

**Answer on Question#40105, Physics, Electric Circuits**

IF A SLAB OF INSULATING MATERIAL  $4 \times 10^{-3} \text{m}$  THICK IS INTRODUCED BETWEEN THE PLATES OF A PARALLEL PLATE CAPACITOR, THE SEPARATION BETWEEN PLATES HAS TO BE INCREASED BY  $3.5 \times 10^{-3} \text{m}$  TO RESTORE THE CAPACITY TO ORIGINAL VALUE. THE DIELECTRIC CONSTANT OF THE MATERIAL WILL BE -

1. 6; 2. 8; 3. 10; 4. 12.

**Solution**

The capacitance of parallel-plate capacitor with a plate separation  $d$  and a plate area  $A$  is

$$C = \frac{\epsilon_0 A}{d},$$

where  $\epsilon_0 = 8.85 \cdot 10^{-12} \text{Fm}^{-1}$  - permittivity of free space.

When we introduce a slab and increase a plate separation capacitance will be

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}, C_1 = \frac{\epsilon_0 A}{d + \Delta d - h}, C_2 = \frac{k \epsilon_0 A}{h},$$

where  $k$  – dielectric constant,  $h = 4 \cdot 10^{-3} \text{m}$  – thickness of slab.

So

$$\frac{1}{\frac{\epsilon_0 A}{d}} = \frac{1}{\frac{\epsilon_0 A}{d + \Delta d - h}} + \frac{1}{\frac{k \epsilon_0 A}{h}} \rightarrow d = (d + \Delta d - h) + \frac{h}{k} \rightarrow k = \frac{h}{h - \Delta d} = \frac{4 \cdot 10^{-3}}{4 \cdot 10^{-3} - 3.5 \cdot 10^{-3}} = 8.$$

**Answer: 2. 8.**