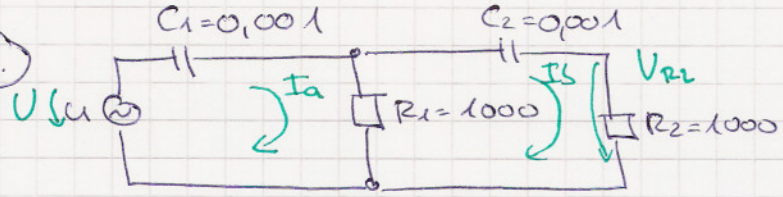
7.



$\omega = 1000$, $U = 90V$
$u = U \cdot \sin(\omega t)$

Určete fázový posuv mezi fázory U_a a U_{R2}

Potřebujeme spočítat U_{R2}. Platí: $U_{R2} = R_2 \cdot I_{R2}$
Proud I_{R2} spočítáme pomocí smyčkových proudů I_a, I_b. Platí $I_b = I_{R2}$

Pozn. $C_1 = C_2 = C$
$R_1 = R_2 = R$

$$\frac{1}{j\omega C} \cdot I_a + R_1 \cdot (I_a - I_b) - U = 0$$
$$\frac{1}{j\omega C} \cdot I_b + R_2 \cdot I_b + R_1 \cdot (I_b - I_a) = 0$$

$$I_a \cdot \left(\frac{1}{j\omega C} + R\right) + I_b \cdot (-R) = U$$
$$I_a \cdot (-R) + I_b \cdot \left(2R + \frac{1}{j\omega C}\right) = 0$$

$$D = \begin{vmatrix} \frac{1}{j\omega C} + R & -R \\ -R & 2R + \frac{1}{j\omega C} \end{vmatrix} = \left(\frac{1}{j\omega C} + R\right)\left(2R + \frac{1}{j\omega C}\right) - R^2 =$$

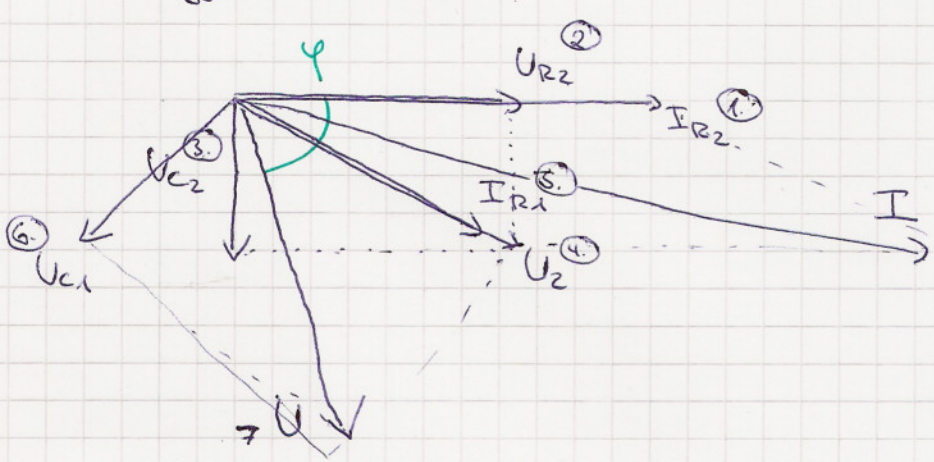
$$= \frac{2R}{j\omega C} - \frac{1}{\omega^2 C^2} + 2R^2 + \frac{R}{j\omega C} - R^2 = R^2 + \frac{3R}{j\omega C} - \frac{1}{\omega^2 C^2}$$

$$I_b = \frac{\begin{vmatrix} \frac{1}{j\omega C} + R & U \\ -R & 0 \end{vmatrix}}{D} = \frac{U \cdot R}{R^2 + \frac{3R}{j\omega C} - \frac{1}{\omega^2 C^2}}$$

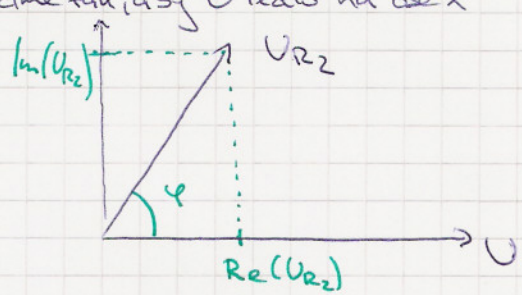
$$U_{R2} = I_b \cdot R = \frac{UR^2}{R^2 + \frac{3R}{j\omega C} - \frac{1}{\omega^2 C^2}} = \frac{90 \cdot 10^6}{10^6 + \frac{3 \cdot 10^3}{j} - 1} = \frac{90 \cdot 10^6}{(10^6 - 1) - 3 \cdot 10^3 j} \cdot \frac{((10^6 - 1) + 3 \cdot 10^3 j)}{((10^6 - 1) + 3 \cdot 10^3 j)}$$

$$= \frac{90 \cdot 10^6 \cdot ((10^6 - 1) + 3 \cdot 10^3 j)}{(10^6 - 1)^2 + 9 \cdot 10^6} = 89{,}99928 + 0{,}26999811\, j$$

Vyjádříme obvod pomocí fázorů:



A otočíme tak, aby U leželo na ose x



Platí: $\operatorname{tg}\varphi = \frac{Im}{Re}$

$\Rightarrow \varphi = \operatorname{arctg}\frac{Im}{Re} \doteq 3 \cdot 10^{-3}$ rad