Phys 783 – Plasma Kinetic Theory

CLASS DETAILS:
• Meeting Info: TR, 2:30-3:45pm 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 treats kinetic theory in the context of plasma physics at a graduate level. The objective of this course is to develop a deep understanding of the physics at the kinetic level and the techniques of kinetic theory used in plasma physics. Three course goals are that after this semester, you will be able to
(1) understand papers using kinetic theory and be able to analyze them,
(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 likely also discuss: cyclotron damping, collisions and dissipation including Fokker-Planck theory, drift waves and instabilities, and numerical methods 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 means not just completing course activities for the sake of completing them. Explicitly pursue the generation of knowledge at all levels, from immediate recall on big picture concepts, to a deep physical and analytical understanding.
• 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 and embrace their benefits.
• 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).

- 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 has quickly become the standard plasma physics text)
- Handouts will be provided as necessary

**OTHER BOOKS OF INTEREST:**
- *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 likely be at least one instance where my travel will interfere with class time: I will possibly miss class on Thurs, Feb. 28. Let us pursue make-up classes according to availability; please fill out the doodle poll for a typical week when it is sent.

**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 class consisting of me lecturing from my notes to you and you copying them down *in class*, I will provide you with my lecture notes and you are to go through them *outside of class*. The idea is to go through them with the same depth (or more!) as you would if you were copying down notes in class - a cursory read won’t cut it! Use this time to highlight important parts, carry out derivations, make connections with previous topics, think about the big picture, etc. Compile questions you have about the material. The goal is to learn the material deeply - imagine you had to present the lecture and learn it that deeply. You are expected to spend 6-9 hours on this course outside of class; a significant portion of this time should be spent going over the notes.
- The first part of class will be devoted to answering questions on the material, and as needed the material will be supported with in-class “lecture.”
- The second part of class will be spent in small groups working problems, which can be conceptual, calculations, or a combination of the two. The problems have been constructed to address key concepts in the notes. At the end of class, we will discuss the problems as a group, then have a short discussion about the next day’s reading. Turn in your work for the problems to get credit.
- There will also be “traditional” homework problems due every 1 1/2 - 2 weeks. Knowing that some of your outside-of-class time will be spent going over the notes, the size of the homework will be smaller than normal. (Feedback is appreciated - if homework assignments are too onerous, let me know!)
HOMEWORK:
• Given that you are expected to spend a significant portion of your time on this course going over the course notes, it is appropriate to award you credit for your efforts. For the first three weeks (at least), please turn in something to give me an idea of your efforts going through the notes. This can be as simple as submitting the notes I gave to you, but with highlights, calculations, etc., that you have performed in going over the notes. It can be as complicated as your notes from rewriting the handouts, complete with derivations, figures that you have sketched, etc. After the first three weeks, we will assess the process and can make adjustments depending on how things are going.
• Problems in the traditional homework are intended to challenge you beyond mere regurgitation. The problems 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” on kinetic theory to assess what knowledge of kinetic theory you bring to class. It is multiple choice. Do the best you can on it, 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 (35%), class participation on worksheets (20%), evidence that you are successfully carrying out required activities from the lecture notes (35%), and the pre- and post-test (5% each, full credit for completion rather than score). There will be approximately 9 homework assignments. Homework grading will be weighted to make more time consuming problems 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.
In accordance with university guidelines, students will have their performance evaluated solely upon performance in the course work as measured against established academic standards (i.e., not prejudicially, capriciously, or arbitrarily) and every effort will be made to return graded materials within two weeks of submission.

GRADING POLICIES:
• Turning in your notes from the handouts is due at the beginning of class. No credit can be given for late notes for “unexcused” absences.
• Traditional homework is due at the beginning of class on the day it is due. Traditional 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.
  o 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.
• Take pride in your work. If your solution is illegible, I can’t give credit.
• Grade appeals must be made within 1 week of the assignment being 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.

WVU POLICIES AND STATEMENTS

SOCIAL JUSTICE STATEMENT:

“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.”

INCLUSIVITY STATEMENT:

“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.”

SEXUAL MISCONDUCT STATEMENT:

“West Virginia University does not tolerate sexual misconduct, including harassment, stalking, sexual assault, sexual exploitation, or relationship violence [BOG Rule 1.6]. It is important for you to know that there are resources available if you or someone you know needs assistance. You may speak to a member of university administration, faculty, or staff; keep in mind that they have an obligation to report the incident to the Title IX Coordinator (https://titleix.wvu.edu/staff). If you want to speak to someone who is permitted to keep your disclosure confidential, please seek assistance from the Carruth Center, 304-293-9355 or 304-293-4431 (24-hour hotline), and locally within the community at the Rape and Domestic Violence Information Center (RDVIC), 304-292-5100 or 304-292-4431 (24-hour hotline). For more information, please consult WVU’s Title IX Office (https://titleix.wvu.edu/confidential-resources).”

STATEMENT ON THE SALE OF COURSE MATERIALS:

“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.”
ACADEMIC INTEGRITY STATEMENT:

“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. 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 WEAPON POLICIES:

“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.”

ADVERSE WEATHER STATEMENT:

“In the event of inclement or threatening weather, everyone should use his or her best judgment regarding travel to and from campus. Safety should be the main concern. If you cannot get to class because of adverse weather conditions, you should contact your instructor as soon as possible. Similarly, if your instructor(s) are unable to reach the class location, they will notify you of any cancellation or change as soon as possible, using agreed upon methods to prevent students from embarking on any unnecessary travel. If you cannot get to class because of weather conditions, instructors will make allowances relative to required attendance policies, as well as any scheduled tests, quizzes, or other assessments.”

STUDENT EVALUATION OF INSTRUCTION STATEMENT:

“Effective teaching is a primary mission of West Virginia University. Student evaluation of instruction provides the university and the instructor with feedback about your experiences in the course for review and course improvement. Your participation in the evaluation of course instruction is both strongly encouraged and highly valued. Results are strictly confidential, anonymous, and not available to the instructor until after final grades are released by Admissions and Records. Information about how you can complete this evaluation will provided by your instructor.”