Syllabus: Physics 105 – Mathematical Methods in Physics

Instructor: Dr. Alex Pettitt **E-mail:** pettitt@csus.edu

Class time and location

Tuesday/Thursday, 10:30 – 11:45
SQU142, or virtual lectures via Zoom if ever required.

Office Hours

Monday 11:00 – 11:50, Tuesday 15:00 – 15:50, Thursday 9:00 – 9:50.
Also by appointment when necessary, or virtually by Zoom if ever required.
Office hours are held in SQU414 by default, if I am not present then I will instead be holding my office hours in the physics tutor center just downstairs (SQU238).

Contacting the Instructor

Email is the standard route to getting in contact, but messaging via Canvas also works. A Slack workspace will also be available for more direct contact outside of class.

Online Resources

Canvas will be used for all online class elements. This includes: announcements, links to external websites, posted grades, homework assignments, quizzes, and exam material. Additional learning materials (e.g. slides) from the lectures will also be uploaded to Canvas.

Course Commitment

This course involves lectures three times a week, but it is expected that students read and study the text themselves in tandem to the course. The university recommends students spend twice the lecture time as private study (be it on assessments or digestion of course material), which means you should plan to dedicate at least 7 – 8 hours each week on this course (2.5hr on lectures + 5hr on non-lecture activities).

Course Goals

The goal of this course is to prepare students for the intensive mathematics needed to be successful in the physics upper-division curriculum. While this is mainly directed towards electromagnetism and quantum mechanics, many of the topics have a wide application in other fields such as computing and signal processing. Our specific goals are:

- Expand the usage of calculus to many dimensions, specifically in preparation for upper-division E&M and fields.
- Utilize complex numbers as tools to solve physics problems and to re-cast solutions in a different basis.
- Understand the notation of vectors spaces and *abstract* vector spaces.
- To express complex linear systems as eigenvalue problems for various vector spaces.
- To be able to solve ordinary and partial differential equations similar to those that appear frequently in physics.
- To apply integral transforms and special functions, recognizing their importance in physics.

Tools

In addition to a calculator, students should have access to a computer with plotting software (e.g., Python, Matlab, Mathematica, Gnuplot, or even Desmos or Excel if you absolutely must!).

Textbook

Mathematical Methods in the Physical Sciences, Mary L. Boas ISBN: 978-0-471-19826-0

Lectures

This course will offer in-person lectures in SQU142. Students are *strongly* encouraged to attend lectures, but attendance is not mandatory. Some small elements of audience participation will take place during the lecture. If ever required (e.g. the instructor falls ill), virtual lectures will be provided via Zoom at the same scheduled meeting time.

Topics

The course is split into the 6 parts shown below, with the corresponding chapters in Boas as indicated. Note that the course builds upon the following prerequisites, which are assumed to be familiar material to the students: MATH 32; PHYS 11A, PHYS 11B, PHYS 11C or PHYS 5A, PHYS 5B (it is highly recommended that you have already taken MATH 45).

Part I: Complex numbers
Less than 10% of the course
Chapter 2
- Real and imaginary parts
- The complex plane

Part II: Vector Calculus
Roughly 15% of the course
Chapters 5 and 6
- Surface integrals
- Line integrals
- Grad, div and curl
- Stokes' and divergence theorems

Part III: Linear Algebra
Roughly 20% of the course
Chapter 3
- Row operations
- Determinants
- Linear operators
- Linear dependence
- Special matrices
- Vector spaces
- Eigen problems

Part IV: Ordinary Differential Equations
Roughly 20% of the course
Chapter 12
- Sturm-Liouville equations
- Legendre equation
- Orthogonality
- Series solutions
- Frobenius's method
- Fuch's theorem

Part V: Partial Differential Equations
Roughly 20% of the course
Chapter 13
- Boundary conditions
- Laplace equation
- Diffusion equation
- Wave equation
- Non-Cartesian coordinates

Part VI: Integral Transforms
Roughly 15% of the course
Chapters 7 and 8
- Fourier transforms
- Convolution
- Delta function

Important Dates

Some useful dates to keep in mind.

Tues. Aug 30th – First class
Tues. Oct 18th – Midterm
Thur. Nov 24th – No class (*Thanksgiving*)
Thur. Dec 8th – Last class
Thur. Dec 15th – Final Exam, 10:15 – 12:15

Homework

Homework will be assigned periodically to give you hands-on experience with some of the important concepts and to help prepare you for exams. Some of the homework may consist of plotting results. Homework will constitute 30% of your semester grade.

Attendance and participation

Your attendance will be a part of your grade, that is how many lectures you attend. If you have a medical or otherwise serious reason to be exempt from the lecture then you must let me know ***before*** the lecture otherwise you will be marked absent. In addition, there will be a number of times in class that call on your active participation. The simplest example is I may give a question to work through in pairs during class and then report back. Other examples may be to ask students to walk the class through their homework solution, or to host a discussion in Canvas about a particular topic.

Exams

There will be two exams in this course, see "Important Dates" above. The first exam will occur approximately halfway through the course, and will cover material encountered up to that point. The second/final exam will be held in our second meeting slot in "finals week" and will cover the entire content of the course (i.e., it will be cumulative) but will focus heavily on the material covered after the midterm. The final exam will be worth 30% of your semester grade, the midterm 25%. Make-up exams will be given only in the most extraneous of circumstances with proof provided of their necessity, and only by prior arrangement.

Course Grade

Your course grade is determined by the points you earn during the semester in each of the following categories:

Attendance + participation:	15%
Homework:	30%
Midterm:	25%
Final Exam:	30%
Total:	**100%**

There is also a chance for extra credit which can supplement these percentages. Grades will be assigned based upon a traditional grading scale:

≥ 95 %	A	≥ 77 %	B –	≥ 62%	D +
≥ 90%	A –	≥ 73 %	C +	≥ 58%	D
≥ 87 %	B +	≥ 69 %	C	≥ 55%	D –
≥ 82 %	B	≥ 66 %	C –	below 55 %	F

Canvas

Please check announcements via email and Canvas *frequently*. Please set your Canvas announcements to automatically send you a message when an announcement has been posted. I will post details of exams, homework, lecture material etc., please don't ignore it!

Course Etiquette and Questions

Questions are valid at any time during a lecture, and are also welcome via the discussion board in Canvas. If you are unsure of something the instructor has just said, there is a very good chance that someone else is unsure as well, so help your fellow classmates by asking a question. Questions during class itself can be simply posed by asking out loud ("excuse me Professor") but it's polite to raise your hand first.

Extra Credit Opportunities

In general, I will not be offering extra credit for this class. However, I will take a "sit-rep" on this after the midterm and may offer some kind of (<5%) opportunity (e.g., a coding assignment, or topic summary quizzes).

COVID: Safety and wellness

You should be aware by now of Sacramento State's Fall 2022 COVID 19 policies. You can find out more at Sacramento State's COVID-19 page. We will be following those policies in this classroom. Vaccines are required for everyone on campus except those who have been granted a religious or medical exemption per the CSU's COVID-19 vaccination requirement. Masks are not required at this point but are recommended indoors. Please respect your fellow students' decision to mask or not mask. You can schedule a vaccine at My Turn California and find out more about vaccines and booster eligibility on the CDC website. Remember that COVID-19 is still a threat, even for those who are vaccinated and boosted. Please practice self-care, monitor your health for any possible symptoms of COVID-19, and contact a health care provider immediately should you believe you may be infected.

COVID: Attendance

Do not come to class if you have COVID-19 symptoms or test positive. COVID-19 tests and safety supplies are available at many locations around campus, including the library and student union. The University will continue to offer free testing to students who are symptomatic through Student Health and Counseling Services. To increase safety on campus, you are required to report a positive COVID-19 test. You will find a confidential reporting form on the Student Affairs COVID-19 web page. Everyone who tests positive, regardless of vaccination status, is required to stay home for at least 5 days. You should stay home for up to 10 days if your symptoms are not resolved or you continue to test positive. If you come into contact with someone who has tested positive for COVID-19, please refer to this flowchart. If you need to isolate, please notify me immediately.

- If you are isolating and not ill, I expect you to stay up to date with your academic work remotely as best you can. Checking in with me for assignments will be your responsibility.
- If you are ill, please contact me as soon as you are well so we can work together to catch you up with the rest if the class.
- You will find the latest updates to academic continuity during COVID-19 here.

COVID: Flexibility

The degree to which COVID-19 will impact the Sacramento State campus this fall is hard to predict. We want to focus on making your time as a Hornet a memorable and fulfilling experience. But patience and flexibility on all our parts will still be necessary as we navigate COVID-19 -related absences. Communicating with me in a clear and timely manner will help you stay on track academically and help all of us stay healthy.

Code of Conduct

The Department of Physics and Astronomy has unanimously approved the following statement: "The faculty of the Department of Physics and Astronomy will not tolerate academic dishonesty. Falsification of data, copying, unauthorized collaboration, plagiarism, alteration of graded materials, or other actions (as described in, but not necessarily limited to the Sacramento State Policy Manual) *will be promptly reported to the Office of Student Affairs.* The offending student will be penalized on the assignment in question. Serious infractions will result in course failure and a recommendation for administrative sanctions."

Netiquette

Given that this class is partially online, it is important that we keep in mind the importance of some basic guidelines for participating in online discussion forums. You can find more info about this in our Canvas course. In short, it is very important to be clear in your messages, avoid potentially offensive comments, and generally reread your messages before posting to make sure they say what you meant to convey. You can also find more information here: http://www.albion.com/netiquette/corerules.html.

Students with Disabilities

Sacramento State is committed to ensuring an accessible learning environment where course or instructional content are usable by all students and faculty. If you believe that you require disability-related academic adjustments for this class (including pregnancy-related disabilities), please immediately contact Services for Students with Disabilities (SSWD) to discuss eligibility. A current accommodation letter from SSWD is required before any modifications, above and beyond what is otherwise available for all other students in this class will be provided. Please be advised that disability-related academic adjustments are not retroactive. SSWD is located on the first floor of Lassen Hall 1008. Phone is 916-278-6955 and e-mail is sswd@csus.edu. For a complete listing of services and current business hours visit https://www.csus.edu/student-affairs/centers-programs/services-students-disabilities/.

Basic Needs Support

If you are experiencing challenges with food, housing, financial or other unique circumstances that are impacting your education, help is just a phone call or email away. The CARES office provides case management support for any enrolled student. Email the CARES office at cares@csus.edu to speak with a case manager about the resources available to you. See the CARES website for more information: https://www.csus.edu/student-affairs/crisis-assistance-resource-education-support/.

Student Health & Counseling Services

There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful. Student Health & Counseling Services at The WELL is here to help: call (916) 278-6461 and visit their website at https://www.csus.edu/shcs/. Student Health and Counseling Services staff are committed to continuing to provide exceptional service to our campus community. Though many students may be away from campus, most services are offered using secure remote technology. If you or someone you know is feeling suicidal or in danger of self-harm, call someone immediately, day or night: 1-800-273-TALK (8255) to speak with a nurse or call 911.

Gender Violence Resources

CSUS is committed to providing an environment free of all forms of discrimination and sexual harassment, including sexual assault, domestic and dating violence, and genderbased stalking. If you (or someone you know) has experienced or experiences genderbased violence (intimate partner violence, attempted or completed sexual assault, harassment, coercion, stalking, etc.), know that you are not alone. CSUS has staff members trained to support survivors in navigating campus life, accessing health and counseling services, providing academic and housing accommodations, helping with legal protective orders, and more. Please visit https://www.csus.edu/student-affairs/crisis-assistance-resource-education-support/.

Note: the instructor reserves the right to update the syllabus and schedule during the semester.