General Information (with update on midterm exam)

Instructor: John Collins, 303K Osmond  
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Web site: http://www.phys.psu.edu/~collins/525/

Lecture times: MWF 11:15–12:05 pm in 322 Sackett.

Office hours: Monday and Friday 2–3 pm.

Exam times: Midterm: Wed. Oct. 22, from 10:10am to 12:05pm. (By arrangement with Prof. Rigol, this uses the time slot of both 561 and this course.) The room is to be determined.  
Final: to be determined (in the week of December 15–19).  
WARNING: Do not make travel plans for the end of semester until you definitely know the dates of this and other final exams.

Course Objectives: The course is primarily aimed at graduate students of physics. On successful completion of the course, students should have a good grasp of the mathematical tools listed in the curriculum. They should be able to use these tools competently as needed in other courses, and in research work. The tools are basic ones generally considered to be particularly important for graduate study in physics independent of research area. Teachers of other courses will rely on your fluency in mathematical methods.

The course is also suitable for students in other disciplines who need comparable competence.

Course structure: The course is planned on the assumption that all of the students will have at least a minimal previous acquaintance with some of the topics of the course, and the pace is adjusted accordingly.

The material explicitly covered in lectures will be a subset of the material you are expected to be familiar with. You should work through the whole of the relevant chapters of the textbook.

Feel free to ask questions in class or afterwards, if clarification or further explanation of particular topics is needed.

Homework: As usual in physics (and mathematics) courses, it is essential to work problems on the course material. You do not fully understand the principles of an area of mathematics or physics until you can apply them. Now the object of the homework is to help you learn the material, and if necessary learn from difficulties you encounter. Therefore, I have assigned a fairly small portion of the course grade to homework. This of course does not reflect the importance of doing the homework or the
time involved. It is on the exams that will you will be able to show to me that your work has succeeded.

I may only grade a subset of the homework, with the ungraded problems being indicated on the assignments. I will post solutions to the homework problems on the course website [http://www.phys.psu.edu/~collins/525](http://www.phys.psu.edu/~collins/525) (after the due date, of course, for graded problems). You will be able to check your solutions against mine, particularly for the ungraded problems. If you have questions, please feel free to discuss them with me. Numerical scores for a problem will be based not only on the accuracy of the bottom line result, but also on the quality of the argument you use to get there, and on the inclusion of adequate details of the steps to get your solution. Each graded problem on the homework and exams will have a maximum score of 4 (unless stated otherwise).

If you wish, I will be happy to look over your solutions to the ungraded problems. Just hand them in with the others that will be graded.

For those of you who find this useful, I encourage you to discuss the homework together. This is normally best in small groups. You may well find, for example, that the effort of explaining the course material to others (and getting their reactions) may assist your own learning. But do not rely on this to the exclusion of doing solo work on the material. Moreover, unless I suggest otherwise for specific assignments, you should write up the homework separately from others you have worked with, to ensure you have your own personal understanding of the material.

*Use of Mathematica etc:* Unless it is stated otherwise, you should not use Mathematica or other similar computer software to solve the homework problems. To gain the necessary fluency with the course material, you need to be able to work through the problems yourself. While more complicated problems can be very usefully solved by Mathematica (etc), it is also important to be able to check the methods you use. Solving particular cases by hand, etc, is an essential tool in being able to verify that the software is doing what you expect it to do.

**Grading:**

20% homework
30% midterm exam
50% final exam

The meanings of the letter grades, with the *approximate* boundary lines in the numerical grades, are:

- **A** = “Excellent”, full understanding of the course material, as appropriate for a professional physicist. A and A−: above about 82%;
- **B** = “Good”. B−, B, and B+: about 62–81%;
- **C** = “Acceptable but substandard”. C: about 50–61%.
(The parts of the above definitions in quotes are those made by Penn State University.) I will adjust the boundaries that relate letter grades and numerical scores depending on my judgment of the difficulty of the homework and examinations.

The exams will be closed book/notes. It may be useful to have an electronic calculator available for numerical work. However, algebra, etc. is to be written out in sufficient detail.

**Collaboration:** Examinations are to be individual work of the students in the course, and no collaboration or copying is allowed.

However, on the homework assignments a certain amount of collaboration is allowed in this course—see the comments above.

**Books**

*Official textbooks for course:*


*Other books:*


**List of topics to be covered**

- (Approx. 5 lectures) Complex variables; complex-analytic functions; Laurent expansions; contour integration.

- (Approx. 3 lectures) Finite and infinite dimensional vector spaces; Hermitian structures; Hilbert spaces.
- (Approx. 4 lectures) Linear operators and their properties; self-adjoint operators; eigenvalues and eigen-vectors; unitary operators.

- (Approx. 3 lectures) Distributions/generalized functions

- (Approx. 4 lectures) Calculus of variations and its application to classical mechanics and classical field theory. This introduces ideas of functionals and functional analysis.

- (Approx. 6 lectures) Fourier series; Fourier integrals and their properties; applications to differential equations; distributions; Green’s functions.

- (Approx. 12 lectures) Differential equations that occur commonly in physics; special functions; orthonormality and completeness. Applications of the methods introduced earlier.

**General Penn State policies**

All Penn State Policies [http://www.psu.edu/ufs/policies/](http://www.psu.edu/ufs/policies/) regarding ethics and honorable behavior apply to this course.

Penn State welcomes students with disabilities into the University’s educational programs. Every Penn State campus has an office for students with disabilities. The Office for Disability Services (ODS) Web site provides contact information for every Penn State campus: [http://equity.psu.edu/ods/dcl](http://equity.psu.edu/ods/dcl) For further information, please visit the Office for Disability Services Web site: [http://equity.psu.edu/ods](http://equity.psu.edu/ods).

In order to receive consideration for reasonable accommodations, you must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation. If the documentation supports your request for reasonable accommodations, your campus disability services office will provide you with an accommodation letter. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. You must follow this process for every semester that you request accommodations.