

task_y7dozgdsljqvnqge_with_calculation

Student Group

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

Table of Contents

| | |
|--|---|
| Exercise E2 Capacitor (written test, approx. 7 % of a 120-minute written test, SS2022) | 2 |
|--|---|

electrostatic, capacitor, plate capacitor, capacity, exam ee2 SS2022

Exercise E2 Capacitor
(written test, approx. 7 % of a 120-minute written test, SS2022)

Calculate the capacitance of the capacitor shown in the picture. The dielectric constant of the dielectric material is $\epsilon_r = 3$ and the thickness of the dielectric material is $d = 1.0 \text{ mm}$. The length of the capacitor is $l = 1.5 \text{ cm}$ and the width of the capacitor is $w = 0.7 \text{ cm}$. The distance between the plates is $d = 1.0 \text{ mm}$.

- Depth of component: $w = 0.7 \text{ mm}$
- Dielectric constant: $\epsilon_r = 3$
- Thickness of dielectric: $d = 1.0 \text{ mm}$
- Length of capacitor: $l = 1.5 \text{ cm}$
- Width of capacitor: $w = 0.7 \text{ cm}$

The capacity can be derived from the geometry by:
$$C = \epsilon_0 \epsilon_r \frac{A}{d}$$

The air is another capacitor in series to the dielectric material. Therefore, the capacity can be calculated as
$$\frac{1}{C_{\text{total}}} = \frac{1}{C_{\text{dielectric}}} + \frac{1}{C_{\text{air}}}$$

The capacity of air is
$$C_{\text{air}} = \epsilon_0 \epsilon_{\text{air}} \frac{N \cdot l \cdot w}{d}$$

$$= 8.854 \cdot 10^{-12} \cdot 1 \cdot \frac{5 \cdot 1.5 \cdot 10^{-3} \cdot 0.7 \cdot 10^{-3}}{0.1 \cdot 10^{-6}} = 0.465 \text{ nF}$$

The material shall have a dielectric permittivity of $\epsilon_r = 3$. The following calculation shall ignore boundary effects on the end of the layers.

For this, we have to count facing areas A_0 . There are $N = 5$.
.. What is the field strength in the dielectric material between the layer, when a voltage of $U = 6.3 \text{ V}$ is applied?

The electric field strength E is given by:
$$E = \frac{U}{d} = \frac{6.3 \text{ V}}{1 \cdot 10^{-6} \text{ m}} = 6.3 \cdot 10^6 \text{ V/m}$$

Therefore, the formula is
$$C = \frac{\epsilon_0 \epsilon_r N \cdot l \cdot w}{d} = 8.854 \cdot 10^{-12} \frac{\text{As/Vm} \cdot 3 \cdot \{5 \cdot 1.5 \cdot 10^{-3} \text{ m} \cdot 0.7 \cdot 10^{-3} \text{ m}\}}{1 \cdot 10^{-6} \text{ m}}$$

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

Permanent link:
https://mexle.te.hs-heilbronn.de/electrical_engineering_and_electronics/task_y7dozgdsljqvnqge_with_calculation

Last update: **2024/07/05 01:16**

