PHYSICS 301/MATH 355

Spring 2014

Instructor: Dr. David B. Slavsky
Class Meetings: Lectures: MWF 9:20-10:10 in Dumbach 230;
Mathematica Labs: M 1:40-2:30 pm in LSB 315 **or**
W 2:45-3:35 pm in LSB 315
Office Hours: MWF 11:00-12:00 in Cudahy 404 or by appt.
Contact Information: Cudahy 404, phone 773-508-8352, fax 773-508-3506, email dslavsk@luc.edu
Text: Mathematical Methods in the Physical Sciences, by Boas; you can purchase either the Loyola University customized version or the 3rd edition—both use the same pagination
Course web page:
http://www.luc.edu/faculty/dslavsk/courses/phys301/phys301-2014.shtml

Course Description

This is a course for physics and math majors seeking to learn the mathematics necessary for solving the sorts of more realistic problems that arise in various physical sciences. The course prerequisite is Math 263 (multivariable calculus or its equivalent) and co-requisite is Math 264 (differential equations or its equivalent.) We will make extensive use of many of the techniques you learned in multivariable calculus, including line integrals, partial differentiation, and Green's and Stokes' Theorems. If you are rusty on any of these topics, please review your multivariable book or go over the relevant sections in Boas.

The goal of the course is to provide you with the background necessary for future physics courses, such as mechanics, electromagnetic theory, optics and quantum mechanics, and also to provide students with a set of skills to solve the problems one encounters in advanced physics and engineering. Scientific programming is an important element of this skill set, and we will make extensive use of Mathematica this semester to expand and enhance your background in scientific programming.

Our first topic this semester will be the study of Fourier series. In introductory calculus, you learned how you can express many different types of functions as infinite series of polynomials. Fourier series allow you to write functions (even functions with discontinuities) as an infinite series of sin and cos terms. You will encounter Fourier series in many aspects of physics, including the electronics course many of you are also registered for this term.

Vector calculus was a major component of Math 263; using your knowledge of vectors and vector calculus as a starting point, we will learn how to represent vector operators in Einstein summation notation, and will become facile in manipulating and proving vector expressions in this format. Our discussion of vector operators will begin with Cartesian coordinates, but will be extended to show how vectors and vector operators can be written in any orthogonal coordinate system. While our results can be generalized to any curvilinear orthogonal system, we will focus on those systems used most frequently in physics: Cartesian, cylindrical and spherical coordinates.

We should begin our study of differential equations sometime in March. If you are co-registered in Math 264, you will already have covered many basic concepts in differential equations (separable equations, nth order constant coefficient equations, method of undetermined coefficients, et al.). We will build on this knowledge base and study series solutions of differential equations putting particular emphasis on the solution to Legendre's equation and the properties of Legendre polynomials. (For those of you who have completed Math 264 or its equivalent, please review these basic concepts of ODEs).

Finally, we will investigate the nature of partial differential equations (PDEs); many of the most important and well known problems in physics require solutions of PDEs. We will complete the course by studying basic solutions to these types of problems.

The course will make extensive use of the software package Mathematica; many homework assignments will either allow you or require you to use Mathematica. Such assignments must be done using Mathematica (not MatLab, Maple or any other software platform.)

Grading

Your grade in the course will be determined by grades on homework assignments, two hour exams, an extended Mathematica programming assignment and a final exam.

Homework will represent an important component of this course: mastering the concepts and skills of this course (or any advanced science/math course) requires in-depth investigation of the material. Homework assignments will provide the practice you will need to achieve fluency in mathematical physics. Homework will be assigned each week throughout the semester. Each homework will be due at the beginning of class on its assigned due date. I will post solutions to the course website and will make these solutions public as soon as I collect homework, so assignments must be submitted at (or before) the start of class on the assigned due date. There will be no credit given for assignments submitted after the solutions are made public. Assignments will typically include problems that must be solved using the Mathematica software package. (Mathematica should be loaded on all Loyola network machines.)

Hour Exams will be given twice during the semester. The first will be on Wednesday, February 26; the second will be on Wednesday, April 16. The first hour exam will cover all material presented in class or assigned for reading from the beginning of the term through the day of the exam; the second exam will cover material done in class or assigned for reading from approximately Feb. 28 through the date of the second exam, although for purposes of continuity, some material from the first half of the semester might appear on the second exam. The exact scope of the exams will be discussed thoroughly in class prior to exam dates.

In addition to weekly homeworks, you will also have a more extensive mathematical **modeling program** to complete (using Mathematica). This project will require that you use Mathematica and mathematical modeling techniques to generate answers to a realistic physics problem.

The **final exam** will be given in this room (Dumbach 230) on Saturday (sorry folks, I don't make the exam schedule) May 3 from 1:00-3:00. The final exam will be comprehensive, covering everything we have studied during the semester.

Your **final grade** will be calculated according to:

Final average =

0.20 x homework avg + 0.35 x hour exam avg. + 0.10 x project grade + 0.35 x final exam

Final averages > 90% will earn an A for the course; final averages > 80% will earn a B for the course; final averages > 60% will earn a C for the course; passing will require a final average > 50%. I reserve the right to lower the thresholds for certain grades, in other words, final averages in the 80s might earn A's, but I will not under any circumstances raise the thresholds for grades.

Format for Homework assignments

We will both spend a lot of time this term on homework. For homework assignments to serve the purposes we want, I ask for your help in facilitating my ability to grade them quickly and return them to you as soon as possible. Your homework sets must be legible (I can't grade what I can't read) and must show your complete solutions (in other words, I must be able to follow the logic you used to reach a final answer). Full credit can be given only for correct answers showing complete work. If your assignment includes multiple pages (and they will include multiple pages), they must be stapled (not paper clipped, not pages folded over) so that pages do not separate as I work with them or transport them. (Assignments will lose 20% of their credit if they do not follow this format.) Homework assignments must be submitted in hard copy at the beginning of class. No credit will be given for late homework.

Policy for missed exams and assignments

Students are expected to take exams on the scheduled dates and times. Make up exams for hour exams will be given only if one (or more) of the following conditions applies:

- Illness or hospitalization requiring physician's intervention.

- Death of a close family member.
- Unavoidable court date (including jury duty).
- Representing Loyola in an official capacity which requires your absence from class (i.e., debating team, model UN, intercollegiate athletics).
- Religious observance that prohibits normal work/school activities on that day.

Travel, unless it is travel for one of the reasons listed above, is not an approved reason for missing exams. In all cases, students must provide written, relevant and verifiable documentation of the circumstances.

As noted above, late homeworks will receive no credit. If the homework is late due to one of the five reasons listed above, I will work with the student to determine an appropriate alternate assignment.

Policy Regarding Academic Dishonesty

It is my expectation that each of you will continue to meet the high standards of conduct that I have come to expect from Loyola students.

Homework must be the result of your own effort. While it is often very useful for students to work together on homework, be careful that the work you submit must clearly be the result of your own efforts. Students will receive a grade of zero for the first instance of copied homework during the semester; a second such instance will result in a grade of F for the course.

Academic dishonesty on exams, which includes specifically but not exclusively copying from another's paper, using crib notes, transferring information to another student during the exam, will result in a grade of F for the course.

In all cases of academic dishonesty, I will send copies of the material to the Dean's Office for inclusion in your permanent Loyola file.

General Comments

This is a course where students are encouraged to be active participants in the study of mathematical physics. I urge you to ask questions in and/or out of class; don't leave class without asking those nagging questions that you can't figure out (but assume you will get upon further reflection doing homework). This is material that requires thought and practice, and the more ways we have of analyzing a problem the more we can expand and enhance your understanding of how to frame and solve interesting problems in physics.

In past years, my syllabus has included the statement: "I will give reading assignments with the expectation that you will have read the material prior to coming to class." There are two important elements in this statement that I would like to spend time discussing on the first day of class.

The first involves class attendance. I know all your professors extol the virtues of class attendance, but having taught this class for a number of years, I have empirically observed the high correlation between unsatisfactory outcomes and absenteeism. In other words, if you miss a lot of class, you are likely to receive a poor grade or have to withdraw from the course.

The second describes *how* you should read an advanced math or physics text. While learning new techniques of solving problems is important, the focus of your studies is now concentrated more on deriving equations and learning how physical conditions can be expressed in mathematical form. Thus, as you read the text, you should be deriving everything the author is (or is describing). As an example, we will begin the semester by studying Fourier series. The computation of Fourier coefficients is described on pp. 350-351 of the text. As you read this section, you should explicitly work out the values of the integrals that are cited in the derivation of these coefficients. By deriving each result in the text, you will gain deeper understanding of the topic, and you will no longer need to (or feel the need to) resort to rote memorization of equations.

I will also make use of email and the course website to communicate with the class in aggregate, so please check your (Loyola) email and the course website frequently.