ELECTROMAGNETISM ASSIGNMENT FOR THE SIXTH TIME

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Abstract. Here is the electromagnetism assignment for the sixth time which is for the corse given by professor Weichao Liu. In order to practise the expertise in scientific film of physics, students need to practise using LaTeXto composing their own work, even if this is only a ordinary homework.

Main Text

5-33. To solve this electrical system, we introduce complex numbers.

$$\tilde{X}_C = \frac{1}{\mathrm{i}\omega C}$$

$$\tilde{U} = U_m \exp\left(\mathrm{i}\omega t\right)$$

$$\tilde{I} = \mathrm{i}\omega C U_m \exp\left(\mathrm{i}\omega t\right)$$

In this way, Ohm's law can be used normally, and the final result can be taken as the real part.

$$I = \mathrm{Re}\tilde{I} = -\omega C U_m \sin\omega t$$

The total current is the true conserved quantity that satisfies the continuous return of charge.

$$I + S\frac{\partial}{\partial t}D = 0$$

And cylindrical capacitors meet

$$C = \frac{2\pi\varepsilon_0 l}{\ln\dfrac{b}{a}}$$

As a result.

$$\frac{\partial}{\partial t}D = \omega C U_m \sin\omega t = \frac{2\pi\varepsilon_0 l\omega U_m \sin\omega t}{\ln\dfrac{b}{a}}$$

5-36.

(1). Find by formula

$$f = \frac{c}{\lambda} = 1.0\times 10^8\ \mathrm{Hz}$$

(2). We know:

$$\boldsymbol{E} \times \boldsymbol{B} \;//\; \boldsymbol{k}$$

So $\boldsymbol{B} \;//\; \boldsymbol{z}$.

And we have relation

$$\sqrt{\varepsilon_0 \varepsilon_r} E = \sqrt{\mu_0 \mu_r} H \qquad \text{When the medium is uniformly linear}$$

So $B = \mu_0 H = \sqrt{\varepsilon_0 \mu_0} E = \dfrac{E}{c} = 1.0 \times 10^{-6}\,\mathrm{T}$.

(3). Through simple relationships.

$$k = \frac{2\pi}{\lambda} = \frac{2}{3}\pi\,\mathrm{m}^{-1}$$

$$\omega = \frac{2\pi}{T} = \frac{2\pi c}{\lambda} = 2\pi \times 10^{8}\,\mathrm{s}^{-1}$$

(4). Poynting vector is used to describe the energy flow of an electromagnetic wave.

$$\boldsymbol{S} = \boldsymbol{E} \times \boldsymbol{B}$$

$$\bar{S} = \frac{1}{2\mu_0} EB = 119.37\,\mathrm{W/m^2}$$

5-37.

(1). According to the magnetic field energy density formula.

$$w_m = \frac{1}{2}\frac{1}{\mu_0} B^2 = 3.98 \times 10^{-15}\,\mathrm{J/m^{-3}}$$

(2). Find the full magnetic flux, and then apply Faraday's law of electromagnetic induction.

$$\Psi_m = NBS \cdot \sqrt{2} B \cos \omega t$$

$$E = -\frac{\mathrm{d}\Psi_m}{\mathrm{d}t} = \omega NBS \cdot \sqrt{2} B \sin \omega t$$

$$E_{\text{eff}} = \omega NBSB = 4.15 \times 10^{-6}\,\mathrm{V}$$

5-40.

(1). According to conservation of energy, the flux of the Poynting vector is conserved.

$$\bar{S} = \frac{W}{2\pi r^2} = 1.59 \times 10^{-5}\,\mathrm{J/m^2}$$

(2). The Poynting vector satisfied

$$\bar{S} = \frac{1}{2\mu_0} E_m B_m$$

Electromagnetic fields matter

$$E_m = cB_m$$

As a result

$$E_m = 0.11\,\mathrm{V}$$

$$B_m = 3.65 \times 10^{-10}\,\mathrm{T}$$

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