**PHYSICS 301/MATH 355**

**Spring 2016**

**Instructor:** Dr. David B. Slavsky
**Class Meetings:** Lectures: MWF 9:20-10:10 in Cudahy 202;
Mathematica Labs: M 1:40-2:30 pm in Crown Center 103 **or**
W 2:45-3:35 pm in Crown Center 103
**Office Hours:** M at 11:30-12:30 and W, F at 1:00-2:00 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 Engineering and Physics by Felder and Felder; please bring your text to class each day.
**Course web page:**
http://www.luc.edu/faculty/dslavsk/courses/phys301/phys301-2016.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. Math 263 (multivariable calculus or its equivalent) is a pre-requisite and Math 264 (differential equations) is the co-requisite. 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 our text.

The course has a number of important learning goals. First and most obviously, students will learn a number of methods and techniques that will be useful (indeed critical) in studies of more advanced physics courses. Additionally, this course should serve as a nexus between mathematics and physics; we are not just interested in learning new mathematical techniques, but also in learning how to express physical problems in terms of these mathematical formalisms. Finally, since scientific programming is an important element of the skill set all physicists should possess, we will make extensive use of Mathematica this semester to expand and enhance your background in scientific programming, and to use Mathematica to highlight some of the concepts we will cover in class.

Our first topic this semester will be orthogonal curvilinear coordinates (see http://luc.edu/faculty/dslavsk/courses/phys301/classnotes/scalefactorscomplete.pdf ). This will also be a topic those of you in Phys 314 will encounter early in the semester. Our second major topic will be the study of Fourier series. In introductory calculus, you learned how many functions can be expressed as a series of polynomials; we will discover that an even larger set of functions (even functions containing discontinuities) can be expressed as a series of sin and cos functions. Fourier series (also known as Harmonic Analysis) has a broad array of applications in physics; those of you in electronics will encounter those this semester.

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. 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.)

I anticipate that we will cover the following sections in Felder/Felder (our first topic is not included in the book; please read the classnote on the course website). Those sections marked by an asterisk will be covered if time permits.

9.1-9.5; 9.6*
8.1-8.11
12.1-12.5, 12.8*, 12.6*-12.7*, 10.12*
11.1-11.5, 11.7-11.8, 11.6*

## Grading

Your grade in the course will be determined by your scores on homework assignments, two hour exams, a series of in class group assignments 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 in class on its assigned due date. I will post solutions to the course website and will make these solutions public as soon as I return to my office after class, so assignments must be submitted in class on the assigned due date. There will be no credit given for assignments submitted after the solutions are made public. Assignments will often 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 Monday, February 29; the second will be on Friday, April 22. 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 March 2 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.

Many studies of student learning show that well directed **group work** can significantly enhance student learning in math and physics courses. The text we are using this term has been written explicitly to facilitate (among other objectives) in class group work. Throughout the semester I will divide the class into groups (of five or six students) to work on various problems. As you read through the book, you will see that the book includes a number of motivating and discovery exercises; these, along with many of the end of chapter problems are well designed for group work. Groups will work on these problems during class, and submit written their results in writing. See section below for the details of grading group work.

The **final exam** will be given in this room (Cudahy 202) on Saturday, May 7 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 =

0.15 x homework avg + 0.35 x hour exam avg. + 0.15 x group work 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 (with a D) will require a final average > 50% (however a grade of D will **not** satisfy the prerequisites for higher level physics courses). 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.

**<u>Format for Homework assignments</u>**

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; do not be guilty of this: http://www.condenaststore.com/-sp/I-think-you-should-be-more-explicit-here-in-step-two-Cartoon-Prints_i8562937_.htm ). Full credit can be given only for correct answers showing complete work. Conversely, no work = no credit. If your assignment includes multiple pages (and they will include multiple pages), write on only one side of the sheet. Assignments 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 25% of their credit if they do not follow these guidelines.) As describe earlier in the syllabus, no credit will be given for late homework.

## Grading Group Work

As described above, group work will be an important part of the course. In this section, I will describe how group work will be graded; please read this section carefully to make sure you understand your responsibilities in this enterprise.

The grade each student receives for any group work will be the determined by a **group grade** and **a peer assigned grade**.

The group grade is the grade I assign to the entire group of students; each student in the group will receive the same group grade for a specific assignment.

The peer assigned grade for each student will be determined by the other members of the group. Every student will assign a grade to each of the other students in the group (but will not grade him/herself) on a scale from 0-10 (0 the lowest). Make sure you follow these guidelines:

- You must use only integers in assigning peer grades
- The sum of all scores in your group must equal 5*(N-1) where N is the number of students in your group. In other words, 5 must be the average of your scores.
- You may not assign all members of your group the same grade.

Here is an illustration of how I will compute students' grades for group work. Let's consider a group of five students composed of Boltzmann, Clausius, Gibbs, Helmholtz and Kirchoff. Since this is a pretty high powered group, their group grade was a 95%. Boltzmann received peer grades of 5, 4, 4 and 5, for an average of 4.5 suggesting that the other members of the group regarded his contributions as just below the group's mean. Thus, we can compute Boltzmann's total grade for this assignment as (4.5/5)*95% =85.5%

The purpose of the peer reviewed grade is to ensure that all members of a group contribute to the overall success of the work, and that no one earns a high grade by virtue of someone else's efforts. In my experience, it is rare (but not unprecedented) for any group member to receive a score above 6 or below 4.

Please submit your peer scores via email (to dslavsk@luc.edu ) for all other members of your group no later than 5 pm of the business day after the class in which we did group work. Provide a brief justification for any score above 6 or below 4. Please remember to use only your Loyola email account when submitting these scores to ensure authenticity and confidentiality. It is important that you submit your scores in a timely fashion; your peers deserve to know their grades as soon as possible. Therefore, your grade for the assignment will be reduced by 20 percentage points for failure to submit group grades on time.

**Peer grades must be confidential. You should not discuss these grades with anyone else in the class. Any form of collusion in the determination of peer grades will be considered a form of academic dishonesty. Students will receive a grade of zero for the first instance of academic dishonesty, and an F in the course for a second instance.**

## 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.
- Off-campus interview for graduate or professional school.

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 homework assignments 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.

Students who have an unexcused absence when group work is done will receive a zero for that 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 independent 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.

You can review Loyola's policies on academic honesty by reading the following links:

www.luc.edu/education/academics_policies_integrity.shtml

http://www.luc.edu/education/academics_policies_main.shtml

Please see section below for the policies regarding use of electronic devices in class.

## Use of electronics during class period

To maintain the proper atmosphere during class, all electronic devices must be turned off and stored out of sight during class period. If you wish to take notes on a laptop (which I imagine would be very difficult given the extensive use of diagrams, equations and special symbols), please sit toward the back of class so as not to disturb your neighbors. Prior to the hour exams and final exam, I will remind you to turn off and store out of sight all electronic devices. The visible presence of any electronic device (with internet and/or communications capabilities) will constitute academic dishonesty and will result in a grade of zero on the exam.

## Accommodations for Persons with Disabilities:

Students who have disabilities which they believe entitle them to accommodations under the Americans with Disabilities Act should register with the Services for Students with Disabilities (SSWD) office. To request accommodations, students must schedule an appointment with an SSWD coordinator. Students should contact SSWD at least four weeks before their first semester or term at Loyola. Returning students should schedule an appointment within the first two weeks of the semester or term. The University policy on accommodations and participation in courses is available at: http://www.luc.edu/sswd/

## 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 (actually, almost pre-destined) to receive a poor grade or to 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. 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.