

# PHYSICS 301/MATH 355

Spring 2017

**Instructor:** Dr. David B. Slavsky

**Class Meetings:** Lectures: MWF 9:20-10:10 in Cudahy 313;

Mathematica Labs: W 2:45-3:35 pm in Crown Center 103

**Office Hours:** M, F 12:30-2:00 and W 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](mailto:dslavsk@luc.edu)

**Text:** Mathematical Methods in Engineering and Physics by Felder and Felder

**Course web page:**

<http://www.luc.edu/faculty/dslavsk/courses/phys301/phys301-2017.shtml>

**Course pre-requisites and co-requisites :** A grade of C- or higher in Math 263 is required for this course. Students must have completed or currently be enrolled in Math 264. Students lacking the proper requirements to enroll in this class may be withdrawn from the course at any time during the semester.

## 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 our text.

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.

A year ago the Physics Department changed the sequence of courses in the major. Phys 314 (Theoretical Mechanics) was moved from the first semester of (typically a student's) junior year to the spring semester of the sophomore year, meaning that second year physics majors should be taking Math Methods and Mechanics simultaneously.

This means that we will change the order of topics in the course, starting with orthogonal coordinate systems (please visit the course web page for the reading assigned for this topic).

Our second 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, a group presentation and the 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 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 Monday 27 February; the second will be on Wednesday 19 April. 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 3 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.

The **final exam** will be given in this room (Cudahy 313) on Saturday, May 6 from 1:00-3:00. The final exam will be comprehensive, covering everything we have studied during the semester.

During the last few weeks of the semester, the Mathematica lab sessions will be devoted to **group presentations** in which groups of 3-5 students will provide a 20 minute presentation on some aspect of Mathematica that has not yet been covered in class but relates to course work in either Phys 301 or 314.

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

Final average =

$0.25 \times \text{homework avg} + 0.35 \times \text{hour exam avg.} + 0.05 \times \text{group presentation} + 0.35 \times \text{final exam}$

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. 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 20% of their credit if they do not follow these guidelines.) 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.
- 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.

### **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_integrity.shtml)

[http://www.luc.edu/education/academics\\_policies\\_main.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.