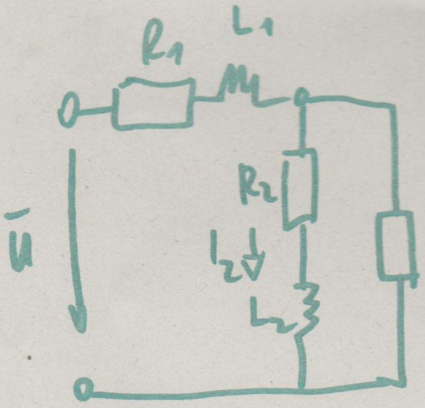
1.) Veszteséges rezgőkör

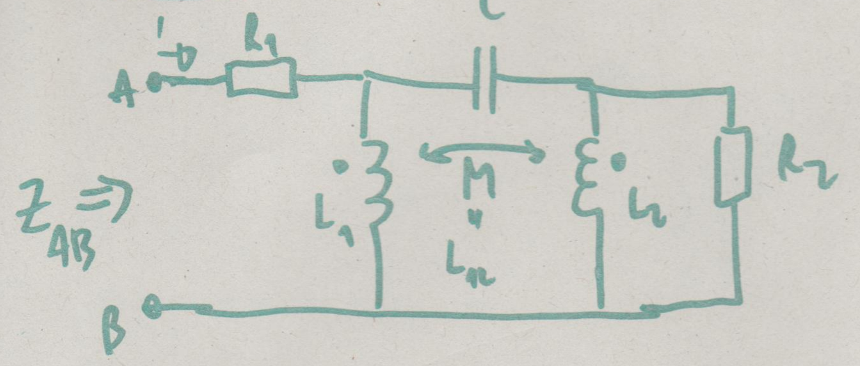
2.) Hummel-kapcsolás
(3.1-16.)



R=?, hogy I_2 90°-kal késsen $\bar{U}$-hoz képest

Mindig megoldható!

3.) 3.1-27



$R_1 = 2\ k\Omega$; $R_2 = 2\ k\Omega$; $L_1 = 100\ \mu H$

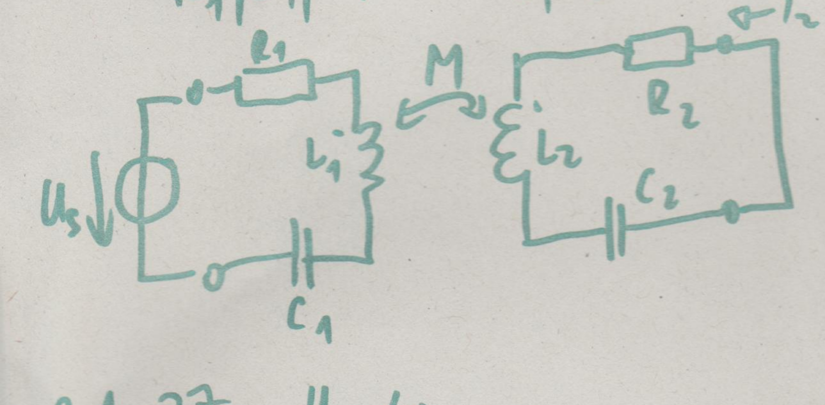
$L_2 = 10\ \mu H$; $L_{12} = 20\ \mu H$

$C = 50\ pF$ $\quad f = 2\ MHz$

vagy

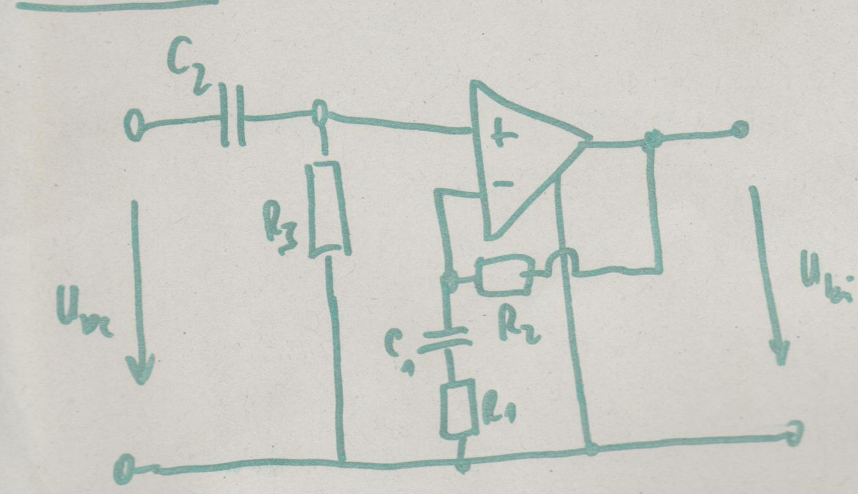
3.1-28.

R_1, L_1, C_1 és R_2, L_2, C_2 soros rezgőkörök

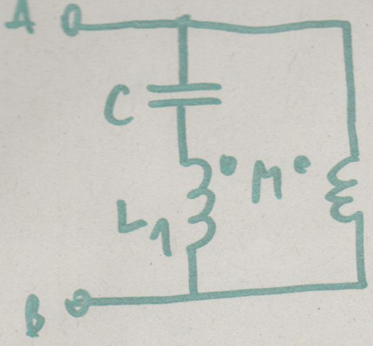


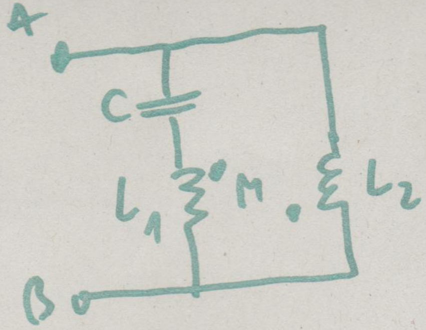
M=?, hogy I_2 maximális legyen?

3.1-37. U_{ki}/U_{be}



3.2-3.1 $Z_{AB}(j\omega) = ?$ rezonáns ($Z=0$) és antirezonáns ($Z \to \infty$) állapotok → általánosítás lehetősége nem reaktáns hálózatokra?



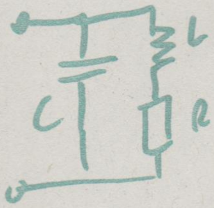


Soros rezgőkör → 3.2-4

$$\omega_0 = \frac{1}{\sqrt{LC}}$$ rezonancia frekvencia

$$Q_0 = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{\sqrt{L/C}}{R}$$ jósági tényező

$\boxed{3.2.5}$

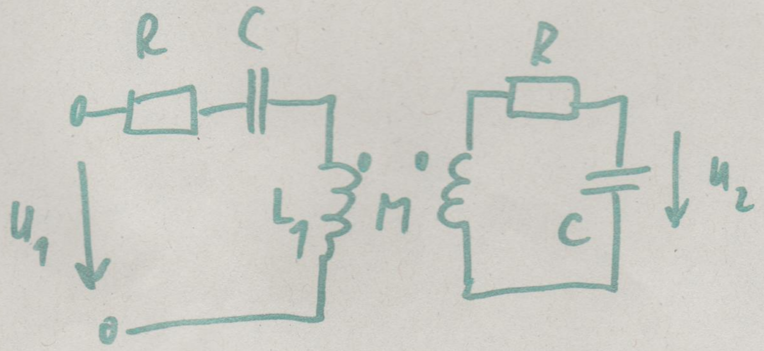


ω_φ, ahol a fázisszög 0 (fázisrezonancia + látszólagos ellenállás maximális (amplitúdó rezonancia) ω_Z

$\boxed{3.2-7}$

Sávszűrő

$\frac{U_2}{U_1}$

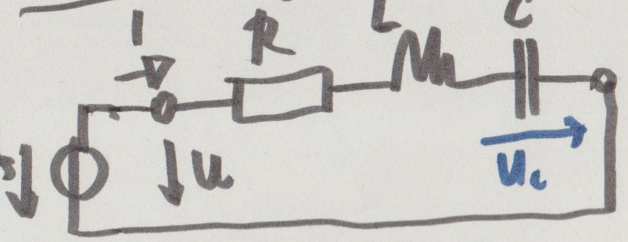


k =

$Q_0 = \omega_0 \cdot \frac{L}{R}$ $Q_0 \geq 100$ nagys értékben

$$k = \frac{M^2}{L_1 L_2}$$

Soros rezgőkör (vontességy)



$$\bar{I}\cdot\left(R+j\omega L+\frac{1}{j\omega C}\right)=\bar{U}$$

$$\bar{Y}=\frac{\bar{I}}{\bar{U}}=\frac{1}{R+j\omega L+\frac{1}{j\omega C}}=\frac{j\omega C}{1+j\omega C R+(j\omega)^2 LC}$$

$$j\omega\boxed{\frac{1}{L}}\cdot\frac{1}{(j\omega)^2+j\omega\frac{R}{L}+\frac{1}{LC}}$$

$$\frac{R}{L}=R\cdot\sqrt{\frac{C}{C}}\cdot\frac{1}{\sqrt{L}\cdot\sqrt{L}}=\underbrace{R\cdot\sqrt{\frac{C}{L}}}_{Q_0^{-1}}\cdot\underbrace{\frac{1}{\sqrt{LC}}}_{\Omega_0}=\frac{\Omega_0}{Q_0}$$

pl. $L=1$; $C=1$; k.b.r

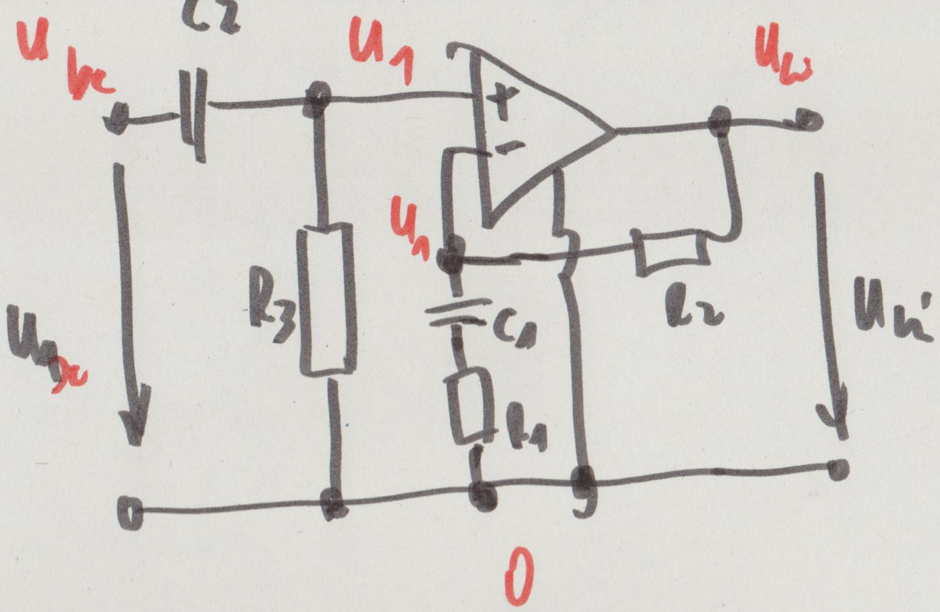
$R=1 \rightarrow Q_0=\frac{\sqrt{L/C}}{R}=1$

$R=0{,}1 \rightarrow Q_0=\frac{\sqrt{L/C}}{0{,}1}=10$ (nagy jósági)

$R=10 \rightarrow Q_0=\frac{\sqrt{L/C}}{10}=0{,}1$ (kis jósági)

U_c-re ~~...~~ vonatkozó $H(j\omega)$

$$H(j\omega)=\frac{1/LC}{(j\omega)^2+j\omega\cdot\frac{R}{L}+\frac{1}{LC}}$$



$$\left.\begin{aligned} & j\omega C_3 (U_1 - U_{be}) + \frac{1}{R_3} U_1 = 0 \\ & \frac{U_1 - U_{ki}}{R_2} + \frac{U_1}{R_1 + \frac{1}{j\omega C_1}} = 0 \end{aligned}\right\}$$

$$\frac{U_{ki}}{U_{be}} = \frac{(j\omega)^2 \left(C_1 C_3 R_1 R_3 + C_1 C_3 R_2 R_3\right) + C_3 R_3 j\omega}{(j\omega)^2 C_1 C_3 R_1 R_3 + (C_1 R_1 + C_3 R_3) j\omega + 1}$$

$$H(j\omega) = \frac{\left(1 + \frac{R_2}{R_1}\right)(j\omega)^2 + \frac{1}{C_1 R_1} j\omega}{(j\omega)^2 + j\omega\left(\frac{1}{C_3 R_3} + \frac{1}{C_1 R_1}\right) + \frac{1}{C_1 R_1 C_3 R_3}}$$

p1. $R_1 = 1\ k\Omega$; $R_3 = 5\ k\Omega$

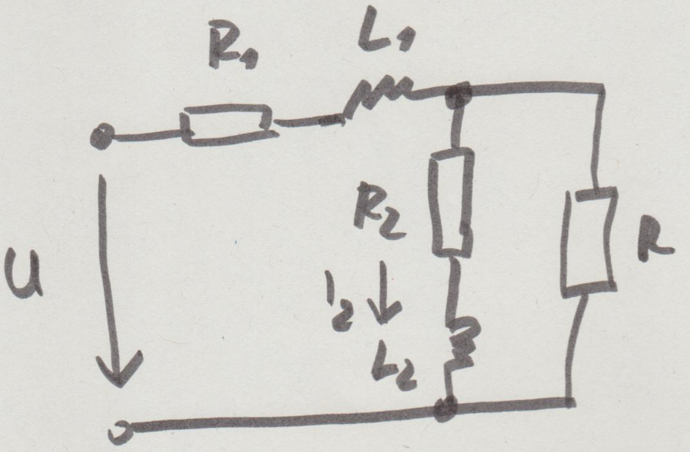
$C_1 = 2\ nF$; $C_3 = 0{,}5\ nF$

$R_2 = 4\ k\Omega$

$$H(j\omega) = \frac{5 \cdot j\omega (10 j\omega + 1)}{2 \cdot (2 j\omega + 1)\left(\frac{5 j\omega}{2} + 1\right)}$$

$\omega \to 1/2$ $\qquad$ $\omega \to 2/5$

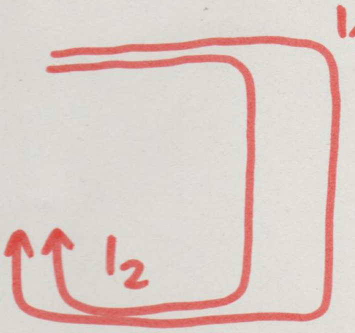
Hummel-kapcsolás



$\bar{I}_2$ késik $\bar{U}$-hoz képest

$$\bar{I}_2 = \underbrace{\bigcirc}_{\text{valós kifejezés}} \cdot e^{-j\pi/2} \cdot \bar{U} = \bigcirc (-j) \cdot \bar{U}$$

pl. hurokáramok?



$$(R_1 + j\omega L_1)(I_1 + I_2) + R I_1 - U = 0$$

$$(R_1 + j\omega L_1)(I_1 + I_2) + (R_2 + j\omega L_2) I_2 - U = 0$$

$$\frac{\bar{I}_2}{\bar{U}} = \frac{R}{(j\omega)^2 L_1 L_2 + j\omega\left(R(L_1 + L_2) + L_1 R_2 + L_2 R_1\right) + R(R_1 + R_2) + R_1 R_2}$$

$$\frac{\bar{I}_2}{\bar{U}} = \frac{\bigcirc}{j\omega \Sigma}$$

$$-L_1 L_2 \omega^2 + R(R_1 + R_2) + R_1 R_2 = 0$$

$$\boxed{R = \frac{\omega^2 L_1 L_2 - R_1 R_2}{R_1 + R_2}}$$

a feladat megoldható, ha

$$\omega^2 L_1 L_2 - R_1 R_2 > 0$$

$$\omega^2 > \frac{R_1 R_2}{L_1 L_2} \quad \text{azaz} \quad \boxed{\omega > \sqrt{\frac{R_1 R_2}{L_1 L_2}}}$$

mire alkalmazható

$\bar{U}_2 = R_2 \cdot \bar{I}_2$ és $\bar{U}$ mérésével (fázis különbség)

R értékét megállapítjuk, ha

R_2, L_2, R_1 nagy pontosságú, akkor

L_1 mérhető R alapján

$$L_1 = \frac{R(R_1 + R_2) + R_1 R_2}{L_2 \omega^2} \quad \text{módon}$$

- Rajzoljuk fel $\frac{\bar{U}_2}{\bar{U}}$-t

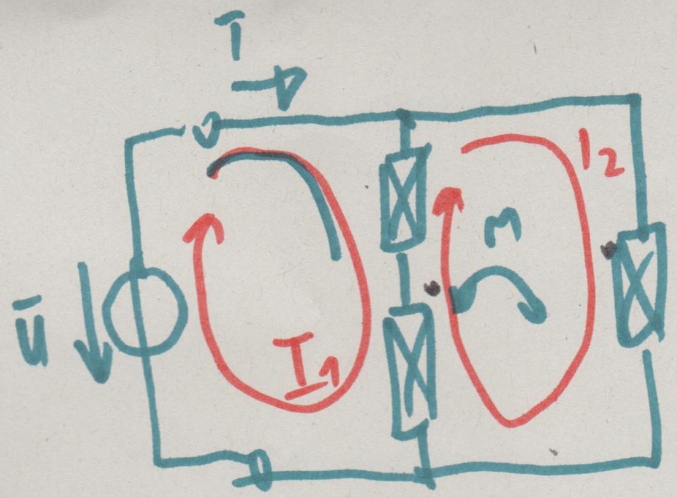
$R_1 = 1\ k\Omega \quad L_1 = 2\ mH$

$R_2 = 2\ k\Omega \quad L_2 = 3\ mH$

$\omega = \cancel{0{,}5}\ 2\ Mrad/s$

$R = 7{,}334\ k\Omega$

$$Z_{AB} = \frac{\bar U_{AB}}{\bar I_{AB}}$$

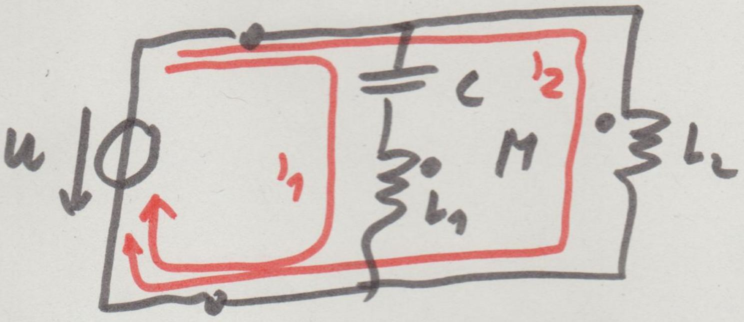


$$-\bar U + (\bar I_1 - \bar I_2)\frac{1}{j\omega C} + j\omega L_1 (I_1 - I_2) + j\omega M (I_2)$$

$$\frac{1}{j\omega C}\cdot (I_2 - I_1) + j\omega L_1 (I_2 - I_1) - j\omega M I_2 + j\omega L_2 I_2 + j\omega M (I_1 - I_2) = 0$$

$$\begin{pmatrix} j\omega L + \frac{1}{j\omega C} & -\frac{1}{j\omega C} - j\omega L_1 + j\omega M \\ -j\omega L_1 - \frac{1}{j\omega C} + j\omega M & j\omega (L_1 + L_2 - 2M) + \frac{1}{j\omega C} \end{pmatrix} \begin{pmatrix} \bar I_1 \\ \bar I_2 \end{pmatrix} = \begin{pmatrix} \bar U \\ 0 \end{pmatrix}$$

jobban megválasztott hurokáramok



$$\left.\begin{aligned} -\bar{U} + \frac{1}{j\omega C} \cdot I_1 + j\omega L_1 I_1 + j\omega M I_2 = 0 \\ -\bar{U} + j\omega L_2 I_2 + j\omega M I_1 = 0 \end{aligned}\right\}$$

$$\begin{pmatrix} j\omega L_1 + \frac{1}{j\omega C} & j\omega M \\ j\omega M & j\omega L_2 \end{pmatrix} \begin{pmatrix} I_1 \\ I_2 \end{pmatrix} = \begin{pmatrix} \bar{U} \\ \bar{U} \end{pmatrix}$$

$$Z_{AB} = \frac{U_{AB}}{I_{AB}} = \frac{j\omega\left((j\omega)^2 C (L_1 L_2 - M^2) + L_2\right)}{(j\omega)^2 (L_1 + L_2 - 2M) C + 1}$$

$$= j\omega \cdot \underbrace{\frac{L_1 L_2 - M^2}{L_1 + L_2 - 2M}}_{[L]} \cdot \frac{(j\omega)^2 + \frac{L_2}{C(L_1 L_2 - M^2)}}{(j\omega)^2 + \frac{1}{C(L_1 + L_2 - 2M)}}$$

$k = \frac{M^2}{L_1 L_2}$

csatolási tényező

($k < 1$ van

$k > 1$ nincs

rezonancia : $Z \to \infty$

$$j\omega \cdot \frac{N(j\omega)}{M(j\omega)} \cdot A = Z$$

$N(j\omega) \neq 0$ és $|N(j\omega)| \not\to \infty$

$M(j\omega) \to 0$

$$j\omega^2 \cdot C(L_1 + L_2 - 2M) + 1 = 0$$

$$(j\omega)^2 = -\frac{1}{C(L_1 + L_2 - 2M)} = -\omega^2$$

$$\omega_r = \frac{1}{\sqrt{C(L_1 + L_2 - 2M)}}$$

mH, nF

pl. $L_1 = 10$; $L_2 = 20$

$M = \sqrt{0{,}1 \cdot L_1 L_2} \approx$

$= 4{,}4721$

$C = 2$

$\omega_r = 0{,}1541$

antirezonancia, ha $Z \to 0$

$$N(j\omega) = 0$$

$$L_2 + (j\omega)^2 \cdot C(L_1 L_2 - M^2) = 0$$

$$\omega^2 = \frac{L_2}{C(L_1 L_2 - M^2)} = \frac{1}{L_1 C(1 - k^2)} = \frac{1}{L_1 C} \cdot \frac{1}{1 - k^2}$$

$$\omega = \frac{1}{\sqrt{L_1 C}} \cdot \frac{1}{\sqrt{1 - k^2}} = 0{,}2357 \text{ Mrad/s}$$