

Electrodynamics-II

Muhammad Amer Mustafa

Lecturer UOS Sub Campus Bhakkar

7.3 ■ MAXWELL'S EQUATIONS

7.3.1 ■ Electrodynamics Before Maxwell

So far, we have encountered the following laws, specifying the divergence and curl of electric and magnetic fields:

$$(i) \quad \nabla \cdot \mathbf{E} = \frac{1}{\epsilon_0} \rho \quad (\text{Gauss's law}),$$

$$(ii) \quad \nabla \cdot \mathbf{B} = 0 \quad (\text{no name}),$$

$$(iii) \quad \nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \quad (\text{Faraday's law}),$$

$$(iv) \quad \nabla \times \mathbf{B} = \mu_0 \mathbf{J} \quad (\text{Ampère's law}).$$

A changing electric field induces a magnetic field.

7.3.3 ■ Maxwell's Equations

In the last section we put the finishing touches on Maxwell's equations:

$$(i) \quad \nabla \cdot \mathbf{E} = \frac{1}{\epsilon_0} \rho \quad (\text{Gauss's law}),$$

$$(ii) \quad \nabla \cdot \mathbf{B} = 0 \quad (\text{no name}),$$

$$(iii) \quad \nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \quad (\text{Faraday's law}),$$

$$(iv) \quad \nabla \times \mathbf{B} = \mu_0 \mathbf{J} + \mu_0 \epsilon_0 \frac{\partial \mathbf{E}}{\partial t} \quad (\text{Ampère's law with Maxwell's correction}).$$

7.3.5 ■ Maxwell's Equations in Matter

$$\begin{aligned} \text{(i)} \quad \nabla \cdot \mathbf{D} &= \rho_f, & \text{(iii)} \quad \nabla \times \mathbf{E} &= -\frac{\partial \mathbf{B}}{\partial t}, \\ \text{(ii)} \quad \nabla \cdot \mathbf{B} &= 0, & \text{(iv)} \quad \nabla \times \mathbf{H} &= \mathbf{J}_f + \frac{\partial \mathbf{D}}{\partial t}. \end{aligned} \tag{7.56}$$