task_pdkggtyexxy1ktu3_with_calculation

Student Group

First Name	Surname	Matrikel Nr.

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complex impedance, exam ee1 WS2022

Exercise E1.1 Impedances at different Frequencies
(written test, approx. 18 % of a 60-minute written test, WS2022)

2. A coil L with the inductance $L=4.7 ~{\rm µH}$ is added in series to the circuit. The coil has a DC resistance of $R_L=1.0 ~\Omega$.
Calculate the new resistor values R_2 and R_3 so that the current I_3 is still $21 ~{\rm mA}$ at $f=450 ~{\rm kHz}$, while the current I_2 is $60 ~{\rm mA}$.
Results: $R_2=$ 7.3 ~\Omega, $R_3=$ 20.0 ~\Omega

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

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\begin{align*} R_1 &= 1.00 ~\Omega \\ \end{align*}

\begin{align*} R_2 &= 7.0 ~\Omega \\ \end{align*}

A series circuit means that the current is constant on every component.
The equivalent impedance for R and L combined is given by \begin{align*}
{{\underline{U}}over{\underline{I}}} &= R_2 + \underline{X}_{L2} \\ &= R_2 +
\jmath \cdot \omega L \end{align*} Since ${\rm MHz} \cdot {\rm nF} = {\rm mA} / {\rm kΩ}$ is perpendicular
to R_2 this can be simplified to: \begin{align*} \left| gets clear that
$\underline{I}_{3R}$ is perpendicular to $\underline{I}_{3C}$ (It has to, since R_3
is perpendicular to ${\rm j} \cdot {X}_{3C}$ too).
Therefore, the resulting current of the parallel circuit is given as: \begin{align*}
\underline{I}_{3} &= \underline{I}_{3R} + \underline{I}_{3C} \\
This can be rearranged to get R_2: \begin{aligned} R_2 &= \sqrt{ \left|
I}_{3C}|^2 - {X}_{L2}^2 } \\ &= \sqrt{ \left({{U_1}\over{I_3}} \right)^2 -
\right)^2 - (2\pi \cdot 450~{\rm kHz} \cdot 4.7 ~ {\rm µH})^2 } \\ \end{align*}
Back to the first formula: \begin{align*} 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}}} \\ \end{align*}