# Electromagnetic Theory

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## Introduction

Why we need to learn Electromagnetic Theory?

It is the base of communication Technology.
Wireless Radiofrequency Communication, Microwave and optical communications through waveguides, Transfer of signal through transmission lines.

Design of multipurpose antenna is a very challenging field which need a sound understanding of Electromagnetic Phenomena in vacuum, in conductors and in dielectric media.

Electronic devices and circuits ar governed by the principles of Electromagnetic Theory.

Electromagnetic phenomena is the first instance where we visibly see action at a distance. We know the effect of one magnet on another or the effect of a current carrying wire on a magnetic needle.
This led to the idea of electric and magnetic fields. We have the sources as the electric charges and currents and the fields caused by them.
These fields are not just some abstract entities. They have energy stored in them.
As the sources move, these fields change in time. The time variation of electric and magnetic fields connects each other as shown by Faraday and Maxwell.

The time varying fields can also exist independent of the sources. They constitute what we call the light or electromagnetic radiation.

All the phenomenon that we observe in light like reflection, refraction etc. can be now understood in terms of electromagnetic fields.

Irrespective of its engineering applications, every natural phenomenon that we experience is a manifestation of Electromagnetic Theory.
Atoms can be completely understood only by electromagnetic theory.
All the chemical reactions follow from the electronic properties.
All of solids are electromagnetic interactions between atoms and electrons.
The platform on which we stand supports us due to the electrostatic force between the feet and the floor.

Gravity is too weak at ordinary scale to consider. Nuclear forces don't survive at classical distance scales.

Electromagnetic Theory is the first classical field theory. This was quantized by the pioneering works of Feynmann, Schwinger and Tomonaga (Quantum Electrodynamics).
Quantum theories of Weak and Strong interaction is also achieved in similar lines.

This is the first Field Theory and we need the mathematical machinery to do calculus with Fields. So we start with Vector Calculus.