

Answer on Question #69082 Physics / Electromagnetism

The capacitance of a parallel plate capacitor is increased by a factor of 5 when a dielectric material fills the space between its plates. What is the relative permittivity of the dielectric material? If this material is placed in between the plates of a cylindrical capacitor of outer and inner radii $b = 12$ cm and $a = 10$ cm respectively, calculate the capacitance per unit length of the cylindrical capacitor.

Solution:

The capacitance of a parallel plate capacitor is

$$C = \frac{\epsilon\epsilon_0 A}{d}.$$

Thus the relative permittivity of the dielectric material is $\epsilon = 5$.

The capacitance of cylindrical capacitor

$$C = \frac{2\pi\epsilon\epsilon_0 L}{\ln(b/a)}.$$

So the capacitance per unit length of the given cylindrical capacitor is

$$\frac{C}{L} = \frac{2\pi\epsilon\epsilon_0}{\ln(b/a)} = \frac{2 \times 3.14 \times 5 \times 8.85 \times 10^{-12}}{\ln\left(\frac{12}{10}\right)} = 1.52 \text{ nF}.$$

Answers: $\epsilon = 5$, $\frac{C}{L} = 1.52 \text{ nF}$.

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