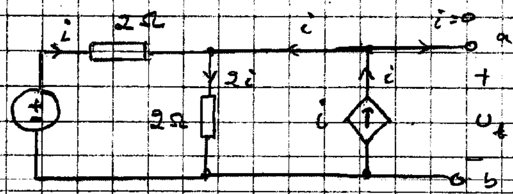
Lösningar till tentamen i Elektriska kretsar och signaler del A 2002-12-20

1/



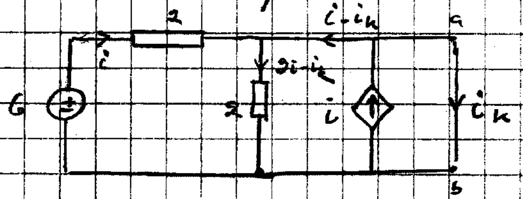
a) 1/ Tomgångsspänning sätt utströmmen i fig

KVL : $-6 + 2i + 2i \cdot 2 = 0$

$\Rightarrow i = 1$

KVL $\quad 2i \cdot 2 - u_t = 0 \quad \Rightarrow \underline{\underline{u_t}} = 4 \cdot i = \underline{\underline{4\ V}}$

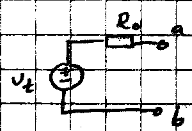
2/ Kortslutning



KVL $\quad -6 + 2i = 0 \quad \Rightarrow i = 3$

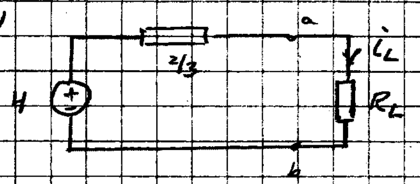
" $\quad (2i - i_k)2 - 0 = 0$

$\Rightarrow \underline{\underline{i_k}} = 2i = 6\ A$



$R_o = \dfrac{u_t}{i_k} = \underline{\underline{\dfrac{2}{3}}}\ \Omega$

b)



Anpassning (fall 1)

Max effekt i R_L för $\underline{\underline{R_L = \frac{2}{3}\ \Omega}}$

KVL $\quad -4 + \frac{2}{3} i_L + R_L i_L = 0$

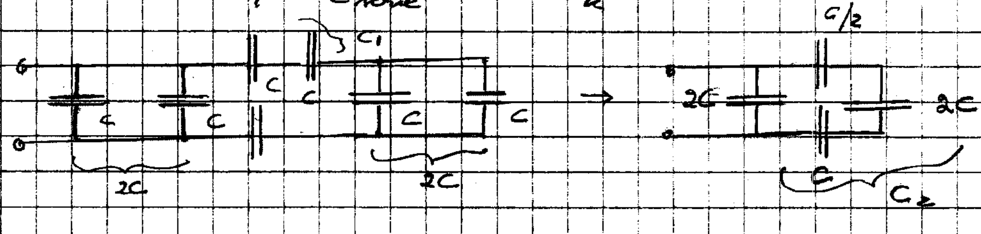
$\Rightarrow i_L = \dfrac{4}{\frac{2}{3} + R_L} = 3\ A \qquad$ Effekt i R_L : $\underline{P_{L\,max}} = R_L i_L^2 = \underline{\underline{6\ W}}$

2a/ $\quad C_{//} = \Sigma C_k \, ; \quad \dfrac{1}{C_{serie}} = \Sigma \dfrac{1}{C_k}$

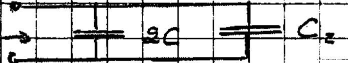
$\dfrac{1}{C} + \dfrac{1}{C} = \dfrac{1}{C_1}$

$\Rightarrow C_1 = C/2$

C_{tot}



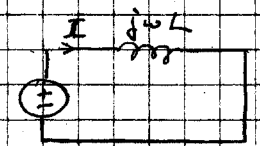
C_{tot}



$\dfrac{1}{C_2} = \dfrac{1}{C} + \dfrac{1}{2C} + \dfrac{1}{C/2} = \dfrac{7}{2C} \Rightarrow C_2 = 2C/7$

$\underline{\underline{C_{tot}}} = 2C + C_2 = \underline{\underline{\dfrac{16}{7} C}}$

2b/



$U_0 = j\omega L \, I \qquad 100\, e^{j0^\circ} = j\omega L \cdot 20 e^{j\alpha} =$

$= \omega L \cdot 20\, e^{j(\frac{\pi}{2} + \alpha)}$

$U_0 = 100\, e^{j0^\circ}$

$I = 20\, e^{j\alpha}$

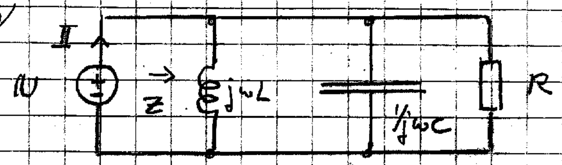
$\omega = 2\pi f = 2\pi \cdot 50$

Beloppen lika, vinklarna lika $\Rightarrow$

$\begin{cases} 100 = 20 \omega L & \Rightarrow \underline{L} = \dfrac{100}{20 \cdot 100\pi} = \underline{\underline{15{,}9 \cdot 10^{-3}\ H}} \\ 0 = \alpha + \frac{\pi}{2} & \Rightarrow \underline{\underline{\alpha = -\frac{\pi}{2}}} \quad (\alpha = -90^\circ) \end{cases}$

Lösn. El kretsar och signaler del A 2002-12-20 forts EP

3/



Parallellresonanskrets

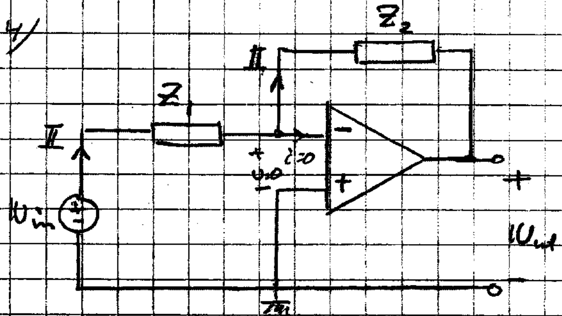
$$\frac{1}{Z} = Y = \underbrace{\frac{1}{j\omega_0 L} + j\omega_0 C}_{=0 \text{ vid resonans}} + \frac{1}{R} \qquad \omega_0^2 = \frac{1}{LC}$$

$$\Rightarrow Z(\omega_0) = R \ ; \quad \frac{U}{I} = \frac{U_m e^{j0}}{I_m e^{j0}} = R$$

$$\Rightarrow R = \frac{10}{10^{-2}} = \underline{\underline{10^3\ \Omega}} \qquad Q_{\parallel} = \frac{R}{\omega_0 L} \ ; \quad 100 = \frac{10^3}{2\cdot 10^3 L}$$

$$\Rightarrow \underline{\underline{L = 5\cdot 10^{-3}\ H}} \qquad \omega_0^2 = \frac{1}{LC} \Rightarrow \underline{\underline{C}} = \frac{1}{\omega_0^2 L} = \frac{1}{4\cdot 10^6 \cdot 5\cdot 10^{-3}} = \underline{\underline{50\cdot 10^{-6}\ F}}$$

4/



a) Impedanser $Z_1 = \frac{R_1}{1 + j\omega R_1 C_1}$

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

KVL t.v. $-U_{in} + Z_1 I + 0 = 0$

" th $-0 + Z_2 I + U_{ut} = 0$

$$\Rightarrow U_{ut} = -Z_2 I = -Z_2 \frac{U_{in}}{Z_1} \qquad H(j\omega) = \frac{U_{ut}}{U_{in}} = -\frac{Z_2}{Z_1} =$$

$$= \underline{\underline{-\frac{R_2}{R_1}\,\frac{(1 + j\omega R_1 C_1)}{(1 + j\omega R_2 C_2)}}} = -\frac{R_2}{R_1}\,\frac{1 + j\omega/\omega_1}{1 + j\omega/\omega_2} \qquad \omega_1 = \frac{1}{R_1 C_1} \ ; \ \omega_2 = \frac{1}{R_2 C_2}$$

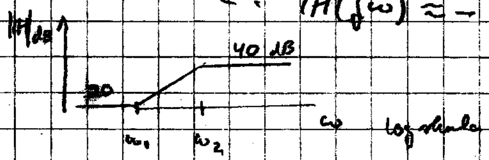
b) $\omega_1 = \frac{1}{R_1 C_1} = 200 \qquad \omega_2 = \frac{1}{R_2 C_2} = 2\cdot 10^3$

$\omega < \omega_1$: $H(j\omega) \approx -\frac{R_2}{R_1} = -10 \qquad 20\ {}^{10}\log 10 = 20$ dB

$\omega_1 < \omega < \omega_2$: $H(j\omega) \approx -\frac{R_2}{R_1}\, j\omega R_1 C_1 = -j\omega R_2 C_1$ $\quad |H|$ stiger med 20 dB/dekad

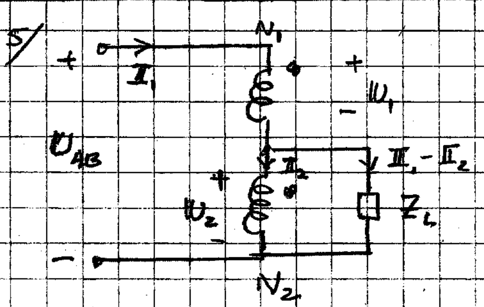
$\omega > \omega_2$: $H(j\omega) \approx -\frac{R_2}{R_1}\,\frac{j\omega/\omega_1}{j\omega/\omega_2} = \frac{-R_2\omega_2}{R_1\omega_1} = -10\cdot 10$

$20\ {}^{10}\log(100) = 40$ dB



Ideala transformatorns ekv. + KVL

5/



$$\begin{cases} \frac{U_1}{N_1} = \frac{U_2}{N_2} & (1) \\ N_1 I_1 + N_2 I_2 = 0 & (2) \\ -U_{AB} + U_1 + U_2 = 0 & (3) \\ -U_2 + Z_L(I_1 - I_2) = 0 & (4) \end{cases}$$

$$\Rightarrow U_{AB} = \frac{(N_1 + N_2)^2}{N_2^2} Z_L I_1 \Rightarrow Z_{in} = \frac{U_{AB}}{I_1} = \underline{\underline{\frac{(N_1 + N_2)^2}{N_2^2} Z_L}}$$