task_pdkggtyexxy1ktu3_with_calculation

Student Group

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complex impedance, exam ee1 WS2022

Exercise E7 Impedances at different Frequencies
(written test, approx. 18 % of a 60-minute written test, WS2022)

2. A RLC series circuit with the resistor values $R_2=34.7 ~\Omega$ and $R_3=21.0 ~\Omega$ is connected to a voltage source with $U_3=1.0 ~{\rm V}$, which generates a current $I_3=50 ~{\rm mA}$.
Back to the first formula: $$R_3 \cdot {I}_{3R} = {X}_{3C} \cdot {I}_{3C}$$
$$R_3 = {X}_{3C} \cdot {{I}_{3C}\over{I}_{3R}} = {{1}\over{2\pi \cdot f \cdot C_3}} \cdot {{\sqrt{|{I}_{3}|^2 - |{I}_{3R}|^2}}\over{I}_{3R}}$$
Result: $R_3 = 20 ~\Omega$

Result: $L_2 = 4.7 ~{\rm µH}$

1. A resistor R_1 shall have the same absolute value of the impedance as a capacitor $C_1=40 ~{\rm nF}$ at $f_1=4 ~{\rm MHz}$.

Solution

Solution

Solution

$$R_1 = 1.00 ~\Omega$$

$$R_2 = 10.0 ~\Omega$$

A series circuit means that the current is constant on every component.
The equivalent impedance for R and L combined is given by $$\begin{aligned} \frac{\underline{U}}{\underline{I}} &= R_2 + \underline{X}_{L2} \\ &= R_2 + j \cdot \omega L \end{aligned}$$ Since $\underline{X}_{L2}$ is perpendicular to R_2 this can be simplified to: $$\left|\frac{\underline{U}}{\underline{I}}\right|^2 = |R_2|^2 + |\underline{X}_{L2}|^2$$
Therefore, the resulting current of the parallel circuit is given as: $$\underline{I}_3 = \underline{I}_{3R} + \underline{I}_{3C}$$
This can be rearranged to get I_{3R}: $$I_{3R} = \sqrt{I_3^2 - I_{3C}^2}$$
Back to the first formula: $$R_3 \cdot {I}_{3R} = {X}_{3C} \cdot {I}_{3C}$$
$$R_3 = {X}_{3C} \cdot {{I}_{3C}\over{I}_{3R}} = {{1}\over{2\pi \cdot f \cdot C_3}} \cdot {{\sqrt{|{I}_{3}|^2 - |{I}_{3R}|^2}}\over{I}_{3R}}$$

Parallel circuit means that the voltage is the same on R_3 and C_3. $$\underline{I}_{3C} = \frac{\underline{U}_3}{\underline{X}_{C3}} = \frac{\underline{U}_3}{-j \cdot \frac{1}{2\pi \cdot f \cdot C_3}}$$ (It has to, since R_3 is perpendicular to $\underline{I}_{3R}$ is perpendicular to ${\rm j}\cdot\underline{X}_{3C}$ too)
$\underline{I}_{3R}$ is perpendicular to $\underline{I}_{3C}$ (It has to, since R_3 is perpendicular to ${\rm j}\cdot\underline{X}_{3C}$ too)