## PHYS:5905 Special Topics in Physics: Numerical Simulation of Plasmas Spring 2019


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**Office Hours:** 10:00-11:00am M, 10:00am-12:00pm W, or by appointment
**Department:** Physics & Astronomy, 203 Van Allen Hall, Prof. Fred Skiff, Chair


**Catalog Description:** The course will introduce the basics of the discretization and numerical integration of differential equations, as well as the determination of the order of convergence and stability of numerical algorithms. Popular algorithms for both fluid and kinetic simulation of plasmas will be discussed, covering major simulation approaches including finite-difference, spectral, and N-body methods as well as explicit and implicit timestepping with consideration of stability and efficiency. Optimization of numerical algorithms will be presented, including parallel computing using message passing (MPI) and multi-threading (OpenMP) standards. We will survey a wide range of publicly available codes accessible to the scientific community for the study of plasma physics, space physics, and astrophysics.

**Meeting:** Tuesday and Thursday 9:30am - 10:45 am
201 Van Allen Hall

**Textbooks:** No required texts

**Web Page:** `https://homepage.physics.uiowa.edu/~ghowes/teach/phys5905/index.html`

**Grading:** Class Attendance and Participation: 20%
Homework: 50%
Final Project: 30%

**Homework:** One cannot learn numerical simulation of plasmas by listening to lectures, but rather through actively writing simulation code. Typical class meetings will involve 30–45 minutes of lecture on new material, and the remainder of the class meeting will be dedicated to beginning hands-on exercises in the computer lab. Required sections of these assignments may be completed as homework outside of class, and optional sections may be completed at the discretion of the student. The instructor will be available to answer questions during the in-class exercise periods. Students are also encouraged to help each other, both in class and outside of class, but must write their own code to complete the required problems.

**Project:** Each student will propose a final project on a problem relevant to his or her own research, or any other topic of interest. This project code take a number of different possible forms: write a new code, optimize a code, make a serial code parallel, make a significant change to an existing code, increase dimensionality of a code, improve a code by implementing a library, improve a code by using compressed, self-describing output, or port a code to a new platform and create a package for distribution. An appropriate topic and scope will be chosen in consultation with the instructor. A key part of the project is a final report describing the work completed and quantitative or visual demonstration of the result.

**Topics:**
1. Single Particle Motion and Numerical Integration Techniques
2. Fluid Simulation
3. Kinetic Simulation
4. Parallelization
5. Optimization, Validation, and Visualization
6. Practical Aspects of Scientific Computing

**Reference books:** W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, *Numerical Recipes: The Art of Scientific Computing*
A. Iserles, *A First Course in the Numerical Analysis of Differential Equations*

**The College of Liberal Arts and Sciences**
**Policies and Procedures**

**Administrative Home**

The College of Liberal Arts and Sciences (CLAS) is the administrative home of this course and governs its add/drop deadlines, the second-grade-only option, and other policies. These policies vary by college (https://clas.uiowa.edu/students/handbook).

**Electronic Communication**

Students are responsible for official correspondences sent to their UI email address (uiowa.edu) and must use this address for all communication within UI (Operations Manual, III.15.2).

**Accommodations for Disabilities**

UI is committed to an educational experience that is accessible to all students. A student may request academic accommodations for a disability (such as mental health, attention, learning, vision, and physical or health-related condition) by registering with Student Disability Services (SDS). The student should then discuss accommodations with the course instructor (https://sds.studentlife.uiowa.edu/).

**Nondiscrimination in the Classroom**

UI is committed to making the classroom a respectful and inclusive space for all people irrespective of their gender, sexual, racial, religious or other identities. Toward this goal, students are invited to optionally share their preferred names and pronouns with their instructors and classmates. The University of Iowa prohibits discrimination and harassment against individuals on the basis of race, class, gender, sexual orientation, national origin, and other identity categories set forth in the Universitys Human Rights policy. For more information, contact the Office of Equal Opportunity and Diversity at diversity@uiowa.edu or diversity.uiowa.edu.

**Academic Integrity**

All undergraduates enrolled in courses offered by CLAS have, in essence, agreed to the College's Code of Academic Honesty. Misconduct is reported to the College, resulting in suspension or other sanctions, with sanctions communicated with the student through the UI email address.

**CLAS Final Examination Policies**

The final exam schedule for each semester is announced around the fifth week of classes; students are responsible for knowing the date, time, and place of a final exam. Students should not make travel plans until knowing this final exam information. No exams of any kind are allowed the week before finals.
(https://clas.uiowa.edu/faculty/teaching-policies-resources-examination-policies.)

**Making a Complaint**

Students with a complaint should first visit with the instructor or course supervisor and then with the departmental executive officer (DEO), also known as the Chair. Students may then bring the concern to CLAS
(https://clas.uiowa.edu/students/handbook/student-rights-responsibilities).

**Understanding Sexual Harassment**

Sexual harassment subverts the mission of the University and threatens the well-being of students, faculty, and staff. All members of the UI community must uphold the UI mission and contribute to a safe environment that enhances learning. Incidents of sexual harassment must be reported immediately. For assistance, definitions, and the full University policy,
see https://osmrc.uiowa.edu/.