Phys 783 – Plasma Kinetic Theory

CLASS DETAILS:
• Meeting Info: MWF, 1:30-2:20pm Rm G06 White Hall
• Course Web Site: http://ulysses.phys.wvu.edu/~pcassak/phys783.html
• Instructor: Paul Cassak Rm 333 White Hall
• Contact Info: Paul.Cassak@mail.wvu.edu (304) 293-5102

OFFICE HOURS:
• In Room 333 of White Hall unless announced otherwise
•Wednesdays, 2:30-3:30pm + by appointment + whenever the door is open
•Please come by for help with concepts, homework, or other advice!

PREREQUISITES:
• Catalog says – PHYS 481 (Intro Plasma) & PHYS 631 (Graduate Classical Mechanics) & PHYS 634 (Graduate Electricity & Magnetism)
• Also important – Contour integration, Laplace transforms

COURSE OBJECTIVES AND EXPECTED LEARNING OUTCOMES:
This course covers kinetic theory in the context of plasma physics at a graduate level. The objective of this course is to develop a deep understanding of techniques of kinetic theory used in plasma physics. Three course goals are that after this semester, you will be able to
(1) understand any paper using kinetic theory and be able to analyze it,
(2) apply kinetic theory to derive and understand plasma properties of desired systems,
(3)for physical systems of import, remember what kinetic effects are important and evaluate how they impact the system.

Topics we will discuss are:
• (from the graduate catalog) the Vlasov equation, quasilinear theory, nonlinear phenomena, plasma waves and instabilities, Landau damping and finite-Larmor-radius effects;
• We will also discuss cyclotron damping, collisions and dissipation including Fokker-Planck theory, drift waves and instabilities, and applications of kinetic theory.

See the schedule for further details. There is no way to cover everything important and interesting in kinetic theory in a single semester, and it is not the goal of this course to do so. The goal here is to build a foundation and expose you to many examples of its uses, which will allow you to learn whatever application may interest you on your own.

CLASS EXPECTATIONS:
• For all class activities, you should be singularly focused on genuine learning; this should incorporate the generation of knowledge at all levels, from immediate recall on big picture concepts, to a deep physical understanding, to comfort with the analytics.
• It is expected that you will put forth a sincere effort. We will do some “active learning” techniques - please be willing to try it out.
• It is expected that you will do the expected pre-class activities before class.
• Mere attendance is insufficient to obtain the desired level of understanding. Reading course resources, attending lectures, participating in classroom activities, and doing homework is necessary but not sufficient. You won’t deeply learn the material unless you choose to (and you put in the effort).
• We will not discuss everything there is to know - important topics will be left out!
• It is expected that you will be considerate of your fellow classmates and myself.
– be at class on time and prepared for course activities
– cell phones and computers should not be used during class time

TEXTBOOK:
• Printed notes corresponding to the lecture
• Reference - *Fundamentals of Plasma Physics*, Paul M. Bellan
  (it is quickly becoming the industry standard)
• Handouts will be provided as necessary

OTHER BOOKS OF INTEREST:
• *The Physics of Fluids and Plasmas, An Introduction for Astrophysicists*, Arnab Rai Choudhuri **Fluid theory and Kinetic theory - EXCELLENT**
• *The Physics of Plasmas*, Richard Fitzpatrick
  **FREE AT [http://farside.ph.utexas.edu/teaching/plasma/plasma.html]**
• *Basic space plasma physics*, Baumjohann and Treumann and *Advanced space plasma physics*, Treumann and Baumjohann
• There are a lot of older books that cover kinetic theory in great detail (such as *Principles of Plasma Physics* by Krall and Trivelpiece, *Waves in Plasmas* and *The Theory of Plasma Waves* by Stix); some are hard to find

SCHEDULING:
There will be a few instances where my travel will interfere with class time. I will possibly miss class on February 20 (M) and February 27 - March 3 (M-F). Make-up classes will be scheduled according to availability; we will discuss everyone’s schedules before finalizing.

COURSE LOGISTICS:
The course will contain aspects of a traditional class, but will also have many components of what is called an “inverted” (or “flipped”) classroom. Here is how it is expected to work:
• Rather than me lecturing from my notes to you and you copying them down *in class*, I will provide you with my notes and you are to go through them outside of class. The idea is to go through them with the same depth (or more!) that you would if you were copying down notes in class - a cursory read won’t cut it! Learn the material deeply - imagine you had to present the lecture and learn it that deeply. Use this time to learn the material, to make connections with previous topics, and to think about the bigger picture. Make notes of questions you have and bring your questions to class.
• The first part of class time will be devoted to answering questions on the material, and there will be some discussion of the most important points.
• The second part of class time will be spent working problems, which can be conceptual, calculation problems, or a combination of the two. Most of them have been carefully constructed to address key concepts in the notes. We will discuss the group problems at the end of class, and there will be a short discussion about the next day’s reading. Turn in what you have written for the problems to get credit.
• There will also be traditional “homework” problems to be given approximately every week or every other week. Knowing that some of your outside-of-class time will be spent on studying the notes, it will be intended that the size of the homework will be smaller than a traditional lecture course. (Feedback is appreciated - if homework assignments are too onerous, let me know!)
HOMEWORK:
- In the past, I have asked students to turn in their notes from going through the lecture notes as part of there homework grade (as a way to demonstrate that the notes were being read at a sufficiently deep level). Let's try not doing that at the beginning, and if it becomes apparent that the reading is not being done conscientiously then we will make this homework.
- For the traditional homework part, problems are intended to challenge you beyond mere regurgitation. They are not chosen randomly – they often cover topics that would be covered in class if time allowed, or address aspects that often cause students trouble.
- If you’re stuck on homework, talk to your classmates or come see me for help!

“EXAMS”:
The “exams” in the class will be non-traditional. Your performance does not affect your grade - you get 100% on the exams independent of your score (as long as you take it). On the first day of class, you will be given a conceptual “pre-test”. It is multiple choice. Do the best you can on it using your knowledge from previous courses or from your intuition, even though it is not expected that you come into class with kinetic theory knowledge. For the final “exam,” you will get the same test as a “post-test” which will help gauge how much you learned.

GRADING BREAKDOWN AND SCHEME:
Your grade will be based on your traditional homework (40%), class participation on worksheets (40%), evidence that you are carrying out required activities from the lecture notes (10%), and the pre- and post-test (5% each, full credit for showing up). There will be approximately 10 homework assignments. Homework grading will be weighted to make more time consuming assignments worth more points. Grades will be awarded roughly as follows:
- A 100-90%, B 90-80%, C 80-70%, D 70-60%
Some regard will be paid to natural breaks in the grade distribution. I reserve the right to adjust grade scales (i.e., curve) in the interest of fairness and propriety if warranted.

GRADING POLICIES:
- Traditional homework is both due at the beginning of class on the day it is due. Homework turned in up to a week late will be graded by the same standards as on-time homework, but with a penalty of 50%. After one week, homework will be graded by the same standards, but no credit is given.
  - If you don’t finish on time, submit what you have and turn the rest in late!
- Partial credit on traditional homework is awarded, so develop your ideas logically. Show your work (credit is for the process, not the solution!) and draw sketches as needed.
- If we make turning in notes from the handouts required, they are due at the beginning of class. No credit will be given for late notes.
- Take pride in your work. If your solution is illegible, I can’t give credit.
- Grading appeals must be made within one week of when the submission is returned.

COLLABORATION POLICY:
Science is fundamentally a collaborative endeavor. It is very rare in the modern world for someone to sit alone in a room and make important contributions to science. Consequently, working together on homework is encouraged! However, an important balance must be reached. Copying someone else’s solution is not allowed in science, nor will it be allowed in this class. An appropriate technique is to try the homework on your own first, then discuss it with your classmates, then try again on your own.
SOCIAL JUSTICE STATEMENT:
WVU policy – “West Virginia University is committed to social justice. I concur with that commitment and expect to maintain a positive learning environment based upon open communication, mutual respect, and nondiscrimination. Our University does not discriminate on the basis of race, sex, age, disability, veteran status, religion, sexual orientation, color or national origin. Any suggestions as to how to further such a positive and open environment in this class will be appreciated and given serious consideration.

“The West Virginia University community is committed to creating and fostering a positive learning and working environment based on open communication, mutual respect, and inclusion. If you are a person with a disability and anticipate needing any type of accommodation in order to participate in this class, please advise me and make appropriate arrangements with the Office of Accessibility Services (304-293-6700). For more information on West Virginia University’s Diversity, Equity, and Inclusion initiatives, please see [http://diversity.wvu.edu](http://diversity.wvu.edu).” Please let me know if I can be of any assistance, and do so with sufficient notice.

ACADEMIC INTEGRITY STATEMENT:
WVU policy – “The integrity of the classes offered by any academic institution solidifies the foundation of its mission and cannot be sacrificed to expediency, ignorance, or blatant fraud. Therefore, I will enforce rigorous standards of academic integrity in all aspects and assignments of this course. For the detailed policy of West Virginia University regarding the definitions of acts considered to fall under academic dishonesty and possible ensuing sanctions, please see the Student Conduct Code at [http://www.arc.wvu.edu/admissions/integrity.html](http://www.arc.wvu.edu/admissions/integrity.html). Should you have any questions about possibly improper research citations or references, or any other activity that may be interpreted as an attempt at academic dishonesty, please see me before the assignment is due to discuss the matter.”

STATEMENT ON THE SALE OF COURSE MATERIALS:
From WVU — “All course materials, including lectures, class notes, quizzes, exams, handouts, presentations, and other materials provided to students for this course are protected intellectual property. As such, the unauthorized purchase or sale of these materials may result in disciplinary sanctions under the Campus Student Code.”

STATEMENT ON WEAPON POLICIES:
From WVU — “West Virginia University would like to reassure the community that, regardless of recent changes in state laws permitting the concealed carry of weapons, including firearms, a different section of state code (61-7-14) permits the University to prohibit open or concealed carry of any firearm or deadly weapon on property within the custody or control of WVU. So while a person may be allowed generally to carry a concealed weapon without a permit, that permission will not extend to WVU property. Violation of this statute is a misdemeanor and can result in a fine of up to $1,000 and up to six months in jail, or both. In addition, it violates University codes of conduct, and for students can result in disciplinary action up to and including expulsion. For employees, it can result in termination.”