

# Introduction to Electrodynamics by David J. Griffiths Notes

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## 1 Vector Algebra

### 1.6 The Theory of Vector Fields

#### 1.6.1 The Helmholtz Theorem

- The **Helmholtz theorem** states that a vector field  $\mathbf{F}$  is uniquely determined if you're given its divergence  $\nabla \cdot \mathbf{F}$ , curl  $\nabla \times \mathbf{F}$ , and sufficient boundary conditions.

#### 1.6.2 Potentials

- If the curl of a vector field vanishes everywhere, then it can be expressed as the gradient of a **scalar potential**

$$\nabla \times \mathbf{F} = \mathbf{0} \Leftrightarrow \mathbf{F} = -\nabla V.$$

- If the divergence of a vector field vanishes everywhere, then it can be expressed as the curl of a **vector potential**

$$\nabla \cdot \mathbf{F} = 0 \Leftrightarrow \mathbf{F} = \nabla \times \mathbf{A}.$$