

# task\_y7dozgdsljqvnqge\_with\_calculation

## Student Group

First Name	Surname	Matrikel Nr.

## Table of Contents

Exercise E8 Capacitor (written test, approx. 7 % of a 120-minute written test, SS2022) .....	2
--	---

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

### Exercise E8 Capacitor

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

Calculate the capacitance of the capacitor shown in the picture, with the following dimensions:  $w = 0.1 \text{ mm}$  of air ( $\epsilon_r = 1$ ), while the thickness of the dielectric material remains the same.

Length of layer overlap:  $l = 1.5 \text{ mm}$

Distance between single layers:  $d = 1.0 \text{ }\mu\text{m}$

- Depth of component:  $w = 0.7 \text{ mm}$

Number of layers (from the picture): 3 left-side and 3 right-side layers.

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 
$$C_{\text{air}} = \epsilon_0 \epsilon_r \frac{N \cdot l \cdot w}{d}$$
  

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

The material shall have a dielectric permittivity of  $\epsilon_r = 3$ .

The following calculation shall ignore boundary effects on the end of the layers.

$$\frac{1}{C_{\text{total}}} = \frac{1}{0.139 \text{ nF}} + \frac{1}{0.465 \text{ nF}}$$

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

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

Permanent link:  
[https://wiki.mexle.org/electrical\\_engineering\\_and\\_electronics/task\\_y7dozgdsljqvnqge\\_with\\_calculation](https://wiki.mexle.org/electrical_engineering_and_electronics/task_y7dozgdsljqvnqge_with_calculation)

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

