New Course in Linear Algebra

Linear algebra is a mathematical language which lies at the heart of almost every discipline of mathematics, physics, chemistry and engineering. A thorough understanding of the basic constructions and techniques of linear algebra is indispensable for serious study of any one of these fields. In particular, the fundamental ideas underlying linear algebra serve as a prototype for many modern mathematical theories.

In this course, we will cover some parts of linear algebra, however, taking a slightly more sophisticated point of view compared to standard courses, emphasizing the coordinate free formulation of the theory. Along the mathematical development, we will hint on the applications of the material to other fields of mathematics and engineering.

The course is expected to cover the following material:

- Preliminaries: We will introduce the notions of sets, equivalence classes, groups, and fields. In particular, we will construct the finite fields which are somewhat exotic number systems, now days playing a central role in computer science and digital signal processing.
- Basic linear algebra: We will begin by introducing the general notion of a vector space over an **arbitrary field**, giving many concrete examples of vector spaces which appear in practice. Then we will study linear operators between vector spaces, emphasizing the dictionary translating between the coordinate free object and the coordinate dependent description given by a matrix. Also, we will spend time discussing the situation when the ground field is the real and complex numbers. In these particular situations, we will elaborate on some of the geometric attributes of the theory.
- Advanced linear algebra: Our goal in this part is to introduce some of the modern developments in linear algebra. In particular, we will study multilinear forms, culminating, with probably the single most important and useful construction in modern mathematics – **the tensor product**.

A final note: A real understanding of linear algebra is not a trivial matter; this is particularly true when coming to deal with the modern parts of the theory. Although, this course does not require previous knowledge, it is assumed that the student taking this course has some mathematical maturity and is motivated to invest the time and effort required in order to appreciate the material. Also, the course might include an independent project giving the student the opportunity to choose a related topic (such as a specific application) and explain it in class.