Math 121a - Mathematics for Natural Sciences
Mondays and Wednesdays, 3:30 - 4:50 pm

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Office hours:
J. Touboul: Tuesdays and Thursdays, 1:30-3 pm.
TAs: To be determined

Course material: All course material will be made available on latte, login on to http://latte.brandeis.edu.

Course description and objective: It is now a commonplace statement: in the modern world, mathematics are a key tool to describe natural or social phenomena and develop academic or technical advances we use in our everyday life, whether for processing information in phones, displaying a video on your computer, routing information through the web, flying airplanes, scheduling deliveries, to cite a few. Actually, since several centuries, mathematics and physics have developed hand in hand, each science nurturing the other through new techniques or observations, particularly rapidly throughout the XXth century, while the XXIst century sees an explosion of mathematical approaches in biological science.

Interestingly, such applications rely on a few key mathematical tools, developed over centuries, can now be taught to students in a more coherent fashion, and that this class intends to cover these in part. As examples, the applied mathematician interested in investigating a natural phenomenon, modeling financial data or bio-engineering materials, will need to be able to model and study a dynamical evolution in time, optimize quantities under specific constraints, but also transform the data so it can be more easily manipulated, represented or handled with other mathematical methods or with a computer program.

Thus the objectives of this course are to introduce the student to the “hardware store” of applied mathematical tools and enable them to feel comfortable using these tools to solve genuine problems.

Expectation of students’ effort: Success in this course is based on the expectation that students will spend a minimum of 9 hours of study time per week in preparation for the class (reviewing class material, completing homework, preparation for exams, etc.).

Learning goals: The course will introduce 5 sets of tools central in applications, and the learning goals for this class are to be able to:

• use and develop each technique
• identify the appropriate methodology for a given problem
• combine multiple techniques to completely solve an applied problem

In detail, the course will develop as follows.

Course Plan
• complex numbers: complex plane, complex algebra, elementary functions of complex variables.
• infinite series: convergence tests (Abel criteria), the ratio test, the integral test.
• **power series**: geometric series, radius of convergence, Taylor expansions, classical function
• **calculus of variations**: minimum principles (Euler equation), optimization (Lagrange multipliers) and applications.
• **integral transformations**: Laplace and Fourier transforms and its application (e.g., solving ODEs and PDEs).

**Textbook:** We will use the book: Mathematical Methods in the Physical Sciences, by Mary L. Boas, with additions from a variety of sources (further references and reading provided in class).

**Prerequisite:** Math 15 and Math 20 (or Math22a and Math22b).

**Grading Policy:** [TBC] The grade will be based at 30% on the weekly homework assignments and at 70% on three mid-term exams (20% - 20% and 30% respectively). Bonus up to 5 points will be granted based on significant participation (classroom, office hours, etc...).

**Late homework policy:** Unless a specific extension is requested and approved in advance, homework returned late of less than 24 hours will get a 10 points penalty, and after 24 hours, the homework will not be accepted.

**Critical dates:** [To be confirmed]
First midterm: 5th week of the term.
Second midterm: 10th week of the term.
Third midterm: last week of the term.

**Disabilities:** If you are a student with a documented disability on record at Brandeis University and wish to have a reasonable accommodation made for you in this class, please see me immediately.

**Academic Integrity:** You are expected to be familiar with and to follow the University’s policies on academic integrity (see http://www.brandeis.edu/studentlife/sdc/ai ). Faculty will refer any suspected instances of alleged dishonesty to the Office of Student Development and Conduct. Instances of academic dishonesty may result in sanctions including but not limited to failure in the course, failure on the assignment in question, suspension from the University and/or educational programs.