,V}{91k\Omega} = \underline{\underline{115{,}4\,\mu A}}$$

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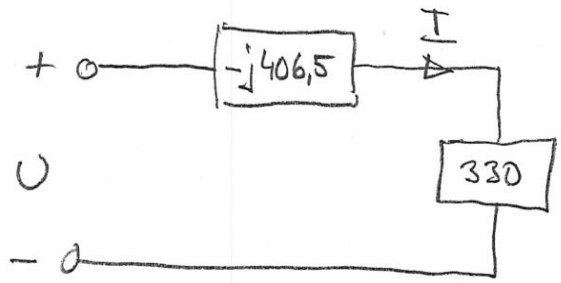
(4) Komplext: $u(t) \leftrightarrow U = 10\,e^{j(3000t - 20^\circ)}$

$$i(t) \leftrightarrow I = |I|\,e^{j(3000t + \beta)}$$

$$R = 330\,\Omega \longleftrightarrow 330, \quad C = 820\,nF \longleftrightarrow \frac{1}{j\omega C} = -j406{,}5$$

Beräkningsschema




$$\cdot\ I = \frac{U}{Z_{TOT}}$$

$$\cdot\ Z_{TOT} = 330 - j406{,}5 =$$

$$= 523{,}6 \cdot e^{-j50{,}9^\circ} \Rightarrow$$

$$I = \frac{10\,e^{j(3000t - 20^\circ)}}{523{,}6\,e^{-j50{,}9^\circ}} = 19{,}1\,e^{j(3000t + 30{,}9^\circ)} \Rightarrow$$

$$|I| = 19{,}1\,mA \quad \beta = 30{,}9^\circ \Rightarrow$$

$$\underline{\underline{i(t) = 19{,}1\sin(3000t + 30{,}9^\circ)\,mA}}$$

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(5a.) $E = 2{,}5\,V \Rightarrow$ höger diod spärrar. Leder vänstra dioden? Tag bort den och beräkna spänningen över 12kΩ:aren.

$$U_{12} = \frac{12k\Omega}{12k\Omega + 2{,}7k\Omega} \cdot 2{,}5V = 2{,}04V > 0{,}7V \Rightarrow$$

dioden leder $\Rightarrow$ $I = \frac{2{,}5V - 0{,}7V}{2{,}7k\Omega} = \underline{\underline{0{,}667mA}}$

(5b) $E = -2{,}5V$. Vänster diod spärrar. Leder den högra? Tag bort den och beräkna spänningen över 2,7kΩ:aren.

$$U_{2,7} = \frac{2{,}7k\Omega}{2{,}7k\Omega + 12k\Omega} \cdot 2{,}5V = 0{,}46V < 0{,}7V \Rightarrow$$

ingen diod leder $\Rightarrow$ $I = -\frac{2{,}5V}{2{,}7k\Omega + 12k\Omega} = \underline{\underline{-0{,}17mA}}$

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

$U_e = \frac{|U|}{\sqrt{2}} = \frac{0{,}8V}{\sqrt{2}}$ ; $I_e = \frac{|I|}{\sqrt{2}} = \frac{1{,}2mA}{\sqrt{2}}$

$\varphi = \frac{1}{3} \cdot 180° = 60° \Rightarrow P = \frac{0{,}8V}{\sqrt{2}} \cdot \frac{1{,}2mA}{\sqrt{2}} \cdot \cos 60° = \underline{\underline{0{,}24mW}}$

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(6b) $T = 0{,}6ms \Rightarrow f = \frac{1}{0{,}6ms} = \underline{\underline{1{,}67kHz}} \Rightarrow$

$\omega = 2\pi f = \underline{\underline{10{,}47krad/s}}$

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(6c) Strömmen ligger före spänningen.

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(6d) Kapacitiv seriekrets $\Rightarrow$

$Z = R + \frac{1}{j\omega C} = R - j\frac{1}{\omega C} =$

$= |Z| \cos\varphi - j|Z| \sin\varphi$

$|Z| = \frac{|U|}{|I|} = \frac{0{,}8V}{1{,}2mA} = 666{,}7\Omega$ ; $\varphi = \frac{1}{3} \cdot 180° = 60° \Rightarrow$

$R = |Z| \cdot \cos\varphi = 666{,}7\Omega \cdot \cos 60° \approx \underline{\underline{333\Omega}}$

$\frac{1}{\omega C} = |Z| \cdot \sin\varphi \Rightarrow C = \frac{1}{\omega \cdot |Z| \cdot \sin\varphi} =$

$= \frac{1}{10{,}47 \cdot 10^3 \cdot 666{,}7 \cdot \sin 60°} F = \underline{\underline{165{,}4nF}}$

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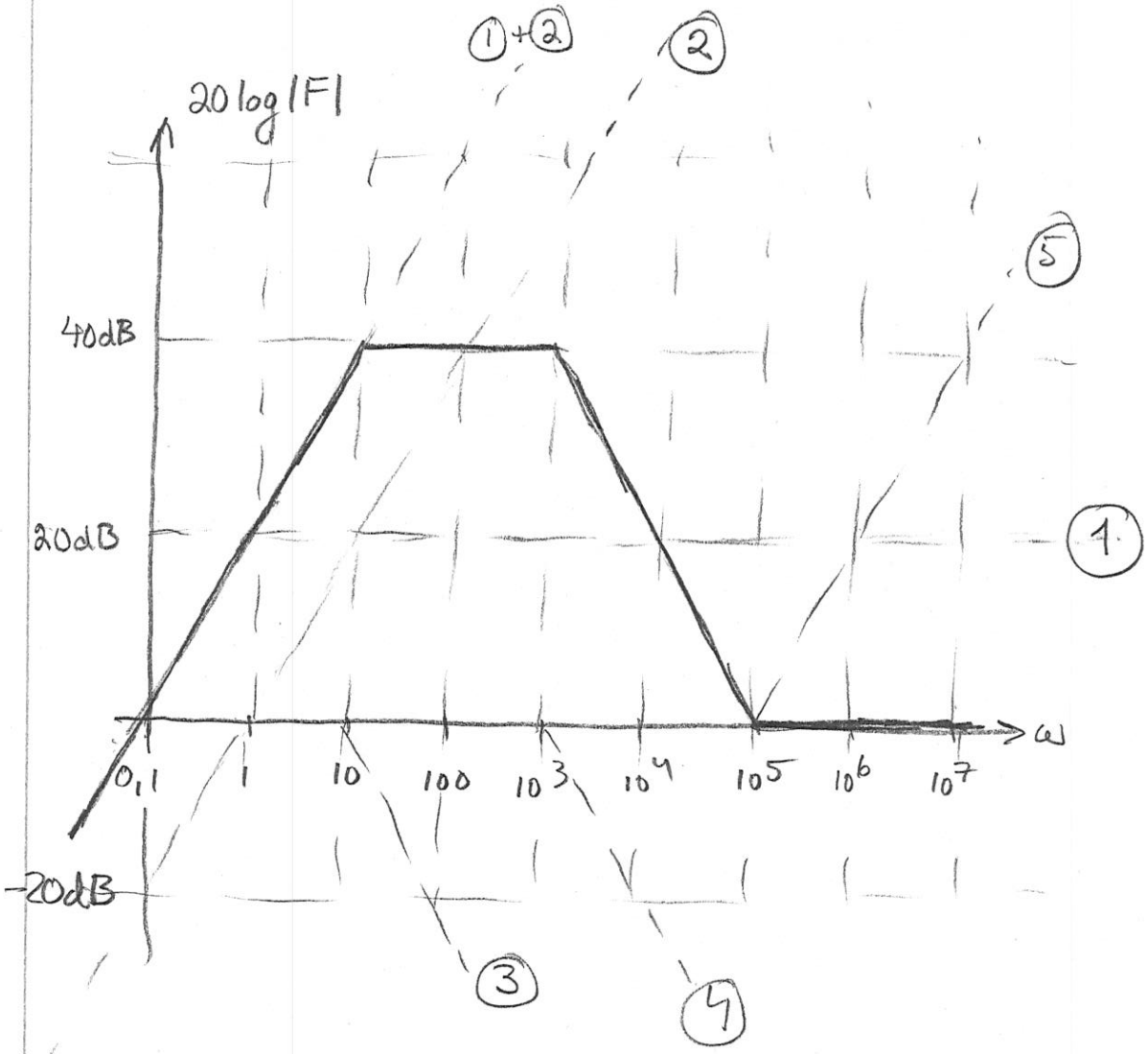
7. $F(\omega) = 10^4 \cdot \frac{j\omega \cdot (1 + j\frac{\omega}{10^5})}{(1 + j\frac{\omega}{10}) \cdot 1000 \cdot (1 + j\frac{\omega}{1000})} =$

$= 10 \cdot \frac{j\omega \cdot (1 + j\frac{\omega}{10^5})}{(1 + j\frac{\omega}{10}) \cdot (1 + j\frac{\omega}{1000})}$

① ② ③ ④ ⑤



(8.) Inverterande förstärkarkoppling.

Låga frekvenser: C = avbrott ⇒

$$A_M = -\frac{82k+330k}{2{,}2k} = \underline{\underline{-187{,}3}}$$

Höga frekvenser: C = kortslutning ⇒

$$A_M = -\frac{82k}{2{,}2k} = \underline{\underline{-37{,}3}}$$

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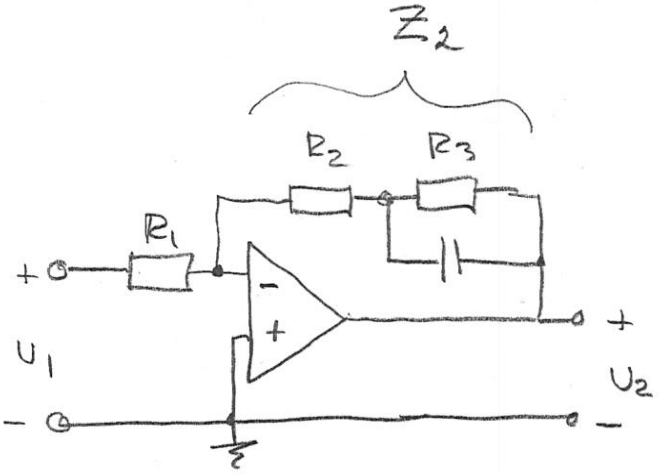
$$F(\omega) = -\frac{Z_2}{R_1} \quad (1)$$

$$Z_2 = R_2 + R_3 /\!/ \frac{1}{j\omega C}$$

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




$R_1 = 2{,}2k\Omega$ $R_2 = 82k\Omega$ $R_3 = 330k\Omega$ $C = 47nF$

$$= \frac{R_3}{1+j\omega R_3 C} \Rightarrow Z_2 = R_2 + \frac{R_3}{1+j\omega R_3 C} = \frac{R_2+R_3+j\omega R_2 R_3 C}{1+j\omega R_3 C} =$$

$$= (R_2+R_3) \cdot \frac{1+j\omega \frac{R_2 R_3}{R_2+R_3} \cdot C}{1+j\omega R_3 C}. \text{ Sätt in i (1):}$$

$$F(\omega) = -\frac{R_2+R_3}{R_1} \cdot \frac{1+j\omega \frac{R_2 R_3}{R_2+R_3} \cdot C}{1+j\omega R_3 C} = -187 \cdot \frac{1+j\frac{\omega}{324}}{1+j\frac{\omega}{64{,}5}}$$

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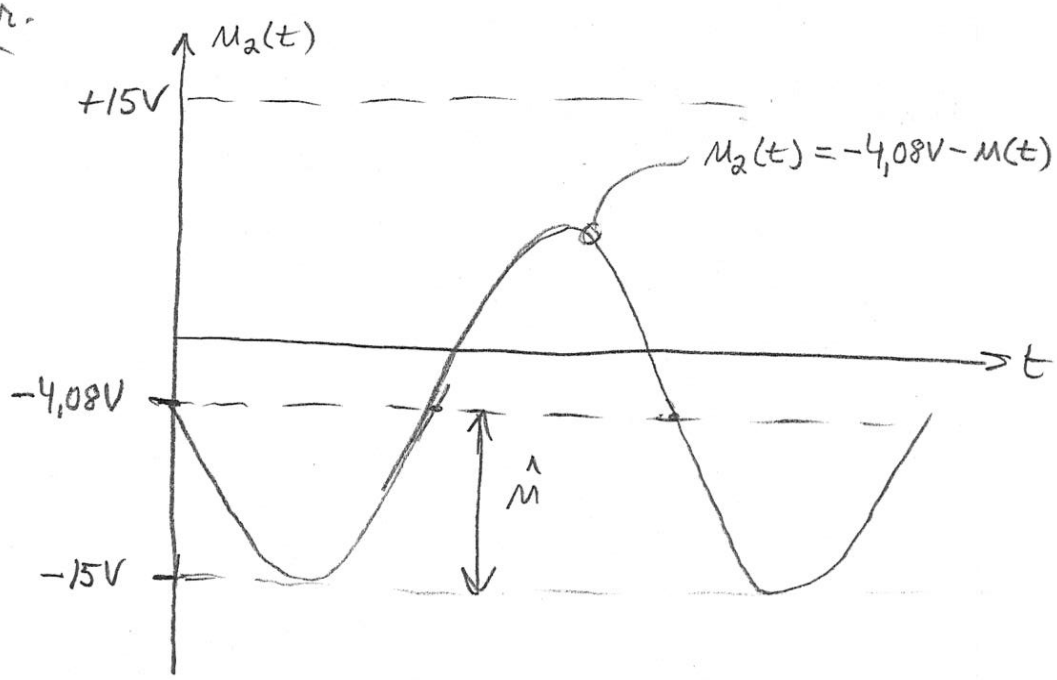
(9.) Summator koppling $\Rightarrow$

$$u_2 = -\frac{68k\Omega}{10k\Omega} \cdot 0{,}16V - \frac{68k\Omega}{4{,}7k\Omega} \cdot u_1 =$$

$$= -4{,}08V - \overbrace{14{,}47 \cdot u_1}^{u(t)} = -4{,}08V - u$$

Vi beräknar först $\hat{u}_{max}$.

Figur.




$\Rightarrow \quad \hat{u} = -4{,}08V - (-15V) = 10{,}92V \quad \Rightarrow$

$$\hat{u}_{1max} = \frac{10{,}92V}{14{,}47} = \underline{\underline{0{,}7547V}}$$