Why Study Electromagnetics?

Electromagnetics (EM) is the subject dealing with electromagnetic fields. An EM field is made of interdependent electric and magnetic fields, which is the case when the fields vary with time - they are dynamic.

An electric field is a force field that acts upon material bodies by virtue of their property of charge. A magnetic field is a force field that acts upon charges in motion. The principle is the same as that of a gravitational field that is a force field which acts upon material bodies by virtue of their property of mass.

EM is all around us. Every time we turn a power switch on, we press a key on our keyboard, or we use an everyday electrical device, EM comes into play. It is the foundation for the technologies of electrical and computer engineering, spanning the entire electromagnetic spectrum, from DC to light waves, from electromechanic technologies to microwaves, antennas and photonics.

Therefore, in the context of engineering education, EM is fundamental to the study of electrical and computer engineering.

The beauty of EM lies in the nature of its compact formalism through a set of four wonderful EM equations, Maxwell's equations. They appear like 4 lines of mathematics, but in them lie a wealth of phenomena and devices that surround us and provide our everyday services. Without the principles of Maxwell's equations, we would all have been in the dark ages, because there would be no such thing as electrical power, electronic communications or computers, which are all typical applications of ECE. EM is fundamental to the study of ECE, whether by design or accident. It may take some time and effort to discover their beauty, but once you've made the first step, you won't go back.

Coming now to the present, the faculty of the ECE Department at SDSMT, realizing the significance of EM to the modern Electrical and Computer engineers, supports research in various areas of Applied Electromagnetics, as well as an extensive series of courses, both undergraduate and graduate:

EE 381 Electric and Magnetic Fields (Montoya)
EE 382 Applied Electromagnetics (Whites)
EE 481 Microwave Engineering (Whites)
EE 483 Antennas for Wireless Propagation (Anagnostou)
EE 692 Guided Waves and Material Measurements (Whites)
EE 692 Advanced Electromagnetics (Anagnostou)
EE 692 Applied EM- FDTD Method (Montoya)
EE 692 Advanced Antenna Engineering (Anagnostou)

- Great! I get the idea why I need to study EM. **How can I get started?**

First, know that **E** means electric field and **B** stands for magnetic field. The static **E** and **B** fields may be independent, but the dynamic **E** and **B** fields are interdependent causing them to be simultaneous and to coexist in any given space. It is that interdependence of **E** and **B** fields that is responsible for EM waves, and that makes EM very illuminating and modern day life most interesting.

In earlier courses, you learn circuit theory. This is all an approximation of electromagnetic field theory! At low frequencies circuit approximations are allowed, and so it makes sense to learn the 'simplified' version first. But at high frequencies electromagnetic effects are prominent. So, whether you are an electrical engineer or a computer engineer, whether you are interested in high frequency electronics or high-speed computer communication networks, electromagnetic effects are prime and studying the fundamentals of EM is sublime.

- **But I still have a problem with EM. It is full of abstract math!**

I want you to know that it is the power of mathematics that enabled Maxwell's prediction of the physical phenomenon of EM radiation through his equations, even before Hertz found it through experiments. In fact it was this accomplishment that partly resulted in the equations to be known after Maxwell, whereas in reality they are not his laws.

For example the first one is Faraday's Law expressed in mathematical form. And math is a compact means for representing the underlying physics, so do not despair when you see math derivations – they are essentials and most useful to understand the concepts, realizing that math is only a means to extend the physics.