

task_kyt15w11e3sempb2_with_calculation

Student Group

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Exercise E1 Resistivity and temperature dependent Resistance (written test, approx. 7 % of a 60-minute written test, SS2023)

The resistivity of a dielectric material is given as $\rho_{\text{PP}}(T) = 10^{17} \cdot \exp(\alpha T + \beta T^2)$ $\Omega \cdot \text{m}$ for $20 \leq T \leq 55$ $^{\circ}\text{C}$. The temperature coefficients α and β are given as $\alpha = -0.048$ $1/\text{K}$ and $\beta = +0.00057$ $1/\text{K}^2$. Calculate the resistance for the dielectric material for 20 $^{\circ}\text{C}$ and 55 $^{\circ}\text{C}$. The length of the material is $l = 10$ cm and the cross-sectional area is $A = 1$ cm^2 .

Solution: The resistivity of the dielectric material is $\rho_{\text{PP}}(20 \text{ } ^{\circ}\text{C}) = 10^{17} \cdot \exp(\alpha \cdot 20 + \beta \cdot 20^2)$ $\Omega \cdot \text{m}$.

For the given material the temperature coefficients in the range of $20 \text{ } ^{\circ}\text{C}$ and 55 $^{\circ}\text{C}$ are given as $\alpha = -0.048$ $1/\text{K}$ and $\beta = +0.00057$ $1/\text{K}^2$.

$$\begin{aligned} R(55 \text{ } ^{\circ}\text{C}) &= R(20 \text{ } ^{\circ}\text{C}) \cdot (1 + \alpha \cdot \Delta T + \beta \cdot \Delta T^2 + \dots) \\ &= 80 \text{ } \Omega \cdot (1 - 0.048 \text{ } 1/\text{K} \cdot (35 - 20 \text{ } \text{K}) + 0.00057 \text{ } 1/\text{K}^2 \cdot (35 - 20 \text{ } \text{K})^2) \end{aligned}$$

Calculate the resistance for the dielectric material for 20 $^{\circ}\text{C}$.

Solution

$$\begin{aligned} R(20 \text{ }^\circ\text{C}) &= \rho \cdot \frac{d}{A} \cdot 10^{17} \cdot \Omega \\ &= 0.8 \cdot 10^{-6} \cdot \frac{1}{1 \text{ m}^2} \end{aligned}$$

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