
SF State PHYS 712: Physics of Plasmas

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Lectures & Office Hours

Lectures: TR 12:30-1:45 PM, on-campus, BUS 122

Office Hours: TR 2:00-3:15 PM, on-campus, TH 334

Quick note on e-mail contact

So that I can identify and respond to e-mails from you expeditiously, please put [PHYS712] at the beginning of the subject line.

Course Overview & Objectives

PHYS 712 is an introduction to the physics of plasmas, often called the “fourth state” of matter. A plasma is an ionized gas, a “soup” of positive and negative ions. Particles are accelerated by electric and magnetic fields; in turn, the motion of ions generates currents and magnetic fields. Because of the long-range nature of electromagnetic forces, plasmas exhibit “collective” effects. Topics include basic plasma concepts; single-particle motion; plasmas as fluids (magnetohydrodynamics); waves in plasmas; collisions, diffusion & resistivity; equilibrium & stability; kinetic theory; and nonlinear effects in plasmas. Applications include both laboratory (fusion research, laser-produced plasmas, propulsion systems) & geophysical/astrophysical plasmas (astro/geodynamos, solar wind/magnetosphere interactions, interstellar medium & star formation, pulsars, intergalactic medium).

Course objectives & student learning outcomes include:

- (1) To understand how the equations of electromagnetism (Maxwell’s equations) and the equations of fluid dynamics (Navier-Stokes equations) are coupled together to yield new linear and nonlinear phenomena in plasmas (e.g., magnetohydrodynamics).
- (2) To develop and apply mathematical tools (vector calculus, linear algebra, differential equations, complex analysis, calculus of variations, numerical/computational methods) to solve problems in plasma physics.
- (3) To apply plasma concepts to real-world plasma systems such as: fusion research, laser-produced plasmas, propulsion systems, astro/geodynamos, solar wind/magnetosphere interactions, interstellar medium & star formation, pulsars, intergalactic medium.

Course Format

This is a lecture course. During class time, instructor will present theory and outline applications. Student questions are strongly encouraged throughout class time. Occasionally, students will work on in-class activities in groups. Homework will explore theory and applications.

Required Learning Resources

“Plasma Physics” by Richard Fitzpatrick (U. Texas, Austin), free online textbook:

<http://farside.ph.utexas.edu/teaching/plasma/Plasma/index.html>

Useful Websites

(1) <https://canvas.sfsu.edu> – Login to access course website on Canvas. Please check frequently for new announcements, updates to the syllabus & schedule, tips & tricks on the homework, and links to additional learning resources.

(2) <http://www.wolframalpha.com> – “Computational Knowledge Engine.” All SF State students have free Pro accounts.

Recommended Preparation

- (1) Physics 330 (Analytic Mechanics)
- (2) Physics 360 & 460 (Electromagnetism I & II)
- (3) Physics 370 (Thermodynamics & Statistical Mechanics)
- (4) Physics 385 (Mathematical Methods for Physics)
- (5) Computer Science 309 (Intro Scientific Programming)

It is okay to be missing some of the above, and we will often review relevant background material. Please see me if you have any concerns about your preparation.

Assignment of Grades

Grades will be determined according to the following rubric:

Homework	70%	Approximately one HW due every other week or so
Oral final exam	15%	Scheduled during finals week, May 22-24
Long Oral Presentation	10%	15 minutes, last week of classes
Short Oral Presentation	05%	5 minutes, scheduled during semester

Letter grades will assigned according to the following table:

	A: 90.0% – 100.0%	A-: 85.0% – 89.9%
B+:	80.0% – 84.9%	B-: 70.0% – 74.9%
C+:	65.0% – 69.9%	C-: 55.0% – 59.9%
D+:	50.0% – 54.9%	D-: 40.0% – 44.9%

Homework

You cannot learn physics solely from lectures. You must work through many problems, seeing how the theoretical concepts discussed in lecture apply in various contexts. Homework is an integral part of the learning process; how serious you take the homework will ultimately determine how much you will understand physics and how well you will do in the course overall. There will be approximately one homework assignment per week. Most problems will require analytic solutions, however there will usually be one problem per assignment that will involve graphing and numerical solution with computer software such as MATLAB, Mathematica, or Python.

Late policy: Students have a bank of 21 late days (weekends and holidays included); partial days count as full days. After the bank of late days is exhausted, late work will incur a flat 25% penalty. For example, you could turn in one assignment 14 days late, and another assignment 7 days late, with no penalty. The next assignment you turn in late will be penalized. You do NOT need to request extensions; I will keep track via our learning management system Canvas. **There is a hard deadline of Friday, May 19, 2023, 11:59 PM. Absolutely no late work will be accepted after this date.**

Policy on Collaboration & Academic Integrity _____

You are strongly encouraged to discuss course material with your fellow classmates. When working on homework, first try to solve the problems on your own. Struggle. Struggle some more. If you get stuck, feel free to discuss overall methods and approaches with your classmates, but not the details! Your written solutions should be solely your own, and should be written-up in isolation from your fellow classmates. Copying is strictly prohibited. Using the internet to download solutions manuals is also considered cheating. Cheating via any method on exams will result in a grade of zero on that exam and being reported to the department chair and/or college dean for possible discipline.

Add, Drop, Withdrawal & Repeat Policy, Grade Option Deadline _____

Fri., Feb. 17: Add/drop deadline. You can drop yourself from the class online without any penalty and without any record, for any reason. After Feb. 17, students must petition for an official withdrawal.

Tue., Mar. 28: Change grade option deadline (letter grade to CR/NC and vice versa).

Mon., Apr. 24: Withdrawal deadline. Documents must be provided to support the petition to withdraw. If the petition is approved, the designation “W” will appear on the transcript. Students are only allowed to repeat a class once at SF State. Note that designations of W, WU, NC count toward this limit.

Expected Code of Conduct _____

Classroom discussion and participation are strongly encouraged. However, please refrain from unrelated chatter. Also, please remember to place cell phones and other electronic communication devices on silent or vibration mode so as not to distract your fellow classmates. If you must arrive late or leave early, please sit toward the back of the room near the doors so as to minimize disruption.

Disability Access _____

Students with disabilities who need reasonable accommodations are encouraged to contact me early in the semester. The Disability Programs and Resource Center is available to facilitate the reasonable accommodations process. The DPRC, located in Student Services Building 110, can be reached by phone at 415-338-2472 (voice/TTY) or by e-mail at dprc@sfsu.edu.

Religious Holidays _____

The faculty of San Francisco State University shall accommodate students wishing to observe religious and cultural holidays when such observances require students to be absent from class activities. It is the responsibility of the student to inform the instructor, in writing, about such holidays during the first two weeks of the class each semester. If such holidays occur during the first two weeks of the semester, the student must notify the instructor, in writing, at least three days before the date that they will be absent. It is the responsibility of the instructor to make every reasonable effort to honor the student request without penalty, and of the student to make up the work missed.

Student Disclosures of Sexual Violence

SF State fosters a campus free of sexual violence including sexual harassment, domestic violence, dating violence, stalking, and/or any form of sex or gender discrimination. If you disclose a personal experience as an SF State student, the course instructor is required to notify the Dean of Students. To disclose any such violence confidentially, contact:

The SAFE Place - (415) 338-2208; http://www.sfsu.edu/~safe_plc/

Counseling and Psychological Services Center - (415) 338-2208; <http://psyservs.sfsu.edu/>

For more information on your rights and available resources - <http://titleix.sfsu.edu>

Health & Safety Commitments

Your health and safety are our paramount concern at SF State. We ask every member of our campus community to join a pledge to make and follow plans to keep fellow students, faculty, and staff safe and well. Feeling confident, safe, and well will help you focus on your academic success. To participate in this class, all students are expected to:

- stay informed on the most up-to-date information related to SF State's COVID-19 response and Campus Comeback plan;
- plan ahead for possible class disruptions due to COVID-19 or other unexpected events, such as unhealthy air quality caused by smoke;
- take care of yourself and others by staying home when you aren't feeling well or believe you have been exposed to COVID-19;
- follow all required health and safety guidelines, including verifying your proof of vaccination or exemption status before coming to class, wearing a multilayered mask over your nose and mouth at all times when indoors on campus, and washing your hands as often as possible with soap and water or hand sanitizer.

For more information about SF State's response to COVID-19 and how you can keep yourself and others safe and well, visit the Campus Comeback Website. To plan for how you will maintain your academic success when unexpected events disrupt regular teaching and learning activities, follow the information on the course syllabus and consult the Keep Learning guide.

Recording of Lectures & Privacy

As the instructor of this course, I will be using Zoom to record our class sessions/lectures for the sole purpose of supporting student learning. To maintain privacy, I will post links to the recordings in our campus's learning management system Canvas to limit access to the members of this course only. It is expected that students also refrain from sharing these recordings outside the context of this course. Students who have privacy concerns may turn off their video and/or change their user name for the duration of the session.

At the beginning of each recorded Zoom session, you will be prompted to acknowledge that the session is being recorded and that you would like to continue in the session. These recordings will be retained for one semester beyond the end of this course, to support students who may have received an incomplete grade, and will then be deleted. As always, any student who has concerns about these recordings may speak with me at any time during the semester to discuss your concerns.