Andy's math/science background information

J. Andrew Fingerhut (andy.fingerhut@gmail.com)

June 1, 2025

Contents

1 Introduction

This document is a place to write up notes on background in math that help in learning science.

2 Notation

$\mathbb{R}^3$ - The set of all points in 3-dimensional space, i.e. where each point is specified by a sequence of 3 real-valued coordinates.

∇ - Called "nabla", and often called "del". Some history of it can be found on the Nabla Symbol page [2].

$\boldsymbol{\nabla} f$ - Gradient of a scalar function $f : \mathbb{R}^3 \rightarrow \mathbb{R}$.

grad$f$ - another way to write the gradient of f, $\boldsymbol{\nabla} f$

2.1 Maxwell's Equations

In partial differentiatal form:

$\boldsymbol{\nabla} \cdot \mathbf{E} = \frac{\rho}{\epsilon_0}$	Gauss's Law
$\boldsymbol{\nabla} \cdot \mathbf{B} = 0$	Gauss's Law for magnetism
$\boldsymbol{\nabla} \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$	Maxwell-Faraday Equation (Faraday's law of induction)
$\boldsymbol{\nabla} \times \mathbf{B} = \mu_0(\mathbf{J} + \epsilon_0 \frac{\partial \mathbf{E}}{\partial t})$	Ampère-Maxwell law

where:

- $\mathbf{E}$ is the electric field
- $\mathbf{B}$ is the magnetic field
- ρ is the electric charge density
- $\mathbf{J}$ is the current density
- ϵ_0 is the vacuum permittivity
- μ_0 is the vacuum permeability

3 Divergence

Divergence has been generalized to many coordinate systems other than the 3-dimensional Cartesian coordinate system $\mathbb{R}^3$, but I will focus on $\mathbb{R}^3$.

The Wikipedia page on Gradient [1] is not too bad for me, as long as I skim over the parts that generalize it to other coordinate systems.

References

[1] Wikipedia. Gradient, 2025. URL `https://en.wikipedia.org/wiki/Gradient`.

[2] Wikipedia. Nabla Symbol, 2025. URL `https://en.wikipedia.org/wiki/Nabla_symbol`.