Math 121A
Mathematics for the Physical Sciences
Spring 2009

Instructor: Dr. Shamgar Gurevich, 867 Evans Hall, Phone: 643-7543.
Time and Location: M-W-F 12-1pm, Room 75 Evans.
Office Hours:

Mon. 1:30-2:30pm
Wed. 1:30-2:30pm

Textbook: Mary L. Boas, Mathematical Methods in the Physical Sciences.
Syllabus: Linear algebra, complex numbers, complex functions, Harmonic Analysis, Discrete Harmonic Analysis, other topics and applications.
Grading: There will be weekly assignments which will be due in one week, a midterm exam and a final. They will count toward the grade as follows:

Assignments	30%
Midterm	30%
Final	40%

Attitude: In our course we will study some fundamental tools of mathematics. The attitude will be to help you to develop your way on how to think about some mathematical objects that you will encounter during your undergraduate studies. Moreover, I expect you to be an integral part of the course. i.e., to attend lectures, to participate in the discussions, to submit homework, and to visit me during my office hours.

What: Let me elaborate on some of the topics that will be covered

1. *Linear Algebra.* Probably the most important notions of mathematics are the notions of *abstract vector spaces* and *Linear operators* between them.

2. *Complex numbers.* We will extend our linear algebra notions to the language of vector spaces over the field of complex numbers.

3. *Theory of complex functions.* The notion of *analytic function* will be presented. A central theorem in complex analysis, known as *Cauchy's theorem*, will be formulated and proved. Using the language of complex functions you will be able to understand the calculations of difficult integrals of real functions.

4. *Harmonic Analysis.* Here the main question is how to think on a function defined on the circle T or on the real line $\mathbb{R}$? Is it really defined by its values? This will lead us to the definition of the L^2 spaces and in particular we will introduce one of the most important transforms in mathematics called the *Fourier transform*. We will learn about a nice application of Harmonic analysis to applied mathematics called Shannon's Sampling Theorem. This is a theorem which is formulated in terms of the Fourier transform and is one of the corner stones of modern information theory and its applications.

5. *Discrete Harmonic Analysis.* Here you will see that one can define all the notions of Harmonic analysis in the case of the "discrete line" $\mathbb{Z}_N = \{0, 1, ..., N-1\}$. In particular we will introduce the discrete Fourier transform (DFT). This will help us to solve a model problem in the application of mathematics to the digital world. Namely, we will learn how to multiply two polynomials in a fast way. The solution will use the Cooley-Tukey Fast Fourier Transform algorithm (FFT).

Good Luck!