

Physics 469/569, “Mathematical Physics”, Fall 2007

Course Information

Instructor: Daniel Phillips
Office: Clippinger Laboratory, Room 242C
Email: phillips@phy.ohiou.edu
Class times: 10:10 am, Monday, Tuesday, Thursday, and Friday
Text: *Mathematical Methods in the Physical Sciences* by Mary L. Boas
Office Hours: 1:30 pm–3:30 pm Monday
URL: <http://www.phy.ohiou.edu/~phillips/Mathphysics.html>

Philosophy

“Philosophy is written in this grand book, the universe, which stands continually open to our gaze. But the book cannot be understood unless one first learns to comprehend the letters in which it is composed. It is written in the language of mathematics . . .”

Galileo Galilei

This course is designed to help you integrate the various different pieces of mathematical knowledge you have acquired in your studies, and use that knowledge to attack physics problems. In the lectures I will discuss mathematical results that I hope you have seen in previous courses. However, I will not present this material with mathematical rigour, but instead will focus on the physical application and interpretation of these results. I will try to present examples of the different techniques we’re covering that are relevant to problems in physics. And I will try to show how the mathematical reasoning we do in class, and in homework, has physical implications. The course is geared towards problem solving, so working through the homework sets is a very important part of learning the material. These will include both mathematical reasoning and physics problems. In this way I hope to help you learn to speak the “language of mathematics”.

Books

Our text book is “Mathematical Methods in the Physical Sciences”, by Mary L. Boas, 3rd edition (Wiley, 2006). *You should all acquire a copy of this book that you can use throughout the quarter.* We will cover only a small portion of it, but there is a lot of other good stuff in there. In writing my lectures I will not follow the Boas presentation slavishly. I will supplement it with material from various books, in particular these four:

G. L. Arfken and H. J. Weber, *Essential Mathematical Methods for Physicists* (Elsevier, 2004);
T. L. Chow, *Mathematical Methods for Physicists: A Concise Introduction* (Cambridge, 2000);
S. M. Lea, *Mathematics for Physicists* (Brooks/Cole, 2004);
H. M. Schey, *Div, Grad, Curl and All That: An Informal Text on Vector Calculus* (Norton, 1996).

Topics to be covered

1. **Series** (Chapter 1) Definition of convergence; Geometric series; Preliminary test; Comparison tests: proving convergence; Alternating and absolutely-convergent series; Taylor series and power series.

2. **Multivariate calculus** (Chapters 4, 5, and 6) Summary of vectors and vector spaces; Partial differentiation; Total derivatives; Chain Rule; Changes of Variables; Multi-dimensional integration; Gradient; Line integrals; Green's theorem; Divergence and Gauss' Divergence Theorem; Curl and Stokes' Theorem;
3. **Differential Equations** (Chapters 8 and 11) First-order DEs; Second-order DEs with constant coefficients; Other linear second-order DEs: solution by series; Wronskians and a method for finding the second solution;
4. **Fourier Series and Transforms** (Chapters 7 and 8) Why do Fourier analysis?; Fourier series; Convergence of the series and Gibbs' phenomenon; Complex Fourier series; Parseval's theorem; Fourier transform; Momentum representation and the Uncertainty principle; Solving differential equations using Fourier Transforms; Convolution; Dirac Delta function.
5. **Scale Analysis** Order of magnitude estimation, estimation of derivatives, dimensional analysis.

Assessment

Percentages for PHYS 469: 10% for in-class participation; 30% from grades on seven homework assignments; 27.5% for mid-term exam; 32.5% for final exam.

Percentages for PHYS 569: 10% for in-class participation; 25% from grades on seven homework assignments; 10% from grades on two numerical projects; 25% for mid-term exam; 30% for final.

Homework

The problem sheets will be handed out at least one week before they are due. The graded assignments will be returned as soon as possible. Solutions to the problems will be provided. *It is expected you will all read and study these solutions.* Each week requests from the class for problems to be solved on the board will be made and a student will volunteer (or be volunteered) to give the solution on the board. *Each student in the class is expected to present at least two problems on the board during the quarter. Your performance of this task will be a prime determiner of your "Participation".* In any given week we will usually devote one of our lecture periods to solving the homework problems in this way.

In grading your written homework solutions I will be looking to see if you understand how to solve the problems. Therefore partial credit will be given for incomplete solutions, and, conversely, the correct answer without adequate explanation will actually yield very little credit. All steps used in reaching the solution must be properly explained and justified. The solution should be able to be read as a coherent discussion in English of the problem. I.e., explanatory sentences should be inserted into the mathematical reasoning. The standard applied to solutions in this regard will be higher for the graduate students taking PHYS 569.

Additional Projects for those taking this class for graduate credit

Students taking the graduate version of this course are expected to complete two additional assignments. These will be given out in the sixth and eighth week of the quarter, respectively, and will be due two weeks after they are handed out. They will involve the solution of a Mathematical Physics problem by numerical methods.

Exams

Mid-term: Friday, October 12, 10 am, Room 259, Clippinger Lab.

Final: Saturday, November 17, 10:10 am.

At the exams students are expected to supply pens or pencils, scratch paper, and a calculator. These exams will be “closed book”: no books, notes, or formulas stored in electronic or written form may be consulted during them. Please note that an adequate “cause of absence” (see the Student Handbook) or prior arrangement is required for any makeups of homework or exams.

Academic misconduct

“Academic misconduct is an A1 violation of the Ohio University Student Code of Conduct and is defined...as dishonesty or deception in fulfilling academic requirements. It includes, but is not limited to: cheating, plagiarism, un-permitted collaboration, forged attendance (when attendance is required), fabrication (e.g., use of invented information or falsification of research or other findings), using advantages not approved by the instructor (e.g., unauthorized review of a copy of an exam ahead of time), knowingly permitting another student to plagiarize or cheat from one’s work, or submitting the same assignment in different courses without consent of the instructor...”

“Cheating is defined as any attempt by a student to answer questions on a test, quiz, or assignment by means other than his or her own knowledge. Examples of cheating include: using the textbook or other materials, such as a notebook, not authorized for use during an examination; observing the work of another student or allowing another student to plagiarize, copy, or observe your work; using unauthorized material during a test, notes, formula lists, notes written on clothing, etc.; taking a quiz, exam, or similar evaluation in the place of another person; providing or requesting assistance from another person in a manner prohibited by the instructor; changing material on a graded exam and then requesting a regrading of the exam; acquiring unauthorized knowledge of an examination or any part of an examination.”

(From OU website <http://www.ohio.edu/judiciaries/academic-misconduct.cfm#students>)

Plagiarism is defined as the presentation of someone else’s ideas or work as your own. **This means you must not copy solutions to problems from those with whom you are taking the class, or from others who have taken the class before you.** Penalties will range from zero on the particular problem on which the offence occurred to an F in the course. Note that I *do* think it is a good idea for you to discuss together how to solve the problems. Operationally, this means that you are welcome to talk together about the homework assignments, but then you should each go off and generate your own solutions to be handed in.

Plagiarism can also occur if you use a result or approach that you read about in a book and fail to properly cite that book. If you base your answer to a problem substantially on something you have read that is fine, but you must cite that source. In general, if you are unsure about a question of plagiarism or cheating, you are obligated to consult me on the matter before submitting the material.