Physics 5012 – Classical Physics II

Professor Bob Lysak: Amundsen 383, phone 625-1323, e-mail: lysak@physics.umn.edu
Office Hours: By appointment.

Class Times and Place:
Lecture: TuTh 13:25-15:05, PAN 110 (Note that we will take a short break near the middle of each lecture period)


The Class
Welcome to Physics 5012. This course is the second semester of the Classical Physics course, intended primarily for first year graduate students in physics and astrophysics, but also appropriate to graduate students in math and engineering as well as advanced physics undergraduates. The subject of this semester is the theory of classical electrodynamics. It will be assumed that students understand classical mechanics at the level of Physics 5011, especially the treatment of special relativity (although subjects in relativity unique to electrodynamics will be covered in full). Many of the topics that are covered will be familiar to you from your undergraduate courses; however, in this course they will be approached at a higher level of mathematical sophistication. Indeed, the application of advanced mathematical techniques to the problems of classical electrodynamics is a primary object of this course.

A high level of mathematical sophistication will be assumed in this course. You will be expected to be able to perform complicated integrals involving special functions, deal with partial differential equations, and have familiarity with complex analysis. As in most physics courses, a great deal of the required mathematics will be developed throughout the course.

The material covered in this course is required knowledge for any professional physicist. It is expected that every student will take this course seriously and make a devoted effort to learn the material and techniques taught in this course, since you will use the concepts and techniques presented in this course for the rest of your career. As a result of this philosophy, it is expected that every student will attend each lecture and examination. In addition, it will be expected that you are reading the book, although material covered in lectures will be emphasized in quizzes. The best strategy is to read the material before the lecture and then again after the lecture (and yet again while working on homework problems).

The textbook for this course is a classic in itself. As a plasma physicist who uses classical electrodynamics every day, I have frequently found the techniques discussed in this book extremely valuable in my research; in fact, I frequently cite this book as a reference in my research papers! We will not have time to cover every subject in this book (I estimate this would take at least a 3 semester course), but we will cover topics in the first 9 chapters rather completely as well as selected topics in Chapters 10-14. Although you will not be responsible for material in sections not covered, you are strongly encouraged to read through these sections. It is quite likely at some future point in your career you will recall reading about some topic in Jackson and be able to find the needed material.
Another text that will be helpful is Volume 8 of the Landau and Lifshitz Course of Theoretical Physics, *Electrodynamics of Continuous Media*. This covers much of the same material as in Jackson, but with a different emphasis. It covers more material on conductors and solids than Jackson does.

The first section of Jackson gives an Introduction and Survey. You should read through this material immediately, and re-read this section periodically throughout the course. At first, some of this material may seem incomprehensible; however, you should understand it better as the course goes on.

Since we will cover material at a sophisticated mathematical level, you will probably find it useful to have reference books on mathematical topics such as integrals and special functions, or equivalent electronic resources. Two books I have found useful are *Pocketbook of Mathematical Functions*, by M. Abramowitz and I. A. Stegun (Verlag Harri Deutsch, 1984) and *Table of Integrals, Series and Products*, by I. S. Gradshteyn and I. M Ryzhik (Academic Press, 1965). You will most likely find these sorts of references useful in solving the problems in this course.

The course consists of the following aspects:

- **Lectures**: In the lectures, you will be exposed to the new subject matter of this course, and you will learn how to apply new mathematical techniques. You are encouraged to ask questions at any time. I will also usually ask if there are questions at the beginning of every class. The outline of lectures will be posted each week on the web site, together with the relevant sections of the book. You should read these sections before lecture, and review them again after lecture in order to relate the material in the lecture and in the book.

- **Homework**: You will receive a homework assignment nearly every week. The homework problems are primarily to increase your understanding, but they will be graded on a 5-point scale. Working the problems in a group is strongly encouraged; however, each student will be expected to turn in their own problem set independently.

- **Quizzes and tests**: Each quiz will consist of 3 problems that will allow you to illustrate your knowledge of the subject matter for that period. These quizzes will be closed book, with useful information (e.g., formulas and integrals) given on a separate sheet that will be provided. Calculators may or may not be allowed for any particular exam, at the discretion of the instructor. Full credit will be given for clear and accurate solutions that both solve the required problem and communicate the answer clearly to the grader. Relevant equations, diagrams and explanatory text will be required for full credit. Partial credit will be given for solutions that contain errors in the physics or mathematics, or solutions that do not clearly communicate your understanding of the material. The quiz problems will generally be similar to the homework problems that will be assigned, so doing and understanding the homework will be essential to a successful performance on the quizzes.

- **Office visits**: I encourage you to come to my office at any time to discuss the homework problems or other aspects of the course. The professor has an “open door” policy so that you can ask questions at any time he is available. However, don’t be offended if occasionally I cannot take the time to speak to you because of other pressing business. To be sure, it is a good idea to call or e-mail ahead if you wish to meet.

- **Class Web Page**: Information relevant to the class is given on the class web page, accessible through the physics department site (link is given above). Homework and quiz solutions will be regularly posted on this site. In addition, lecture material that extends the information given in the
text will be posted periodically. You should visit this web site every day or two to keep up on any current developments.

**GRADING:**
The grade for Physics 5012 will be based on **2 quizzes, homework** and a **final examination**.

**Quizzes:** Quizzes will be given during the scheduled lecture period on **Thursday Feb. 18 and Thursday Mar. 31**. These quizzes will usually consist of 3 problems. The quizzes will take up one hour, and will be proceeded by a short review and discussion. Quizzes will be returned in lecture during the following week.

**Final examination:** The course schedule calls for the final exam for this course on Friday, May 13 from 8:30-11:30 am. This time will likely be modified to provide a better schedule for those in the class who are TA’s and have grading responsibilities. **No early, late, or make-up finals will be given.**

**Homework:** Homework will be given nearly every week, and will generally consist of 2-4 problems from the text. Homework must be turned in by the end of class on the date specified. Late homework will be accepted, but will earn a reduced grade.

**Course grade:** The course grade will be determined by combining the grades from the various components of the course in the following way.

(a) Each of the 2 quizzes will count as 20%.
(b) The homework solutions will count as 30%
(d) The final will count as 30%

All grades will be on a scale of 0-100%. The numerical score will be weighted in accordance with the unit distribution given above, again on a scale of 0-100. Please be warned that the quizzes will generally be rather tough. The final letter grade for the course will then be assigned as follows. Note that these are minimum standards, and the instructor reserves the right to modify these grades as he sees fit.

| A  | greater than or equal to 80
| A- | less than 80 and greater than or equal to 75
| B+ | less than 75 and greater than or equal to 70
| B  | less than 70 and greater than or equal to 65
| B- | less than 65 and greater than or equal to 60
| C+ | less than 60 and greater than or equal to 55
| C  | less than 55 and greater than or equal to 50
| C- | less than 50 and greater than or equal to 45
| D+ | less than 45 and greater than or equal to 40
| D  | less than 40 and greater than or equal to 35
| F  | less than 35

A C– score or better will be required for an “S” grade for those students registering on the S/N basis.
Tentative Course Outline

The course will be divided into 3 major sections, each lasting 5 weeks with a quiz at the end of the first two sections. The final exam will be comprehensive, but will emphasize material in the final section of the course. The course will follow Jackson’s book; however, we will not spend same amount of time on each chapter. The outline below lists the chapters in Jackson’s book, with the approximate amount of time to be spent on each. Each week, the specific sections that will be covered will be posted on the class web site.

1. Fundamentals of Electrostatics (1.5 weeks)
2. Boundary Value Problems I (1 week)
3. BVP II (1.5 weeks)
4. Dielectric materials (1 week)
   Quiz 1: Feb. 18
5. Magnetism (2 weeks)
6. Maxwell’s Equations (1 week)
7. Electromagnetic waves (2 weeks)
   Quiz 2: March 31
8. Waveguides and Resonant Cavities (0.5 week)
9. Radiation from Antennas (1 week)
10. Scattering (0.5 week)
11. Theory of Relativity (0.5 weeks)
12. Dynamics of Relativistic Charged Particles (1.5 weeks)
13. Radiation from Charged Particles (1 week)
   Final Exam: May 13

Responsibilities:

The University of Minnesota assumes that all students enroll in its programs with a serious learning purpose and expects them to be responsible individuals who demand of themselves high standards of honesty and personal conduct. All students are expected to behave at all times with the utmost respect and courtesy toward all of their fellow students, their instructors, and are expected to have the highest standards of honesty and integrity in their academic performance. Any behavior that disrupts the classroom learning environment or any attempt to present work that the student has not actually prepared as their own work or to pass an examination by improper means, is regarded as a serious offense which may result in the expulsion of the student from the University. The minimum penalty for such an offense is a failing grade for this course. Aiding and abetting the above behavior is also considered a serious offense resulting in equally severe penalties.

Classroom Courtesy:

Lectures end when the idea or technique under discussion has been concluded and the lecturer has clearly indicated that the students are free to leave. For this reason lectures are rarely expected to end exactly at the end of class time. Every student is expected to respect fellow students and the lecturer by being attentive until the class is dismissed. Packing up books, putting on coats, or standing up while the lecture is in progress interferes with the learning of other students and shows
disrespect for all members of the class and for the educational process. Those few students who know they must leave the class before the lecture ends should have the courtesy and respect to sit in the rear of the class and near an aisle so that they can exit the classroom without disturbing the other students. Students who do not have a crucial appointment before the end of the lecture, should not sit in these seats but have the courtesy to sit toward the front and center of the class. Only students sitting at the ends of rows are permitted to leave class before it is dismissed by the instructor. **Cell phones, MP3 players and similar devices must not be used and must be turned off during the lecture period.** Computers may only be used for taking class notes, but keyboarding must not be a disturbance to other members of the class.

**Open-Door Policy:**

If any difficulties or problems arise in this course that interfere in any way with your learning or optimum performance, we would very much like to hear about it. Please stop by to see any of the instructors in this course at any time with any matter that you’d like to discuss. We will do our best to deal with problems promptly and effectively. We also appreciate hearing about the course from students, and we encourage you to come by and chat any time you’d like to. Please get in touch with us in person or by e-mail. *Our doors are open!*

**Mandatory Statement about academic integrity:**
The University expects the highest standards of honesty and integrity in the academic performance of its students. Any act of scholastic dishonesty is regarded as a serious offense, which may result in expulsion. Scholastic dishonesty is defined as submission of false records of academic achievement; cheating on assignments or examinations; plagiarizing, altering, forging, or misusing an academic record; taking, acquiring, or using test materials without faculty permission; acting alone or in cooperation with another to obtain dishonestly grades, honors, submission of false records of academic achievement; cheating on assignments or examinations; plagiarizing, altering, forging, or misusing an academic record; taking, acquiring, or using test materials without faculty permission; acting alone or in cooperation with another to obtain dishonestly grades, honors, awards, or professional endorsement. Aiding and abetting an act of scholastic dishonesty is also considered a serious offense with the same possible consequences. Students may not make commercial use of their notes of lectures or University-provided materials without the express written consent of the instructor. (See the Senate policy at [http://www.policy.umn.edu/Policies/Education/Education/STUDENTRESP.html](http://www.policy.umn.edu/Policies/Education/Education/STUDENTRESP.html).

Academic dishonesty in any portion of the academic work for a course shall be grounds for awarding a grade of F or N for the entire course.

**Student Mental Health and Stress Management**

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. University of Minnesota services are available to assist you with addressing these and other concerns you may be experiencing. You can learn more about the broad range of confidential mental health services available on campus via [http://www.mentalhealth.umn.edu/](http://www.mentalhealth.umn.edu/).