PHY204: Mathematical Physics

Spring 2021, 4 credits

TTh 9:45-11:15, Cousins 127

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Office hours: Open office hours will be on Zoom from 2-3PM on Wednesday, 3:30-5:30 on Thursday and 12:30PM-3PM Friday. Friday office hours will also be held in-person in the Cousins garage. Only students residing on campus or taking other in-person courses can attend in-person office hours. The Zoom link for office hours will be available on Moodle. I will have availability on other days – please don't hesitate to email or stop by my office.

Textbook:
Mathematical Methods in Engineering and Physics by Felder and Felder (Wiley 2016). *Mathematical Methods in the Physical Sciences* by Boas (Wiley 2005) is recommended as an additional resource.

Additional Requirements:
A scientific calculator/graphing calculator can be a helpful thing to have. Feel free to use an app on your phone if a calculator is needed during class. Please have access to your textbook during class. If you have an electronic copy, plan to have it open on your phone or laptop. If you have a hard copy, please bring it to class. We will be pulling problems out of the book during class time.

Prerequisites: MAT-233 and PHY-201 or permission of the instructor

OBJECTIVES OF THE COURSE

This course is designed to give physics and engineering students the opportunity to apply advanced mathematics topics to modelling and describing physical systems. Topics covered in this course will include multivariable calculus, linear algebra, complex numbers, and differential equations. This course is appropriate for students who want to review these topics as they apply to physical systems, particularly before entering an engineering undergraduate or graduate program, and for students who are learning this content for the first time but want an application-focused understanding of the mathematics. By the end of this semester you will be able to:

- Model real world situations using ordinary and partial differential equations.
- Use complex numbers to describe physical systems including circuits.
- Describe vector fields and the physical systems they represent.
- Set up and evaluate double and triple integrals to describe extended bodies.
- Use matrices to describe and understand physical systems

COURSE REQUIREMENTS

1. *Reading and Pre-Class Assignments* – Reading and preparing for class is an essential part of this course. It will be incredibly difficult for you to walk into class and start working if you have not done the reading and prepared beforehand. Before each class I will assign 1-2 problems from the textbook that correspond to the class reading. During class, one student will be randomly selected to present their solution to the problem to the class. You may have one "PASS" during the semester where you hand the problem off to another student, however if you are called on and you are not prepared after you have used your "PASS" you will receive a

zero for the pre-class assignment. In addition, each day before class I will ask you to post at least one question you have about the reading in a forum on Moodle. Questions must be posted by **10PM** the night before class.

2. *Attendance and Class Participation* – Be an active participant in class. Asking and answering questions is an integral part of learning. Working throughout the entire class period is important – this is your primary time to get feedback and assistance from me. The classroom experience will be much more successful and productive if you are prepared for class. You are responsible for making up any work missed. Each student may take **4** absences for any reason. The **5th** absence will result in a one-letter-grade deduction from your course grade (B to C). The **6th** absence will result in an automatic FA grade for the course. Class can be attended via Zoom only if discussed with me at least 24 hours ahead of time. Without prior notification, you will be considered absent if you join the class via Zoom.

   In the classroom, all students will be expected to wear face masks that properly cover the nose and mouth at all times. Social distancing should be followed whenever possible, however realistically when we are examining code we might need to break the 6-foot rule. There will be the possibility to connect your computer to an external screen at times to help mitigate this. At the beginning of each class, all students will be asked to display their status on the Lifeguard app.

3. *Weekly Problem Sets* – Each week I will post a set of problems for you to work on. Your solutions will be due by **11:59PM Friday** night. It will be easiest if you solve the problems directly on the computer, using either a stylus or graphics pad. If you write your solutions on paper, please use a scanning app, like Microsoft Lens, to digitize your solutions. **Solutions should always be submitted as a PDF – please no other file formats!** Problem sets will take considerable time, and you should plan to be working on them throughout the week. If you begin Friday morning, you will struggle to get it done. You will be allowed an extension of up to 48 hours on <u>two</u> problem sets of your choosing; all others that are not submitted by the due date will receive a score of zero. Remember, it is always better to submit some work than nothing at all. This is not to unfairly penalize you – we are trying to cover a lot of material in a relatively short time, and it all builds on itself. Getting behind in the work will only hurt your learning.

   I strongly encourage collaboration, an essential skill in science and engineering. Social interactions are critical to scientists' success - most good ideas grow out of discussions with colleagues; essentially all physicists work as part of a group. Find partners and work together. However, it is also important that you OWN the material. Limit yourself to verbal help; don't take written information from others. This will ensure that you think things through independently after you get help. If you do well on homework and poorly on exams, you are probably getting too much help. **<u>In general, no credit will be given for a correct answer, unless accompanied by a complete and correct derivation.</u>** The point is not to find the answer, but to find out how to *construct* the answer. There will be time for peer discussion during classes: try to help your partners get over confusions, listen to them, ask each other questions, critique, *teach each other.* You will learn a lot this way! Anticipate spending **5-7 hours per week** on homework. This is in addition to time spent on reading and pre-class assignments, exam preparation, and the final project.

4. *Unit Exams* – There are three major units in this course - Linear Algebra, "Fancy" Calculus, and Differential Equations. Each unit will culminate in an in-class unit exam. Unit exams will be closed book and closed note, and are intended to check your understanding of the fundamental concepts of the unit.

5. *Final Project* – As a final project in this course, you will choose a complex physical system to mathematically model using the tools we have developed over the semester. You will be expected to complete background research to understand the physics governing the behavior of the physical system you choose and to correctly identify the mathemetical models required in order to answer the questions I pose about your system. **No late projects will be accepted.**

Dropping the Course: The course may be dropped with a grade of W through Wednesday May 5th (provided that the student's work to that point has been of passing quality). After this date the grade of W will be assigned only in the case of withdrawal from the University or prolonged illness.

Academic Honesty:

Persons who come to Oglethorpe University for work and study join a community that is committed to high standards of academic honesty. The honor code contains the responsibilities we accept by becoming members of the community and the procedures we will follow should our commitment to honesty be questioned.
The students, faculty and staff of Oglethorpe University expect each other to act with integrity in the academic endeavor they share. Members of the faculty expect that students complete work honestly and act toward them in ways consistent with that expectation. Students are expected to behave honorably in their academic work and are expected to insist on honest behavior from their peers.

Oglethorpe welcomes all who accept our principles of honest behavior. We believe that this code will enrich our years at the University and allow us to practice living in earnest the honorable, self-governed lives required of society's respected leaders.

Our honor code is an academic one. The code proscribes cheating in general terms and also in any of its several specialized sub-forms (including but not limited to plagiarism, lying, stealing and interacting fraudulently or disingenuously with the honor council). The Code defines cheating as "the umbrella under which all academic malfeasance falls. Cheating is any willful activity involving the use of deceit or fraud in order to attempt to secure an unfair academic advantage for oneself or others or to attempt to cause an unfair academic disadvantage to others. Cheating deprives persons of the opportunity for a fair and reasonable assessment of their own work and/or a fair comparative assessment between and among the work produced by members of a group. More broadly, cheating undermines our community's confidence in the honorable state to which we aspire."

The honor code applies to all behavior related to the academic enterprise. Thus, it extends beyond the boundaries of particular courses and classrooms *per se*, and yet it does not extend out of the academic realm into the purely social one.

Examples of cheating include but are not limited to:

- **1.1** The unauthorized possession or use of notes, texts, electronic devices (including, for example, tablets, computers and smartphones), online materials or other such unauthorized materials/devices in fulfillment of course requirements.
- **1.2** Copying another person's work or participation in such an effort.
- **1.3** An attempt or participation in an attempt to fulfill the requirements of a course with work other than one's original work for that course.
- **1.4** Forging or deliberately misrepresenting data or results. Submitting results of an experiment, at which one was not present or present for less than the full time, as one's own.
- **1.5** Obtaining or offering either for profit or free of charge materials one might submit (or has submitted) for academic credit. This includes uploading course materials to online sites devoted, in whole or in part, to aiding and abetting cheating under the guise of providing "study aids." There is no prohibition concerning uploading exemplars of one's work to one's personal website or to departmental, divisional, University or professional society websites for purposes of publicity, praise, examination or review by potential employers, graduate school admissions committees, etc.
- **1.6** Violating the specific directions concerning the operation of the honor code in relation to a particular assignment.
- **1.7** Making unauthorized copies of graded work for future distribution.
- **1.8** Claiming credit for a group project to which one did not contribute.

1.9 Plagiarism, which includes representing someone else's words, ideas, data or original research as one's own and in general failing to footnote or otherwise acknowledge the source of such work. One has the responsibility of avoiding plagiarism by taking adequate notes on reference materials (including material taken off the internet or other electronic sources) used in the preparation of reports, papers and other coursework.

1.10 Submitting one's own work for a course that was previously submitted for the same course, or another course, without proper citation.

1.11 Lying, such as: Lying about the reason for an absence to avoid a punitive attendance penalty or to receive an extension on an exam or on a paper's due date; fraudulently obtaining Petrel Points by leaving an event soon after registering one's attendance and without offering to surrender the associated Petrel Point, or by claiming fictitious attendance for oneself or another; forging or willfully being untruthful on documents related to the academic enterprise, such as on an application for an independent study or on a registration form.

1.12 Stealing, such as: Stealing another's work so that he/she may not submit it or so that work can be illicitly shared; stealing reserve or other materials from the library; stealing devices and materials (such as computers, calculators, textbooks, notebooks and software) used in whole or in part to support the academic enterprise.

1.13 Fraudulent interaction on the part of students with the honor council, such as: Willfully refusing to testify after having been duly summoned; failing to appear to testify (barring a *bona fide* last-minute emergency) after having been duly summoned; testifying untruthfully.

Students pledge that they have completed assignments honestly by attaching the following statement to each piece of work submitted in partial fulfillment of the requirements for a course taken for academic credit:

"I pledge that I have acted honorably." (Followed by the student's signature)

The honor code is in force for every student who is enrolled (either full- or part-time) in any of the academic programs of Oglethorpe University at any given time. All cases of suspected academic dishonesty will be handled in accordance with the provisions established in this code. The honor council has sole jurisdiction in matters of suspected academic dishonesty. Alternative ways of dealing with cases of suspected academic fraud are prohibited. In cases of alleged academic dishonesty on the part of students, the honor council is the final arbiter. Reference the current Oglethorpe University Bulletin for information concerning all aspects of the honor code.

GRADING POLICY

Grading scale:

A.....90-100 (A-....90-92)
B.....80-90 (B-....80-82,B+....87-90)
C.....70-80 (C-....70-72,C+....77-80)
D.....60-70 (D+....67-70)
F.....0-60

Note that Incomplete (I) is given only under the rarest of circumstances. Refer to section 5.20.2 of the 2014-2016 Bulletin for a summary of requirements.

Your grade will be computed as follows:

Pre-class Activities (75% forum questions, 25% problem prep)	10%
Weekly Homework	30%
Unit Exams	30%
Final Project	30%

Course Schedule PHY204 (*These dates are very tentative and subject to change)*

Tuesdays		Thursdays	
2/9	Introduction/Review	**2/11**	Review
2/16	Mini-Unit 1: Series	**2/18**	Mini-Unit 1: Series
2/23	Unit 1: Linear Algebra	**2/25**	Unit 1: Linear Algebra
3/2	Unit 1: Linear Algebra	**3/4**	Unit 1: Linear Algebra
3/9	**Unit 1 Exam**	**3/11**	Mini-Unit 2: Complex Numbers
3/16	Unit 2: Fancy Calculus	**3/18**	Unit 2: Fancy Calculus
3/23	*Unit 2: Fancy Calculus*	**3/25**	*Unit 2: Fancy Calculus*
3/30	Unit 2: Fancy Calculus	**4/1**	Unit 2: Fancy Calculus
4/6	**Unit 2 Exam**	**4/8**	Mini-Unit 3: Fourier Series
4/13	Unit 3: Differential Equations	**4/15**	Unit 3: Differential Equations ***Final Project Choice***
4/20	Unit 3: Differential Equations	**4/22**	Unit 3: Differential Equations
4/27	Unit 3: Differential Equations	**4/29**	Unit 3: Differential Equations ***Final Project Initial Thoughts***
5/4	**Unit 3 Exam**	**5/6**	***Project Time***

Important Dates

February 8 - First day of classes
March 23, March 25 – Asynchronous class time
May 5 – Last day to withdraw
May 10 – Last day of classes. **Final project rough draft due.**
May 18 – **Final project final draft due.**

Suggested Study Schedule:
This is just a suggestion and is obviously highly malleable depending on your schedule and other commitments. I hope this gives you some sense of the expectations of this course and helps you to set up your own personal work-flow schedule.

Monday	Read and prepare for Tuesday's class Complete pre-class assignment	1 hr 1 hr
Tuesday	Attend class Work on weekly homework	1.5 hr 1-2 hr
Wednesday	Read and prepare for Thursday's class Complete pre-class assignment	1 hr 1 hr
Thursday	Attend class Work on weekly homework	1.5 hr 1-2 hr
Friday	Work on weekly homework Attend office hours if needed	2-3 hr
Total Time		**11-14 hrs**