PHYS:4731   Plasma Physics I   Fall 2022

Instructor:	Gregory Howes
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Office Hours:	1:00–2:00pm T, 10:00am–12:00pm W, or by appointment
Department:	Physics & Astronomy, 203 Van Allen Hall, Prof. Phil Kaaret, Chair

Catalog Description: Physics of ionized gases, including orbit theory, guiding center motion, adiabatic invariants, ionization balance description of plasmas by fluid variables and distribution functions; linearized wave motions, instabilities; magnetohydrodynamics.

Meeting: Tuesday and Thursday, 11:00am–12:15pm, 618 Van Allen Hall

Textbook: Required: D. A. Gurnett & A. Bhattacharjee, *Introduction to Plasma Physics with Space and Laboratory Applications*
Optional: T. J. M. Boyd & J. J. Sanderson, *The Physics of Plasmas*

Web Page: `http://www.physics.uiowa.edu/~ghowes/teach/phys4731/index.html`

Exams   **Two Midterm Exams:** Thursday, Oct 6th and Thursday, Nov 17th
Final Exam: Tuesday, Dec 13th, 10:00am-12:00pm, 618 VAN

Grading: Homework: 20%
Two Midterm Exams: 20% each
Final Exam: 40%

Topics:
1. Introduction to plasmas
2. Single particle motion
3. From kinetic to fluid plasma descriptions
4. Ideal MHD and MHD waves
5. MHD Equilibria
6. Cold unmagnetized plasma waves

Reference books: R.D. Hazeltine and F.L. Waelbroeck, *The Framework of Plasma Physics*
N.A. Krall and A.W. Trivelpiece, *Principles of Plasma Physics*
D.R. Nicholson, *Introduction to Plasma Theory*

Homework: Homework will be assigned on a regular basis with a time allotment corresponding to the level of difficulty. Longer assignments will be weighted more heavily in the homework score. Some assignments will involve a certain amount of computer work. Late homework will not be accepted. You are encouraged to work together in groups on the homework, but each student must write his or her own solutions; you may discuss how to solve the problem together, but you may not copy another student's solution. Homework must be turned in at the beginning of the class meeting on the day the homework is due.

Solutions: Solutions for the homework assignments and midterm exams will be available only to enrolled students through the ICON course website under the "Files" section.

Exams: There will be two in-class midterm exams, with tentative dates given on the front page of this syllabus, and one in-class final examination to be scheduled by the registrar and announced mid-semester. You may use a Formula Summary Sheet (see below) for each exam.

Formula Summary Sheets: All exams are closed book and closed notes. For each exam, you are allowed to prepare a Formula Summary Sheet to use during the exam. You are also free to use the NRL Plasma Formulary. For each midterm exam, your Formula Summary Sheet may use two sides of 8.5 inch by 11 inch paper. You may also reference the Formula Summary Sheets from previous exams (which do not count against the two-side limit). For the final, in addition to the four sides of Formula Summary Sheets from the two midterm exams, you may include one additional side of 8.5 inch by 11 inch paper (for a total of 5 sides of paper).

COVID-19: ● If you have symptoms consistent with COVID-19, stay home. Do not go to class or work while symptomatic. If you develop symptoms while on campus, go home. Call a health care professional who can assess your symptoms and risk factors and help you make a plan. Consult your UI Health Care provider, Student Health, or personal health care provider to see if you need a COVID-19 test.
● You will not be penalized for missing this class due to illness, and I will work with you to ensure that you are able to make up work as needed.
● If you test positive for COVID-19, you are strongly encouraged to follow CDC protocols for isolation, mask use, and testing to return to normal activities.

Week	Weekly Reading	Class Meeting	Date	Lecture Notes	HW/Exams
1	GB Chap. 1–2 (p.1–18)	1	8/23	Lecture #1	
	"Plasmas" by Harold Grad (1969), *Physics Today* **22**: 34-44	2	8/25	Lecture #2	
2	GB Chap. 3, Sec. 3.1-3.2 (p.23-30)	3	8/30	Lecture #3	
	BS Chap. 2, Sec. 2.1-2.3 (p.12–19)	4	9/1	Lecture #4	HW#1 due 9/1
3	GB Chap. 3, Sec. 3.3-3.4 (p.30–44)	5	9/6	Lecture #5	
	BS Chap. 2, Sec. 2.4–2.7 (p.19–28)	6	9/8	Lecture #6	HW#2 due 9/8
4	GB Chap. 3, Sec. 3.5 (p.44–46)	7	9/13	Lecture #7	
	GB Chap. 3, Sec. 3.8 (p.52–64)	8	9/15	Lecture #8	HW#3 due 9/15
	BS Chap. 2, Sec. 2.8–2.11 (p.28–36)				
	Sec. 16.0–16.1 from Numerical Recipes				
	Introduction to Matlab, by Kristian Sandberg				
5	GB Chap. 3, Sec. 3.6–3.7 (p.46–51)	9	9/20	Lecture #9	
	BS Chap. 2, Sec. 2.12–2.15 (p.37–43)	10	9/22	Lecture #10	HW#4 due 9/22
6	GB Chap. 5, Sec. 5.1–5.3 (p.148–157)	11	9/27	Lecture #11	
	BS Chap. 3, Sec. 3.1–3.2 (p.48–58)	12	9/29	Lecture #12	HW#5 due 9/29
7	Review Lectures #1–11	13	10/4	Midterm #1 Review	
	Review HW #1–5	14	10/6	No Lecture	Midterm Exam #1
8	GB Chap. 5, Sec. 5.4 (p.157–167)	15	10/11	Lecture #13	
		16	10/13	Lecture #14	
9	GB Chap. 6, Sec. 6.1 (p.186–194)	17	10/18	Lecture #15 (Zoom)	
	BS Chap. 3, Sec. 3.3–3.4 (p.58–70)	18	10/20	No Lecture	
10	GB Chap. 6, Sec. 6.2–6.4 (p.194–206)	19	10/25	Lecture #16	
	BS Chap. 4, Sec. 4.1–4.2 (p.77–81)	20	10/27	Lecture #17	HW#6 due 10/27
11	GB Chap. 6, Sec. 6.5–6.6 (p.206–217)	21	11/1	Lecture #18	
	BS Chap. 4, Sec. 4.8 (p.130–132)	22	11/3	Lecture #19	HW#7 due 11/3
12	GB Chap. 7, Sec. 7.1–7.2 (p.221–239)	23	11/8	Lecture #20	
	BS Chap. 4, Sec. 4.3–4.4 (p.82–107)	24	11/10	Lecture #21	HW#8 due 11/10
13	Review Lectures #12–21	25	11/15	Midterm #2 Review	
	Review HW #6–8	26	11/17	No Lecture	Midterm #2
14	GB Chap. 4, Sec. 4.1–4.3 (p.87–105)	27	11/29	Lecture #22	
	BS Chap. 6, Sec. 6.1–6.3.1 (p.197–210)	28	12/1	Lecture #23	HW#9 due 12/1
15	GB Chap. 5, Sec. 5.5 (p.167–173)	29	12/6	Lecture #24	
	BS Chap. 1, Sec. 1.1–1.2 (p.1–6)	30	12/8	Lecture #25	HW#10 due 12/8
	Finals Week, 12/12–12/16			Final Exam TBD	

Textbooks:

Required: **GB=**Gurnett & Bhattacharjee (2017) *Introduction to Plasma Physics: With Space and Laboratory Applications*
Optional: **BS=**Boyd & Sanderson (2003) *The Physics of Plasmas*

Academic Honesty and Misconduct
All students in CLAS courses are expected to abide by the [CLAS Code of Academic Honesty](). Undergraduate academic misconduct must be reported by instructors to CLAS according to [these procedures](). Graduate academic misconduct must be reported to the Graduate College according to Section F of the [Graduate College Manual]().

Student Complaints
Students with a complaint about a grade or a related matter should first discuss the situation with the instructor and/or the course supervisor (if applicable), and finally with the Director or Chair of the school, department, or program offering the course.

Undergraduate students should contact [CLAS Undergraduate Programs]() for support when the matter is not resolved at the previous level. Graduate students should contact the CLAS [Associate Dean for Graduate Education and Outreach and Engagement]() when additional support is needed.

Drop Deadline for this Course
You may drop an individual course before the deadline; after this deadline you will need collegiate approval. You can look up the [drop deadline for this course]() here. When you drop a course, a "W" will appear on your transcript. The mark of "W" is a neutral mark that does not affect your GPA. Directions for adding or dropping a course and other registration changes can be found on the [Registrar's website](). Undergraduate students can find policies on dropping and withdrawing [here](). Graduate students should adhere to the [academic deadlines]() and policies set by the Graduate College.

Date and Time of the Final Exam
The final examination date and time will be announced by the Registrar generally by the fifth week of classes and it will be announced on the course ICON site once it is known. **Do not plan your end of the semester travel plans until the final exam schedule is made public. It is your responsibility to know the date, time, and place of the final exam.** According to Registrar's final exam policy, students **have a maximum of two weeks after the announced final exam schedule** to request a change if an exam conflict exists or if a student has more than two exams in one day (see the [policy]()here).

College of Liberal Arts and Sciences (CLAS) Course Policies
Attendance and Absences
 University regulations require that students be allowed to make up examinations which have been missed due to illness or other unavoidable circumstances. Students with mandatory religious obligations or UI authorized activities must discuss their absences with me as soon as possible. Religious obligations must be communicated within the first three weeks of classes.
Exam Policies

Communication: UI Email
Students are responsible for all official correspondences sent to their UI email address (uiowa.edu) and must use this address for any communication with instructors or staff in the UI community.

University Policies
Accommodations for Students with Disabilities
Basic Needs and Support for Students
Classroom Expectations
Exam Make-up Owing to Absence
Free Speech and Expression
Mental Health
Military Service Obligations
Non-discrimination
Religious Holy Days
Sexual Harassment/Misconduct and Supportive Measures
Sharing of Class Recordings