task_c9fj1si7l797equs_with_calculation

Student Group

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impedance, phasor, cutoff, exam ee1 SS2023

Exercise E4 Complex voltage dividers
(written test, approx. 16 % of a 60-minute written test, SS2023)

4. Draw the two impedance phasors and the resulting phasor for the overall impedance in a diagram. Choose an appropriate scaling factor and write it down.

$\underline{U}_\rm O$ and $\underline{U}_\rm I$.

- $R = 1.1 ~\rm k\Omega$
- $L = 3.5 ~\rm mH$
- $\underline{U}_\rm I = 5 ~\rm V$
- $f_0 = 150 ~\rm kHz$

Result

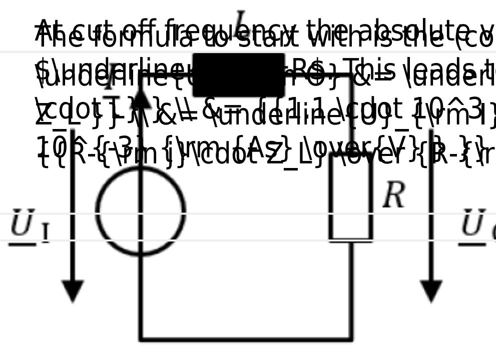
Solution

\begin{align*} \underline{Z}_L &= {\rm j} \cdot 3.3 ~\rm k\Omega \end{align*}

\begin{align*} \underline{U}_{\rm O} &= 0.5 ~\rm V - j \cdot 1.5 ~V \end{align*}

The formula to start with is the (complex) voltage divider: \begin{align*} \underline{U}_{\rm O} &= \underline{U}_{\rm I} \cdot {{R} \over {R+{\rm j}\cdot Z_L }} \\ &= \underline{U}_{\rm I} \cdot {{R} \over {R+{\rm j}\cdot Z_L }} \cdot {{R-{\rm j}\cdot Z_L} \over {R-{\rm j}\cdot Z_L }}\\ \end{align*}

At cut off frequency the absolute values of impedances $\underline{Z}_L$ is equal to $\underline{Z}_R = R$. This leads to: \begin{align*} f_{\rm cutoff} &= {{R} \over {2\pi \cdot L }} \\ &= {{1.1 \cdot 10^3 {\rm {V} \over {A} }} \over {2\pi \cdot 3.5 \cdot 10^{-3} {\rm {As} \over {V} }} \end{align*}



1. Calculate the impedance $\underline{Z}_L$.

Solution

\begin{align*} \underline{Z}_L &= {\rm j} \cdot \omega \cdot L \\ &= {\rm j} \cdot 2\pi \cdot 150 ~\rm kHz \cdot 3.5 ~\rm mH \end{align*}