PHYS:4731 Plasma Physics I Fall 2024

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Office Hours: 11:00am–12:00pm W, 9:45–11:45am Th, or by appointment
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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: Monday, Wednesday, Friday, 1:30pm–2:20pm, 456 Van Allen Hall

Textbook: Required: D. A. Gurnett & A. Bhattacharjee (2017), *Introduction to Plasma Physics with Space and Laboratory Applications*
Optional: T. J. M. Boyd & J. J. Sanderson (2003), *The Physics of Plasmas*

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

Exams **Two Midterm Exams:** Friday, Oct 11th and Friday, Nov 22nd
Final Exam: TBD

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 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).

Week	Weekly Reading	Class Meeting	Date	Lecture Notes	HW/Exams
1	GB Chap. 1–2 (p.1–18)	1	8/26	Lecture #1	
	"Plasmas" by Harold Grad (1969),	2	8/28	Lecture #1/#2	
	Physics Today **22**: 34-44	3	8/30	Lecture #2	
2	GB Chap. 3, Sec. 3.1-3.2 (p.23-30)	4	9/4	Lecture #3	
	BS Chap. 2, Sec. 2.1-2.3 (p.12–19)	5	9/6	Lecture #4	HW#1 due 9/6
3	GB Chap. 3, Sec, 3.3-3.4 (p.30–44)	6	9/9	Lecture #5	
	BS Chap. 2, Sec. 2.4–2.7 (p.19–28)	7	9/11	Lecture #5/#6	
		8	9/13	Lecture #6	HW#2 due 9/13
4	GB Chap. 3, Sec. 3.5 (p.44–46)	9	9/16	Lecture #7	
	GB Chap. 3, Sec. 3.8 (p.52–64)	10	9/18	Lecture #7/#8	
	BS Chap. 2, Sec. 2.8–2.11 (p.28–36)	11	9/20	Lecture #8	HW#3 due 9/20
	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)	12	9/23	Lecture #9	
	BS Chap. 2, Sec. 2.12–2.15 (p.37–43)	13	9/25	Lecture #9/#10	
		14	9/27	Lecture #10	HW#4 due 9/27
6	GB Chap. 5, Sec. 5.1–5.3 (p.148–157)	15	9/30	Lecture #11	
	BS Chap. 3, Sec. 3.1–3.2 (p.48–58)	16	10/2	Lecture #11/Review #1	
		17	10/4	Midterm #1 Review	HW#5 due 10/4
7	Review Lectures #1–11	18	10/9	No Lecture	
	Review HW #1–5	19	10/7	No Lecture	
		20	10/11	No Lecture	Midterm Exam #1
8	GB Chap. 5, Sec. 5.4 (p.157–167)	21	10/14	Lecture #12	
		22	10/16	Lecture #12/#13	
		23	10/18	Lecture #13	
9	GB Chap. 6, Sec. 6.1 (p.186–194)	24	10/21	Lecture #14	
	BS Chap. 3, Sec. 3.3–3.4 (p.58–70)	25	10/23	Lecture #14/#15	
	BS Chap. 3, Sec. 3.3–3.4 (p.58–70)	26	10/25	Lecture #15	
10	GB Chap. 6, Sec. 6.2–6.4 (p.194–206)	27	10/28	Lecture #16	
	BS Chap. 4, Sec. 4.1–4.2 (p.77–81)	28	10/30	Lecture #16/#17	
		29	11/1	Lecture #17	HW#6 due 11/1
11	GB Chap. 6, Sec. 6.5–6.6 (p.206–217)	30	11/4	Lecture #18	
	BS Chap. 4, Sec. 4.8 (p.130–132)	31	11/6	Lecture #18/#19	
		32	11/8	Lecture #19	HW#7 due 11/8
12	GB Chap. 7, Sec. 7.1–7.2 (p.221–239)	33	11/11	Lecture #20	
	BS Chap. 4, Sec. 4.3–4.4 (p.82–107)	34	11/13	Lecture #20/#21	
		35	11/15	Lecture #21	HW#8 due 11/15
13	Review Lectures #11–21	36	11/18	Midterm #2 Review	
	Review HW #6–8	37	11/20	Lecture #22	
		38	11/22	No Lecture	Midterm #2
14	GB Chap. 4, Sec. 4.1–4.3 (p.87–105)	39	12/2	Lecture #22/#23	
	BS Chap. 6, Sec. 6.1–6.3.1 (p.197–210)	40	12/4	Lecture #23	
		41	12/6	Lecture #24	HW#9 due 12/6
15	GB Chap. 5, Sec. 5.5 (p.167–173)	42	12/9	No Lecture	
	BS Chap. 1, Sec. 1.1–1.2 (p.1–6)	43	12/11	No Lecture	
		44	12/13	Lecture #24/#25	HW#10 due 12/13
	Finals Week, 12/16–12/20			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*

Additional College of Liberal Arts and Sciences (CLAS) Syllabus Information

Academic Honesty and Misconduct
All students in CLAS courses are expected to abide by the college's standards 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 DEO (Chair) of the department, school or program offering the course. Sometimes students will be referred to the department or program's Director of Undergraduate Studies (DUS) or Director of Graduate Studies (DGS).

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 Dean's Office when additional support is needed.

Drop Deadline for this Course
You may drop an individual course before the drop 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. To discuss how dropping (or staying in) a course might affect your academic goals, please contact your Academic Advisor. 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 CLAS courses here. Graduate students should adhere to the academic deadlines and policies set by the Graduate College.

Grading System and the Use of +/-
This course will use +/- grading, ranging from A+ to D- and F.

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 the 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 scheduled for the same day (see the policy here).

Attendance and Absences
Attendance at lectures is not required, but is strongly encouraged. Attendance during in-class examinations is mandatory. University regulations require that students be

allowed to make up examinations that have been missed due to illness, religious holy days, military service obligations (including service-related medical appointments), or other unavoidable circumstances or University-sponsored activities. Students with UI-authorized activities must discuss their absences with the instructor as soon as possible. Religious obligations must be communicated within the first three weeks of classes.

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. For the privacy and the protection of student records, UI faculty and staff can only correspond with UI email addresses.

Mental Health Resources and Student Support
Students are encouraged to be mindful of their mental health and seek help as a preventive measure or if feeling overwhelmed and/or struggling to meet course expectations. Students are encouraged to talk to their instructor for assistance with course-related concerns. For additional mental health support, please see the guidance and resources at mentalhealth.uiowa.edu, including the 24-7 UI Support and Crisis Line.

Additionally, the Office of the Dean of Students can help students navigate personal crisis situations. They can provide one-on-one support, help with identifying options, and access to basic needs resources (such as food, rent, childcare, etc.). Student Care and Assistance: 132 IMU, dos-assistance@uiowa.edu, or 319-335-1162 and more info: dos.uiowa.edu/assistance

University Policies

Accommodations for Students with Disabilities
The University is committed to providing an educational experience that is accessible to all students. If a student has a diagnosed disability or other disabling condition that may impact the student's ability to complete the course requirements as stated in the syllabus, the student may seek accommodations through Student Disability Services (SDS). SDS is responsible for making Letters of Accommodation (LOA) available to the student. **The student must provide an LOA to the instructor as early in the semester as possible, but requests not made at least two weeks prior to the scheduled activity for which an accommodation is sought may not be accommodated.** The LOA will specify what reasonable course accommodations the student is eligible for and those the instructor should provide.

Free Speech and Expression
Absences for Religious Holy Days
Classroom Expectations
Non-discrimination
Sexual Harassment/Misconduct and Supportive Measures
Sharing of Class Recordings (if appropriate)