

# task\_pdkggtyexxy1ktu3\_with\_calculation

## Student Group

First Name	Surname	Matrikel Nr.

## Table of Contents

complex impedance, exam ee1 WS2022

## Exercise 1 : Impedances at Frequencies

(written test, approx. 18% of a 60-minute written test, WS2022)

Calculate the **resistor values** which have to be used the following circuits.

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

Solution

$$R_1 = |\underline{X}_{C1}| = \frac{1}{2\pi \cdot f \cdot C_1} = \frac{1}{2\pi \cdot 4 \text{ MHz} \cdot 40 \text{ nF}}$$

Final result

$$R_1 = 1.00 \text{ } \Omega$$

2. A  $RL$  series circuit with  $L_2=4.7 \text{ } \mu\text{H}$ , where an AC voltage source of  $U_2=1.0 \text{ V}$  with  $f_2=450 \text{ kHz}$  generates a current  $I_2=60 \text{ mA}$ .

Solution

Series circuit means that the current is constant on every component.

The equivalent impedance for  $R$  and  $L$  combined is given by 
$$\frac{\underline{U}}{\underline{I}} = R_2 + \underline{X}_{L2} = R_2 + j \cdot \omega L$$
 Since  $j \cdot \omega L$  is perpendicular to  $R_2$  this can be simplified to: 
$$\left| \frac{\underline{U}}{\underline{I}} \right|^2 = |R_2|^2 + |\underline{X}_{L2}|^2 \quad \left| \frac{\underline{U}}{\underline{I}} \right|^2 = R_2^2 + X_{L2}^2$$

This can be rearranged to get  $R_2$ : 
$$R_2 = \sqrt{\left| \frac{\underline{U}}{\underline{I}} \right|^2 - X_{L2}^2} = \sqrt{\left( \frac{1\text{V}}{60\text{mA}} \right)^2 - (2\pi \cdot 450\text{kHz} \cdot 4.7 \text{ } \mu\text{H})^2}$$

Final result

$$R_2 = 10.0 \text{ } \Omega$$

3. A  $\$RC\$$  parallel circuit with  $\$C_3=4.7 \text{ nF}\$$  on an AC current source ( $\$I_{3S}=1.3 \text{ A}\$, \$f_3=200 \text{ kHz}\$$ ), which generates a current of  $\$I_{3R}=1.0 \text{ A}\$$  through  $\$R_3\$$ .

Solution

Parallel circuit means that the voltage is the same on  $\$R_3\$$  and  $\$C_3\$$ :

$$\underline{U}_3 = R_3 \cdot \underline{I}_{3R} = -j \cdot X_{3C} \cdot \underline{I}_{3C}$$
 So it gets clear, that  $\underline{I}_{3R}$  is perpendicular to  $\underline{I}_{3C}$  (It has to, since  $R_3$  is perpendicular to  $-j \cdot X_{3C}$ , too). Therefore, the resulting current of the parallel circuit is given as:

$$\underline{I}_3 = \underline{I}_{3R} + \underline{I}_{3C} \quad || \quad |\underline{I}_3|^2 = |\underline{I}_{3R}|^2 + |\underline{I}_{3C}|^2 \quad || \quad \underline{I}_3 = \sqrt{|\underline{I}_{3R}|^2 - |\underline{I}_{3C}|^2}$$

Back on the first formula:

$$R_3 \cdot \underline{I}_{3R} = X_{3C} \cdot \underline{I}_{3C} \quad || \quad R_3 = X_{3C} \cdot \frac{|\underline{I}_{3C}|}{|\underline{I}_{3R}|} \quad || \quad = \frac{1}{2\pi \cdot f \cdot C_3} \cdot \frac{\sqrt{|\underline{I}_3|^2 - |\underline{I}_{3R}|^2}}{|\underline{I}_{3R}|}$$

Final result

$$R_3 = 70.0 \text{ } \Omega$$

From:  
<https://wiki.mexle.org/> - MEXLE Wiki

Permanent link:  
[https://wiki.mexle.org/electrical\\_engineering\\_1/task\\_pdkggyexxy1ktu3\\_with\\_calculation?rev=1676178068](https://wiki.mexle.org/electrical_engineering_1/task_pdkggyexxy1ktu3_with_calculation?rev=1676178068)

Last update: 2023/02/12 06:01

