

Physics (PHZ) 3113
 9:30 – 10:50 TΘ
 Forkas Alumni Center 103

Research in theoretical physics often proceeds in two stages. The first sharpens a vague idea into a specific question whose answer can be found by solving a specific mathematical problem. The second, much easier stage is to solve that problem.

The balance of courses in the undergraduate physics curriculum reflects the dichotomy of physics research. Most courses are concerned primarily with fundamental theoretical concepts, their mathematical expression, and relation to the material world. These courses *involve* solving problems, of course, but they are *about* the natural phenomena we observe and how we describe them mathematically. The present course, in contrast, is *about* solving problems.

Mathematics is a tool for a physicist, a means to an end. It is not an end in itself. The objective is not to prove mathematical theorems, important though they may be. Rather, the first goal for a physicist is

In mathematics you don't understand things. You just get used to them.

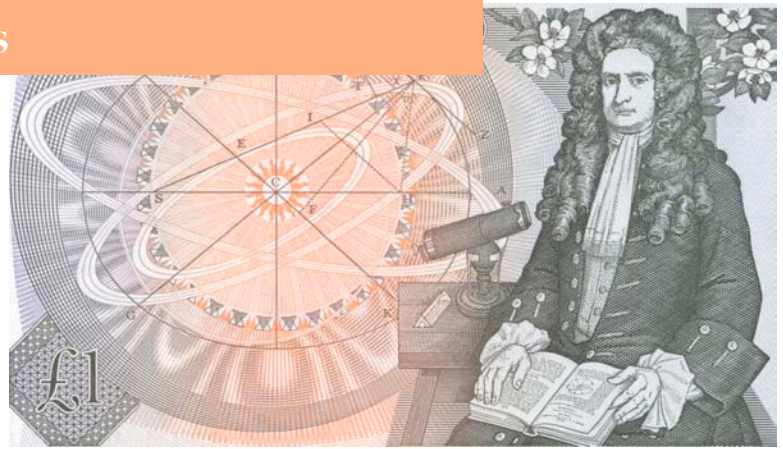
– J. von Neumann

to learn *how* to use those theorems and associated mathematical structures to *calculate* results. A second goal, which often becomes more important as one matures scientifically, is to see *why* the definitions of mathematical structures are as they are. Mathematical definitions often have roots in models of physical phenomena, and understanding they are interesting often yields insight both into how the mathematics works and into the conceptual content of the associated physical models.

Course Objectives

The first objective of this course is to develop students' facility with certain mathematical techniques. By its end, each student should be familiar enough with these that he or she can waste little time wondering how to proceed when solving problems in future courses. It may sometimes be difficult in practice to get a numerical result, but it should be clear in principle how to go about it. The primary responsibility for this objective is the students'. As with any tool, there is no substitute for practice when learning to use the mathematical methods we discuss. Students should therefore commit to devoting substantial time to the assigned problems.

The second objective is to highlight applications of mathematical methods to physical systems. As discussed above, such applications shed light on both the mathematics and the logic underpinning physical models. This allows students to develop valuable intuition for subsequent courses where these same methods will be applied. We will accomplish this objective primarily in the lectures. These will tend to focus in roughly equal parts on *what* the mathematical structures and techniques are, and on *why* and *how* they apply to physics.



Course Web Site <http://physics.fau.edu/~cbeetle/Fall10/PHZ3113/>

Instructor

Prof. Chris Beetle
 Science & Engineering 436
 (o) 561.297.3591
 (f) 561.297.2662
 (m) 561.306.3234
cbeetle@physics.fau.edu

Office hours: 11:00 – 12:00 TΘ
 (or by appointment).

Required Text

- M.L. Boas. *Mathematical Methods for the Physical Sciences*, Third Edition. (Wiley, 2006) ISBN 0-471-19826-9

Course Content

Every undergraduate physics course uses mathematics extensively, and students must master a wide variety of concepts and techniques to succeed in all of them. However, several techniques appear again and again throughout the physics curriculum. These include:

- Fourier series and transforms,
- the theory of complex variables and its applications,
- separation of variables in partial differential equations, and
- special functions, in particular:
 - Legendre, Laguerre and Hermite polynomials,
 - spherical harmonics, and
 - Bessel functions.

These techniques are the subject of this course. They form almost the entire mathematical foundation for typical undergraduate courses in electromagnetism and quantum mechanics. They are also very useful in classical and statistical mechanics, though in these cases some additional mathematical background is usually necessary. This additional background includes the calculus of variations, probability theory and the theory of groups and representations. We will not be able to cover any of these additional subjects here due to time constraints. But we will attempt to cover all of the most essential topics listed above because *every* course in the undergraduate physics curriculum relies to some extent on students' familiarity with them.

A more detailed schedule of the topics to be covered, complete with assigned readings for each lecture and exam dates, is available from the [course web site](#).

Prerequisite Mathematical Background

Each of the major subjects that we will cover could easily be expanded to a full-semester course in its own right. We therefore must move quickly and will have to sacrifice some depth of coverage in favor of breadth. The fast pace of this course also demands that we spend little time reviewing material that should have been covered in courses listed as prerequisites for this one: the Calculus with Analytic Geometry sequence (MAC 2311, 2312 and 2313) and Engineering Mathematics I (MAP 3305). This prerequisite material includes:

- complex numbers,
- elementary functions and calculus in one dimension,
- the linear algebra of vectors and matrices in two and three dimensions, including determinants, and
- vector calculus in Cartesian coordinates in two and three dimensions.

Students who have not taken the courses listed above, but who consider themselves adequately prepared in these areas, may still enroll in this course with the instructor's permission.

Course Structure

The course will mostly follow a traditional lecture format, with time allotted in each class period for student questions and discussion. Students are strongly encouraged to participate actively

during class and to raise questions, especially general ones they believe will interest a substantial portion of the class. Students should make use of the scheduled office hours to discuss more specific questions on homework problems and grading, etc.

The main tool students can use to develop their skills in this course is the homework. It should be taken very seriously, and a substantial portion of the course grade has been based on homework assignments in order to motivate students to do so. Mathematics, and applied mathematics in particular, is a field where understanding comes from practice more than anything else. A serious effort to understand how to solve each homework problem in this course from first principles will be rewarded not only on the exams but in other courses throughout the physics and engineering curricula.

Grading and Related Policies

Final grades for this course will be determined by a statistical curve based on weighted averages of students' scores on the following assignments:

- 30% (roughly) ten weekly assigned practice problem sets will be reviewed to ensure that each student has made a serious effort to complete each problem and graded pass or fail,
- 20% (roughly) ten weekly assigned homework problems will be graded from zero to ten points based on the completeness and correctness of student's solutions,
- 20% one take-home mid-term exam will be graded from zero to one hundred points based on the completeness and correctness of student's solutions, and
- 30 % one take-home, cumulative final exam will be graded from zero to one hundred fifty points based on the completeness and correctness of each student's solutions.

Class Attendance Policy

Students in this class are expected to have attained a certain level of academic maturity and seriousness about the scholarship. It is therefore at each student's discretion whether to attend class, and no portion of a student's final grade depends on in-class participation.

Please note that this policy is not meant to discourage students from attending or participating actively in the lectures. Such participation is the best way to regulate the pace of the lectures to one's individual needs and address any particular areas of difficulty.

Late Homework and Extra Credit Policies

All assigned coursework must be submitted at the beginning of the lecture on the date it is due. However, if a student has a family emergency or illness, he or she may request an individual extension *by email at least twenty-four hours in advance* of the the lecture during which the assignment is due. The instructor may approve or deny such requests at his discretion.

No extra credit will be offered.

Collaboration on Assigned Coursework

Students are encouraged to collaborate while solving practice problem sets and homework problems. However, once these problems have been discussed and their solutions outlined, each student should prepare his or her own solution. Copying is not allowed.

This policy does not extend to exams, where students are expected to work independently.

Important Dates

- Thursday, October 7 Mid-Term Exam Distributed
- Thursday, November 11 No Class due to Veterans' Day Holiday
- Thursday, November 26 No Class due to Thanksgiving Recess
- Tuesday, December 1 Final Exam Distributed

Students with Disabilities

In compliance with the Americans with Disabilities Act (ADA), students who require special accommodations due to a disability to properly execute coursework must register with the Office for Students with Disabilities (OSD) located in

Boca Raton — SU 133 (561.297.3880), in
Davie — MOD I (954.236.1222), in
Jupiter — SR 117 (561.799.8585), or at the
Treasure Coast — CO 128 (772-873-3305),

and follow all OSD procedures.

Honor Code

Students at Florida Atlantic University are expected to maintain the highest ethical standards. Academic dishonesty, including cheating and plagiarism, is considered a serious breach of these ethical standards, because it interferes with the University mission to provide a high quality education in which no student enjoys an unfair advantage over any other. Academic dishonesty is also destructive of the University community, which is grounded in a system of mutual trust and places high value on personal integrity and individual responsibility. Harsh penalties are associated with academic dishonesty. For more information, see:

http://www.fau.edu/regulations/chapter4/4.001_Honor_Code.pdf.