Department of Physics

Physics 3113 fall 2015

Introducing Mathematical Tools of Physics

Abstract. The purpose of this course is to give students the mathematical tools they will need to do well in later classes in the undergraduate physics curriculum: classical mechanics, electricity and magnetism (E&M), quantum mechanics, and statistical mechanics. Each topic we cover in this course will be covered again in the later courses. The goal is to attain familiarity now so that you will be ready to master the techniques when you see them for a second time. This is not a mathematics course: there will be few proofs, but I will provide references for those who would like to explore further. The homework will be at the "bridge" level, that is, harder than in 2048/9 but easier than in mechanics or E&M.

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Office Hours
a. 2:00–2:30 Tuesdays and Thursdays in 2022-D
b. By appointment
c. Any other time if I'm not in a meeting

Teaching Assistant
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Office hours:
a. Wednesdays 11:00–12:00 ISA 4019 A (tutorial room)
b. Fridays 11:45–12:15 (directly after recitation) ISA 4019

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Lectures Tuesdays and Thursdays, 12:30–1:45, Physics Building (ISA) 2023 (Colloquium Room)

Recitation/Quizzes
Fridays, 10:45–11:35, Physics Building (ISA) 2051 (south hall)

primary text There is no required textbook. Lecture outlines will be posted at the Web site (see above).

recommended Russell Hermann at UNC Wilmington has made available for free download a slightly slimmer version of his published textbook. While his outline isn't identical to ours, most of what we cover is still there. Since this book is free, I might assign a few homework problems out of it. See the April, 2012 version at

`http://people.uncw.edu/hermanr/phy311/MathPhysBook/index.htm`

As a reference, I recommend Riley, Hobson, and Bence, *Mathematical Methods for Physics and Engineering: a Comprehensive Guide*, Cambridge University Press, any edition, but *not* the abridged versions with the word "Essential" or "Foundation" in their titles. A student solutions manual is also available. The book covers material at both lower and higher levels than this course and has been used in graduate Math Methods, PHZ 5115. We will concentrate on the basics. Authors of similar reference books include Mary Boas and George Arfken.

prerequisites The prerequisites are grades of at least C− in General Physics II (2061 or 2049) and Calculus III (2313 or 2283) or equivalent preparation.

Homework, cooperation, collaboration, and cheating

Math Methods is a bridge course at the same level as *Modern Physics* (PHY 3101). Part of the reason it is in the curriculum is to give students practice on solving problems before they jump into more advanced classes with heavy workloads (*Electricity and Magnetism*, *Mechanics*, *Quantum Mechanics*, and *Statistical Mechanics and Thermodynamics*). Homework will be assigned and collected every one or two weeks. Students are encouraged to discuss homework, but cooperation must not include copying or plagiarism. Research and my own experience have shown that the most common reason for a student dropping out of physics is the belief that he or she needs to do all the work alone. On the other hand, you should first try each problem. Then when you get together with your colleagues, you will find each stuck at a different place, and together you will get unstuck. While the instructor will always try to help, you will find the most valuable resource in other students. **You must cite any source you use in preparing your homework. To cite another student's help, say something like "Mary showed me how to do this integral."**

Getting unstuck is very different from copying a solution. For example, it is reasonable for a student who has set up the problem but is having trouble evaluating an integral to ask a colleague how she evaluated the integral or for two students whose answers differ by a factor of two to compare notes to figure out where one of them might have gone wrong. It is quite another matter for Bill to copy Mary's solution (or solutions handed out from a previous year). **By turning in any assignment, a student implicitly certifies that the work, the ideas, and the wording are his or her own except as other works have been cited clearly. Briefly, not citing a work from which one has borrowed ideas is a form of dishonesty; copying phrases verbatim without setting them off typographically and citing the source is plagiarism.**

Please read the policy on integrity of scholarship in the undergraduate catalogue. Unfortunately, I have seen violations of this policy in my past classes. It is really very easy for me to detect cheating, and any confirmed case **will result in a grade of FF** in the course and could result in expulsion from the university.

You are not to consult any solutions manual, any previous year's homework solutions, or any other source of solutions, but you may consult textbooks, which you should cite on your homework solutions (see above). In case of any question on the policy, please e-mail or talk with me.

Participation

I expect students to participate in and out of the classroom. Part of your participation grade will come from postings to the course list-server. Each student will be expected to make at least two substantive posts each month (August/September counting as one month, October, and November/December counting as one month). Examples of substantive posts include questions on the material, answering another student's question, or a request for something to be covered in class.

You should subscribe right away to the list server by sending a one-line message to

`listserver@ewald.cas.usf.edu.`

The one line (in the body, not the subject) should read "`subscribe 3113`." Once you have subscribed, you may post questions and comments to the whole class by sending e-mail to `3113@ewald.cas.usf.edu`. *Note that you must use a* `.usf.edu` *return address: mail sent from all other addresses will bounce.*

There is a link to the archive of posts on the course Web site.

Tests and grading

There will be six 25-minute quizzes on Fridays (see calendar), with only the best three out of six counting for the final grade. Each quiz will cover one section of the course. Because students may drop the lowest three scores, there will be no make-ups. If a student, for emergency medical reasons, misses four or more of the six quizzes, the student may be issued a grade of incomplete (I). Attendance will be taken on Fridays (recitations and quizzes) and will count toward the grade. Students need to be present for the whole period to be counted present.

The university has scheduled the final examination for Thursday, 10 December at 10:00 A.M. in the Tuesday-Thursday meeting room. The final exam will be cumulative.

Use of calculators and books is **prohibited** at tests. However, you may bring one **handwritten** 8.5×11" sheet of notes.

At the end of the semester, I compute a numerical course grade for each student based on correct percentages in homework (HW), the highest three quizzes (Q), attendance at Friday recitations (R), participation (P), and

the final exam (F):

$$\begin{aligned} w_1 &= 0.45 * \mathrm{HW} + 0.20 * \mathrm{Q} + 0.04 * \mathrm{R} + 0.04 * \mathrm{P} + 0.27 * \mathrm{F} \\ w_2 &= 0.16 * \mathrm{HW} + 0.15 * \mathrm{Q} + 0.04 * \mathrm{R} + 0.04 * \mathrm{P} + 0.61 * \mathrm{F} \\ w_3 &= 0.20 * \mathrm{HW} + 0.46 * \mathrm{Q} + 0.04 * \mathrm{R} + 0.04 * \mathrm{P} + 0.26 * \mathrm{F} \\ \mathrm{score} &= \max(w_1,\, w_2,\, w_3) \end{aligned}$$

The translation of this numerical score to letter grades is adjusted according to the difficulty of assignments and centered on the idea that a B indicates that a student is completely prepared for the next course. With a grade of C, a student is allowed to take the next course but will need to review on his or her own. An A is as far above a B as a C is below it. A numerical score of 80% guarantees a B, of 90% guarantees an A. Because some test questions are at a level beyond that required for a B, the thresholds tend to be adjusted downward. Historically, the cutoff for an A has been around 60% and for a B around 50%. The course does use + and − grades.

University policies

Standard USF policies at `http://www.usf.edu/undergrad/standard-policies.aspx` are incorporated by reference.

Accommodations for disabled students

From Student Disabilities Services, *"Students in need of academic accommodations for a disability may consult with the office of Students with Disabilities Services to arrange appropriate accommodations. Students are required to give reasonable notice prior to requesting an accommodation."* Reasonable notice includes to the instructor. Please also send me an e-mail if you know in advance that you will need to miss a class (*e.g.*, for a religious observance).

Agreement

I ask students to agree to the following statement as part of first-day attendance: "I understand that to pass this course I shall need to commit at least six to twelve hours a week outside class to reading and homework and to attend at least 75% of the lectures. I understand that there are no make-ups for missed Friday quizzes. I understand that, under university and department policy, any student who cheats or participates in cheating will receive a grade of FF in the course and that further sanction (such as expulsion from the university) is possible. I am responsible for reading the syllabus."

Tentative Schedule

1.	**Approximation.** Doing math in your head; Hooke's law and the Taylor expansion; when the Taylor expansion breaks down; linear *vs.* nonlinear equations.	8/25 9/1	8/27 9/3	8/28 **9/4**
2.	**Linear Algebra.** Vectors in mechanics *vs.* apples and oranges; rotation matrices and linear transformations; coupled springs and eigenstuff; quantum mechanics, spins, and matrices; boosts in special relativity.	9/8 9/15 9/22	9/10 9/17 9/24	9/11 9/18 **9/25**
3.	**Ordinary Differential Equations.** More on springs; "trust, but verify;" boundary conditions; examples; series and series solutions to ODEs	9/29 10/6	10/1 10/8	10/2 **10/9**
4.	**Partial Differential Equations.** The electric field and gradient; the wave equation and partial differential equations; the heat equation and the Laplacian; partial derivatives in thermodynamics.	10/13 10/20	10/15 10/22	10/16 **10/23**
5.	**Vector Calculus.** Integrals in electrodynamics; toward a local description; more on div, grad, and curl; Green-Stokes-Gauss; Taylor expansion in multiple dimensions	10/27 11/3 11/10	10/29 11/5 11/12	10/30 11/6 **11/13**
6.	**Functional Analysis.** Equalizers in home stereo systems; another expansion (Fourier); the Fourier transform applied to diffraction; how are functions like vectors?; Hilbert space and Schrödinger's equation; evaluating real integrals in the complex plane. Time allowing, we may also touch on some additional applications of mathematics in physics, including quantum statistics and group-representation theory.	11/17 11/24 12/1	11/19 * 12/3	11/20 * **12/4**

final exam: Thursday, December 10 at 10:00 AM in ISA 2023

(*) no class November 26–27 (Thanksgiving holiday)
Recitations and (on bolded dates) quizzes on Fridays