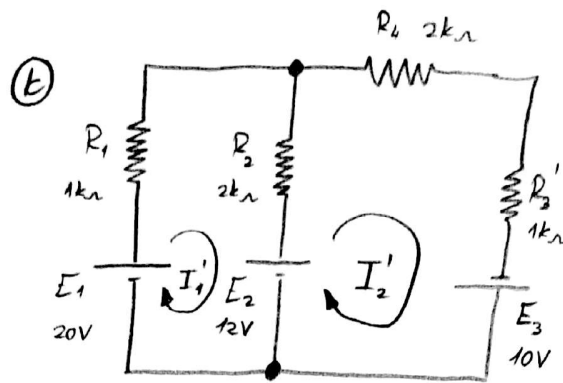


5



$$\begin{pmatrix} +R_{11} & -R_{12} \\ -R_{21} & R_{22} \end{pmatrix} \cdot \begin{pmatrix} I_1' \\ I_2' \end{pmatrix} = \begin{pmatrix} E_1' \\ E_2' \end{pmatrix}$$

$$R_{11} = R_1 + R_2 = 3k\Omega$$

$$E_1' = E_1 - E_2 = 8V$$

$$R_{22} = R_2 + R_4 + R_3' = 5k\Omega$$

$$E_2' = E_2 + E_3 = 22V$$

$$R_{12} = R_{21} = R_2 = 2k\Omega$$

$$\Downarrow$$

$$\begin{pmatrix} 3 & -2 \\ -2 & 5 \end{pmatrix} \cdot \begin{pmatrix} I_1' \\ I_2' \end{pmatrix} = \begin{pmatrix} 8 \\ 22 \end{pmatrix}$$

$\Downarrow$

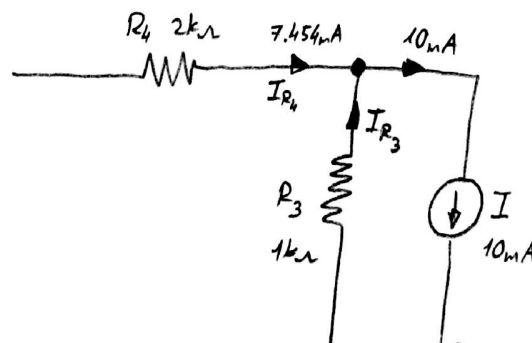
$$\textcircled{2} \quad I_1' = \frac{84}{11} = 7.636mA \quad I_2' = \frac{82}{11} = 7.454mA$$

$\Downarrow$

$$I_{R_1} = I_1' = 7.636mA \quad I_{R_2} = I_1' - I_2' = \frac{2}{11} = 0.181mA$$

$$I_{R_4} = I_2' = 7.454mA$$

על מנת למצוא את הזרם ב- R_3 הוא R_3' נעזרים במשפט קירכהוף השני. הזרם ב- R_3' הוא I (10mA) והזרם ב- R_3 הוא I_{R_3} .



לפי משפט קירכהוף השני, הזרם ב- R_3 הוא I_{R_3} .

$$I_{R_3} = I - I_{R_4} = 10 - 7.454 = \frac{28}{11} = 2.545mA$$

$\Downarrow$

$$\textcircled{3} \quad P_{R_3} = I_{R_3}^2 \cdot R_3 = 2.545^2 \cdot 1 = 6.48mW$$

⑥

$$Z_1 = -j \frac{1}{2\pi f C} = -j \frac{1}{2\pi \cdot 1000 \cdot 1 \cdot 10^{-6}} = -j 159.155 \Omega$$

$$Z_2 = j 2\pi f L = j 2\pi \cdot 1000 \cdot 20 \cdot 10^{-3} = j 125.663 \Omega$$

$$A = D = 1 + \frac{Z_2}{Z_1} = 1 + \frac{j 125.663}{-j 159.155} = 0.21$$

$$B = Z_2 = j 125.663 \Omega$$

$$C = \frac{Z_1 + Z_2 + Z_1}{Z_1 \cdot Z_1} = \frac{2Z_1 + Z_2}{Z_1^2} = \frac{2 \cdot (-j 159.155) + j 125.663}{(-j 159.155)^2} = j 7.605 \text{ mS}$$

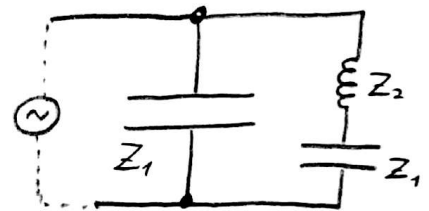
$\Downarrow$

$$\begin{pmatrix} A & B \\ C & D \end{pmatrix} = \begin{pmatrix} 0.21 & j 125.663 \\ j 7.605 \cdot 10^{-3} & 0.21 \end{pmatrix}$$

$$\textcircled{2} \textcircled{1} Z_{oc} = (Z_2 + Z_1) \parallel Z_1 =$$

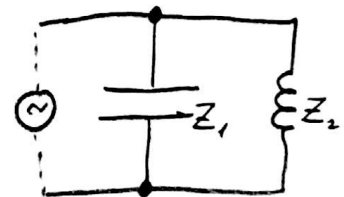
$$= \left(\frac{1}{j 125.663 - j 159.155} + \frac{1}{-j 159.155} \right)^{-1} =$$

$$= -j 27.693 \Omega$$



$$\textcircled{2} Z_{sc} = Z_1 \parallel Z_2 = \left(\frac{1}{-j 159.155} + \frac{1}{j 125.663} \right)^{-1} =$$

$$= j 597.154 \Omega$$



$\Downarrow$

$$\textcircled{3} Z_o = \sqrt{Z_{oc} \cdot Z_{sc}} = \sqrt{-j 27.693 \cdot j 597.154} = \sqrt{16537} = 128.6 \Omega$$

⑫

$$Z_o = \sqrt{\frac{B}{C}} = \sqrt{\frac{j 125.663}{j 7.605 \cdot 10^{-3}}} = \sqrt{16523.734} = 128.54 \Omega$$

7

$$Q_0 = 50$$

$$\omega = 10^6 \frac{\text{rad}}{\text{sec}}$$

$$\underline{U} = \frac{2}{\sqrt{2}} \angle 0^\circ = 1.414 \angle 0^\circ \text{ V}$$

$$\underline{I} = 10 \angle 0^\circ \text{ mA}$$

$$\textcircled{b} \underline{R} = \underline{Z}_T = \frac{\underline{U}}{\underline{I}} = \frac{1.414 \angle 0}{10 \cdot 10^{-3} \angle 0} = \boxed{141.421 \Omega}$$

$$Q_0 = \frac{\omega_0 L}{R}$$

$$50 = \frac{10^6 L}{141.421}$$

$$\boxed{L = 7.071 \text{ mH}}$$

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

$$10^6 = \sqrt{\frac{1}{7.071 \cdot 10^{-3} C}}$$

$$\boxed{C = 141.422 \text{ pF}}$$

$$\textcircled{c} \underline{BW} = \frac{f_0}{Q_0} = \frac{\omega_0 / 2\pi}{Q_0} = \frac{10^6 / 2\pi}{50} = \boxed{3.183 \text{ kHz}}$$

$$\textcircled{d} \omega = 5 \cdot 10^5 \frac{\text{rad}}{\text{sec}}$$

$$\underline{Z}_L = j\omega L = j5 \cdot 10^5 \cdot 7.071 \cdot 10^{-3} = j3535.5 \Omega = \boxed{j3.535 \text{ k}\Omega}$$

$$\underline{Z}_C = -j \frac{1}{\omega C} = -j \frac{1}{5 \cdot 10^5 \cdot 141.422 \cdot 10^{-12}} = -j14142 \Omega = \boxed{-j14.142 \text{ k}\Omega}$$

$$\underline{Z}_T = \underline{Z}_L + \underline{Z}_C + R = j3.535 - j14.142 + 0.141 = (0.141 - j10.607) \text{ k}\Omega = 10.607 \angle -89.23^\circ \text{ k}\Omega$$

$$\underline{I} = \frac{\underline{U}}{\underline{Z}_T} = \frac{1.414 \angle 0}{10.607 \angle -89.2} = 0.133 \angle 89.23^\circ \text{ mA}$$

$$\begin{array}{l} \underline{U}_R = \underline{I} \cdot R = 0.018 \angle 89.23^\circ \text{ V} \\ \underline{U}_L = \underline{I} \cdot \underline{Z}_L = 0.47 \angle 179.23^\circ \text{ V} \\ \underline{U}_C = \underline{I} \cdot \underline{Z}_C = 1.88 \angle -0.77^\circ \text{ V} \end{array}$$

8

$$\underline{U}_1 = 20 \angle 0^\circ \text{ V}$$

$$\underline{I}_3 = 4 \angle \frac{\pi}{4} \text{ A} = 4 \angle 45^\circ \text{ A}$$

$\Downarrow$

$$\textcircled{b} \quad \underline{U}_B = \underline{I}_3 \cdot \underline{Z}_3 = 4 \angle 45^\circ \cdot (1-j) = 4\sqrt{2} \angle 0^\circ \text{ V} = 5.656 \angle 0^\circ \text{ V}$$

$\Downarrow$

$$u_B(t) = 4\sqrt{2} \cdot \sqrt{2} \cdot \sin(314t) = 8 \cdot \sin(314t) \text{ [V]}$$

$$\textcircled{2} \quad \underline{I}_{Z_1} = \frac{\underline{U}_1 - \underline{U}_B}{\underline{Z}_1} = \frac{20 \angle 0^\circ - 5.656 \angle 0^\circ}{4+j2} = 3.207 \angle -26.5^\circ \text{ A}$$

$\Downarrow$

$$\textcircled{c} \quad \underline{I}_{Z_2} = \underline{I}_3 - \underline{I}_{Z_1} = 4 \angle 45^\circ - 3.207 \angle -26.5^\circ = 4.263 \angle 90.54^\circ \text{ A}$$

$\Downarrow$

$$\textcircled{3} \quad \underline{I}_{Z_2} = \frac{\underline{U}_B - \underline{U}_2}{\underline{Z}_2}$$

$$4.263 \angle 90.54^\circ = \frac{5.656 \angle 0^\circ - \underline{U}_2}{j}$$

$$\underline{U}_2 = 9.918 \angle 0.233^\circ \text{ V} \approx 9.918 \angle 0^\circ \text{ V}$$

$\Downarrow$

$$u_2(t) = 9.918\sqrt{2} \cdot \sin(314t) = 14.027 \cdot \sin(314t) \text{ [V]}$$