

6.15 The plates of a parallel-plate capacitor have areas of 10 cm^2 each and are separated by 1 cm. The capacitor is filled with a dielectric material with $\epsilon = 4\epsilon_0$, and the voltage across it is given by $V(t) = 30 \cos 2\pi \times 10^6 t$ (V). Find the displacement current.

Solution: Since the voltage is of the form given by Eq. (6.46) with $V_0 = 30 \text{ V}$ and $\omega = 2\pi \times 10^6 \text{ rad/s}$, the displacement current is given by Eq. (6.49):

$$\begin{aligned} I_d &= -\frac{\epsilon A}{d} V_0 \omega \sin \omega t \\ &= -\frac{4 \times 8.854 \times 10^{-12} \times 10 \times 10^{-4}}{1 \times 10^{-2}} \times 30 \times 2\pi \times 10^6 \sin(2\pi \times 10^6 t) \\ &= -0.66 \sin(2\pi \times 10^6 t) \quad (\text{mA}). \end{aligned}$$
