

task_nyniewamxfshpuwt_with_calculation

Student Group

| First Name | Surname | Matrikel Nr. |
|------------|---------|--------------|
| | | |
| | | |
| | | |

Table of Contents

| | |
|--|---|
| Exercise E18 Resonant Circuit (written test, approx. 4 % of a 120-minute written test, SS2021) | 2 |
|--|---|

resonance, resonant circuit, RMS, exam ee2 SS2021

Exercise E18 Resonant Circuit
(written test, approx. 4 % of a 120-minute written test, SS2021)

6) An alternating current source with the effective voltage $U_{\text{eff}} = 12 \text{ V}$ is connected in series with a resistor $R_i = 200 \text{ m}\Omega$ and a capacitor $C = 30 \text{ nF}$. The resistance R can be varied. The voltage U_C across the capacitor is measured. The resonance frequency f_0 is determined by the condition $U_C = U_{\text{eff}}$.

- $U_{\text{eff}} = 12 \text{ V} \cdot \sin(2\pi \cdot f_0 \cdot t)$

Path: $R_i = 200 \text{ m}\Omega$

$$R_i = 200 \text{ m}\Omega$$

- $C = 30 \text{ nF}$

For the following calculation, the internal resistance R_i and the resistance R have to be combined: $R_{\Sigma} = R_i + R$

Here, either one knows that the gain factor Q stands for $Q = \frac{U_C}{U_{\text{eff}}}$ and therefore can directly use the following formula: $Q = \frac{U_C}{U_{\text{eff}}} = \frac{1}{R_{\Sigma}} \sqrt{\frac{L}{C}}$
 $R_{\Sigma} = \frac{U_{\text{eff}}}{U_C} \sqrt{\frac{L}{C}}$

When the gain factor is not known, one has to derive it:

The voltage U at resonance is only given by the total ohmic resistance R_{Σ} and the source voltage U_{eff} : $I = \frac{U_{\text{eff}}}{R_{\Sigma}}$

This current flow also through the impedance of the capacitor $Z_C = \frac{1}{\omega C}$
 $U_C = Z_C \cdot I = \frac{1}{\omega C} \cdot \frac{U_{\text{eff}}}{R_{\Sigma}}$

At resonance, the angular frequency ω is given by $\omega = \frac{1}{\sqrt{LC}}$

$$U_C = \frac{U_{\text{eff}}}{\frac{1}{\sqrt{LC}} R_{\Sigma}} = \frac{U_{\text{eff}} \sqrt{LC}}{R_{\Sigma}}$$

a) What is the resonance frequency f_0 ?

Path

In both cases, we end up with the same formula, where we have to insert the physical values: $R_{\Sigma} = \frac{U_{\text{eff}}}{U_C} \sqrt{\frac{L}{C}}$
 $R_{\Sigma} = \frac{12 \text{ V}}{12 \text{ V}} \sqrt{\frac{20 \cdot 10^{-3} \text{ H}}{30 \cdot 10^{-6} \text{ F}}}$

The resonant frequency f_0 is given as $f_0 = \frac{1}{2\pi \sqrt{LC}}$

And so, the resistance R is: $R = R_{\Sigma} - R_i$

$$R = \frac{12 \text{ V}}{12 \text{ V}} \sqrt{\frac{20 \cdot 10^{-3} \text{ H}}{30 \cdot 10^{-6} \text{ F}}} - 200 \text{ m}\Omega = 205.4681 \text{ m}\Omega$$

From:

<https://mexle.te.hs-heilbronn.de/> - **MEXLE Wiki**

Permanent link:

https://mexle.te.hs-heilbronn.de/electrical_engineering_and_electronics/task_nyniewamxfshpuwt_with_calculation

Last update: **2024/07/04 03:52**

