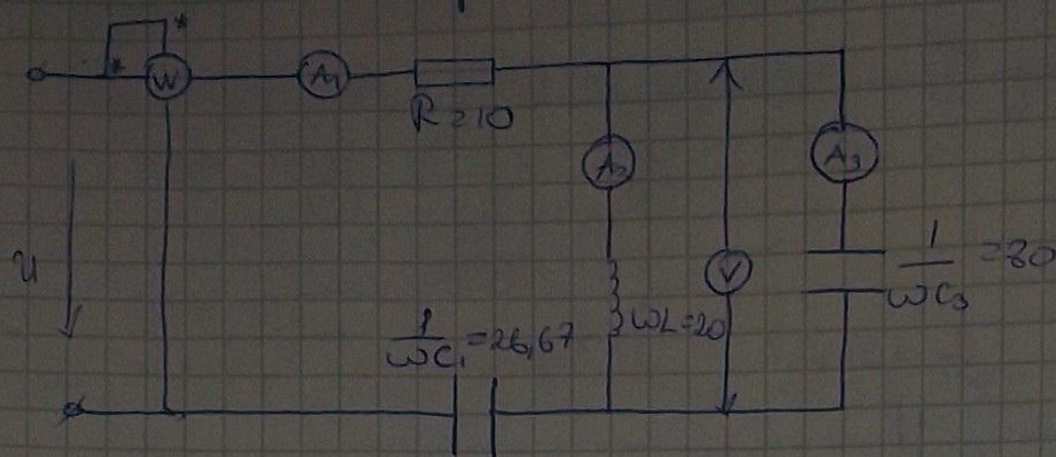


Задача №8



$$u = 220\sqrt{2}\sin(\omega t + 30^\circ) + 180\sqrt{2}\sin(2\omega t - 30^\circ) + 100\sqrt{2}\sin 3\omega t \quad (1)$$

$$u(t) = u^{(0)} + u^{(1)}\sqrt{2}\sin(\omega t + \varphi_1) + u^{(2)}\sqrt{2}\sin(2\omega t + \varphi_2) + u^{(3)}\sqrt{2}\sin(3\omega t + \varphi_3)$$

$$\text{I} \quad k=0$$

$$u^{(0)} = 0 \quad \text{I}_1^{(0)} = \frac{u^{(0)}}{R} = 0$$

$$\text{II} \quad k=1 \quad u^{(1)} = 220 e^{j30}$$

$$\underline{Z}^{(1)} = R + (-j \frac{1}{\omega C_1}) + \frac{j\omega L (-j \frac{1}{\omega C_3})}{j\omega L - j\frac{1}{\omega C_3}} =$$

$$= 10 - j26,67 + \frac{1600}{-j60} = 10$$

$$\underline{I}_1^{(1)} = \frac{u^{(1)}}{\underline{Z}^{(1)}} = \frac{220 e^{j30}}{10} = 22 e^{j30}$$

$$\underline{I}_2^{(1)} = \underline{I}_1^{(1)} \frac{(-j \frac{1}{\omega C_3})}{j\omega L - j\frac{1}{\omega C_3}} = 22 e^{j30} \frac{80}{60} = 29,3 e^{j30}$$

$$\underline{I}_3^{(1)} = \underline{I}_1^{(1)} \frac{j\omega L}{j\omega L - j\frac{1}{\omega C_3}} = 22 e^{j30} \frac{j20}{-j60} = 22 e^{j30} \frac{20 e^{j90}}{60 e^{j90}} =$$

$$= 7,3 e^{j210}$$

$$\overline{S} = u^{(1)} \underline{I}_1^{(1)*} = 220 e^{j30} 22 e^{-j30} = 4840$$

$$P = 4840$$

$$Q = (\underline{I}_2^{(1)})^2 (-j \frac{1}{\omega C_3}) + (\underline{I}_3^{(1)})^2 (j\omega L) + (\underline{I}_1^{(1)})^2 (-j \frac{1}{\omega C_1}) =$$

$$= -j263,2 + j17169,8 - j12908,28 = 0$$

III $k=2$
 $u^{(2)} = 180e^{j30}$

$$\underline{Z}^{(2)} = R + (-j \frac{1}{\omega C_2}) + \frac{j\omega L (-j \frac{1}{\omega C_3})}{j\omega L - j \frac{1}{\omega C_3}} =$$

$$= 10 - j13,335 + \frac{j40 (-j40)}{j40 - j40} = \infty$$

$$\underline{I}_1^{(2)} = \frac{u^{(2)}}{\underline{Z}^{(2)}} = 0 \Rightarrow p^{(2)} = 0$$

$$\underline{I}_2^{(2)} = 0 \quad \underline{I}_3^{(2)} = 0$$

$$S = 0$$

$$Q = 0$$

IV $k=3$
 $u^{(3)} = 100e^{j0}$

$$\underline{Z}^{(3)} = R + (-j \frac{1}{3\omega C_1}) + \frac{j3\omega L (-j \frac{1}{3\omega C_3})}{j3\omega L - j \frac{1}{3\omega C_3}} = 10 - j8,89 + \frac{j60 (-j26,67)}{j60 - j26,67} =$$

$$= 10 - j8,89 + \frac{1600,2}{j33,33} = 10 - j8,89 - j48,0108 = 10 - j56,901 =$$

$$= 57,73e^{-j80,032^\circ}$$

$$\underline{I}_1^{(3)} = \frac{u^{(3)}}{\underline{Z}^{(3)}} = \frac{100}{57,73e^{-j80,032^\circ}} = 1,7322e^{j80,032^\circ}$$

$$\underline{I}_2^{(3)} = \underline{I}_1^{(3)} \frac{(-j \frac{1}{3\omega C_3})}{j3\omega L - j \frac{1}{3\omega C_3}} = 1,7322e^{j80,032^\circ} \frac{(-j26,67)}{j33,33} =$$

$$= 1,7322e^{j80,032^\circ} \frac{26,67e^{j90^\circ}}{33,33e^{j90^\circ}} = 1,3861e^{-j9,968^\circ}$$

$$\underline{I}_3^{(3)} = \underline{I}_1^{(3)} \frac{j3\omega L}{j3\omega L - j \frac{1}{3\omega C_3}} = 1,7322e^{j80,032^\circ} \frac{j60}{j33,33} = 1,7322e^{j80,032^\circ} \frac{60e^{j90^\circ}}{33,33e^{j90^\circ}} =$$

$$= 3,1183e^{j80,032^\circ}$$

$$S^{(3)} = u^{(3)} \underline{I}_1^{(3)*} = 100 \cdot 1,7322e^{-j80,032^\circ} = 173,22e^{-j80,032^\circ} = \underline{29,984 - j170,605}$$

$$P^{(3)} = ||\underline{I}_1^{(3)}||^2 R = 30,0052 \approx P$$

$$Q^{(3)} = ||\underline{I}_2^{(3)}||^2 (-j \frac{1}{3\omega C_3}) + ||\underline{I}_2^{(3)}||^2 (j3\omega L) + (||\underline{I}_1^{(3)}||^2 (-j \frac{1}{3\omega C_1})) =$$

$$= -j259,334 + j115,2764 - j26,6746 = -j170,7322$$

(3)

Вычисление действующего значения тока

$$I_1 = \sqrt{|I_1^{(0)}|^2 + |I_1^{(1)}|^2 + |I_1^{(2)}|^2 + |I_1^{(3)}|^2} = \sqrt{0 + 484 + 0 + 3,00052} = 22,0681 \text{ (A)}$$

$$I_2 = \sqrt{|I_2^{(0)}|^2 + |I_2^{(1)}|^2 + |I_2^{(2)}|^2 + |I_2^{(3)}|^2} = \sqrt{0 + 853,49 + 0 + 1,9213} = 29,3327 \text{ (A)}$$

$$I_3 = \sqrt{|I_3^{(0)}|^2 + |I_3^{(1)}|^2 + |I_3^{(2)}|^2 + |I_3^{(3)}|^2} = \sqrt{0 + 53,29 + 0 + 9,7238} = 7,9381 \text{ (A)}$$

Полезная мощность

$$V_L = \sqrt{(\omega L^{(1)} I_2^{(1)})^2 + (\omega L^{(3)} I_2^{(3)})^2} = 591,8721 \text{ B}$$

$$V_C = \sqrt{\left(\frac{1}{\omega C_3} I_3^{(1)}\right)^2 + \left(\frac{1}{\omega C_3} I_3^{(3)}\right)^2} = 589,8918 \text{ B} \quad V_C \approx V_L$$

$$i_{A1} = 22\sqrt{2} \sin(\omega t + 30) + 1,7322\sqrt{2} \sin(3\omega t + 80,032)$$

$$i_{A2} = 29,3\sqrt{2} \sin(\omega t + 30) + 1,3261\sqrt{2} \sin(3\omega t + 99,968)$$

$$i_{A3} = 7,3\sqrt{2} \sin(\omega t + 210) + 3,1183\sqrt{2} \sin(3\omega t + 80,032)$$

$$P_w = 4840 + 30,0052 = 4870,0052 \text{ (Вт)}$$