# Syllabus PHY 424/ELE 324

# ELECTROMAGNETICS I/Fall 2009

**Professor** Dr. Liviu Movileanu, E-mail: lmovilea@physics.syr.edu
Phones: 315-443-8078 (Office); 315-443-0249 (Lab)
Office: Room 211, Physics Bldg.
Biophysics Research Labs: Rooms B103/B105/B111, Physics Bldg.

**Office hours** Tuesdays, 5:00 – 6:00 P.M., otherwise by appointment
I am often in my office (443-8078) or lab (443-0249/443-1404). Please call me when you have an emergent problem! The best way to contact me outside of class is by e-mail. ***Please do not e-mail me questions that are already answered in this syllabus.***

**Teaching Associate** Gokhan Aydin; Office: 331 Link Hall (RF/Microwave Lab); Mail : 335 Link Hall;
E-mail: goaydin@syr.edu; Web: goaydin.mysite.syr.edu
Phone: 443-4909 (Lab); (315) 395 1143(cell)
Recitations: Thursdays, 12:30- 1:25 P.M.; Fridays, 12:45- 1:40 P.M.
The new location of the Thursday recitation is SCITC 3-216
Office Hours: Tuesdays, 1:30 – 3:30 P.M., otherwise by appointment.

**Prerequisites** PHY 212; MAT 397; also helpful to have MAT 296

**Course description** This course is the first half of a two-semester sequence in Electromagnetics, and deals with the most fundamental concepts of the laws of electromagnetism. You will learn about static electric and magnetic fields as well as the properties of conducting dielectric and magnetic materials. We shall cover most of the first 7 chapters of the textbook. It is critically important that you realize that this is a truly advanced class for undergraduate studies. The PHY 424/ELE 324 employs a solid background in mathematics, including differential and integral calculus, vector algebra, and vector calculus (**see below Math**)

**Course objectives**

- Obtain a comprehensive understanding of the fundamental concepts in electricity and magnetism
- Obtain a complete knowledge of the fundamental laws of electricity and magnetism
- Obtain analytical skills for solving problems in Electricity and Magnetism to reinforce conceptual understanding

**Contents of the class**

- Vector analysis and complements of calculus (see **Math**)
- Electrostatics (The electric field; Divergence and curl of the electrostatic fields; Electric potential; Work and Energy in Electrostatics; Conductors)

• Special techniques in electrostatics (Laplace's equation; The method of images; Separation of variables; Multipole expansion)
• Electric fields in matter (Polarization; The field of a polarized object; The electric displacement; Linear dielectrics)
• Magnetostatics (The Lorentz-force law; The Biot-Savart law; The divergence and curl of B; Magnetic vectorial potential)
• Magnetic fields in matter (Magnetization; The field of a magnetized object; The auxiliary field H; Linear and non-linear media)
• Electrodynamics (Electromotive force; Electromagnetic Induction)

**Math**

You are expected to be or become familiar with the following math contents:
• Vector analysis
• Differential calculus (gradient, divergence, curl, second derivative)
• Cylindrical and spherical coordinates
• Integral calculus
• The Dirac Delta function
• The theory of vector fields

**Lectures**

We will meet twice a week: **Mondays** and **Wednesdays**, 12:45 – 2:05 P.M. Lectures will be held in Archibald Gymnasium Bldg., **Room AG203**. It is important that you ATTEND and PARTICIPATE actively in the lectures. Class participation, through questions and discussions, are encouraged. We introduce new ideas and concepts, then demonstrate them by both conceptual problems and applications. Attendance is highly recommended.

**Recitations**

There will be **two recitations per each week.** The recitations will provide a unique opportunity for enriching the student understanding about the fundamentals of electromagnetic theory by reinforcing difficult concepts, engaging them in cooperative learning activities, describing applications, and working through example problems. **Note:** Attendance in recitations (Thursdays, 12:30- 1:25 P.M.; Fridays, 12:45- 1:40 P.M.) is mandatory.

**Textbook:**

"**Introduction to Electrodynamics**" by David J. Griffiths, Third Edition, Prentice Hall, Upper Saddle River, New Jersey, 1999. This is a truly outstanding textbook for learning the fundamentals of electricity and magnetism at the advanced undergraduate level. We will follow the book very closely. Should we use any material is not covered in the textbook, this will be provided by the instructor. Students must use this textbook to supplement their lecture notes.

**Quiz**:

There will be three quizzes that will be held during the lecture periods. They will be ~20 minutes in duration, and will cover material from last two/three lectures. Please bear in your mind that the date of each quiz will **NOT** be announced. No make-up quizzes will be given (**see the make-up policy**).

**Exams**

There will be one mid-term examination, given during the time and in the place normally scheduled for the lecture (please see timetable on the web page of the course). The mid-term examination will cover most of electrostatics and special

techniques. There will also be a final exam. The date of the final examination is scheduled on Monday, December 21st, 2009, 8:00-10:00 A.M. in Room AG203. The final examination will cover the entire course, but with emphasis on the second part (1/3 of the first half and 2/3 of the second half). All material taught in this class, including lectures, recitations, example problems, homework problems and conceptual examples are subject to the mid-term and final examinations. No make-up exams will be given (**see the make-up policy**).

**Homework:** The homework assignments, which are assigned from the textbook, will be distributed weekly on **Wednesdays**. Homework will be normally due on **Wednesdays** of the following week. Detailed solutions to the homework will be given after the lecture they are due. No late homework will be accepted! A deviation from this rule is permitted only in exceptional cases (e.g., you are excused due to an illness etc.; **please see the make-up policy**) **Homework problems are a very important part of the course.** The only way to obtain a comprehensive understanding of fundamental Electricity and Magnetism is to practice it. Working problems is the only way to obtain a deep clarification of each topic.

**Make-up policy** Should you miss a quiz or examination due illness or emergency, a make-up examination will be scheduled as soon as possible. The make-up tests will be oral examinations. **You need to bring solid documentation (doctor excuse etc.) for a requested make-up.**

**Grading Policy** You will be evaluated, based upon your performance in the class, as follows:

| | |
|---|---|
| Quizzes: | 10% |
| Homework: | 20% |
| Mid-term Examination | 30% |
| Final Exam | 40% |

**GRADING SCALE**

| Letter Grade | Grade Points | Percentages |
|---|---|---|
| A | 4.000 | 85 - 100 |
| A- | 3.666 | 80 - 84 |
| B+ | 3.333 | 75 - 79 |
| B | 3.000 | 70 - 74 |
| B- | 2.666 | 65 - 69 |
| C+ | 2.333 | 60 - 64 |
| C | 2.000 | 55 - 59 |
| C- | 1.666 | 50 - 54 |
| D | 1.000 | 40 - 49 |
| F | 0.000 | 0 - 39 |

**Academic Integrity**:

We encourage you to find other classmates with whom to study. Working with friends can be very helpful in learning a difficult subject like physics. However,

**the final work you turn in must be your own.** There is a distinction between discussing the work, and merely copying someone else's work. The idea here is that you should communicate and help each other to understand the problems and the concepts involved; you will learn more, if you work on the assignments in *groups* and explain the methods and various approaches to each other. You must engage in your own effort on solving the problems.

**The Syracuse University Academic Integrity Policy holds students accountable for the integrity of the work they submit. Students should be familiar with the Policy and know that it is their responsibility to learn about instructor and general academic expectations with regard to proper citation of sources in written work. The policy also governs the integrity of work submitted in exams and assignments as well as the veracity of signatures on attendance sheets and other verifications of participation in class activities. Serious sanctions can result from academic dishonesty of any sort. Students found to cheat will receive an F for that assignment. Students have a right to appeal. For more information and the complete policy, see http://academicintegrity.syr.edu**

**Disability-Related Accommodations:**

Students who are in need of disability-related academic accommodations must register with the Office of Disability Services (ODS), 304 University Avenue, Room 309, 315-443-4498. Students with authorized disability-related accommodations should provide a current Accommodation Authorization Letter from ODS to the instructor and review those accommodations with the instructor. Accommodations, such as exam administration, are not provided retroactively; therefore, planning for accommodations as early as possible is necessary. For further information, see the ODS website, Office of Disability Services http://disabilityservices.syr.edu/

**Webpage/Timetable:** http://www.physics.syr.edu/~lmovilea/ElectricityAndMagnetism2005.html

**Course secretary** Ms. Arlene Johnston (443-1915) is available in Room 111, Physics Building, from 8:00 A.M. to 4:30 P.M. weekdays. She is the person to see for signatures on add/drop forms, or for other administrative matters. If she is ever unavailable, please go to the Physics department, Main Office, Room 201, Physics Building, for assistance.

**General tips for making PHY 424/ELE 324 a success**

Many lectures will build on previous material. This rule does not deviate from the general way in which scientific knowledge builds. For this reason, it is important not to fall behind. **Here is a recipe for making PHY 424/ELE 324 a success**:

**Set aside time to study**. Student surveys state that the average student spends six hours per week working on this course, outside of class. This number should be higher. You will do yourself a favor by scheduling at least 8 hours per week outside of class time, ands sticking consistently to that schedule.

**Attend the lectures**. The purpose of the lectures is to introduce new concepts and to relate them to others. These connections are important. You need to identify these connections, and use them when necessary. If you simply memorize techniques to solve problems, then you will find Electricity and Magnetism to be an enormous and disconnected subject. On the other hand, if you learn to think of physics as governed by just a few rules (e.g., the conservation of mass, charge and energy), then you will find EM to be not only manageable, but also enjoyable.

**Do the homework**. Lectures and study assignments set the stage. But only by answering questions and effectively solving the problems and conceptual examples does deep understanding arrive. Get help early and often. Falling behind will only make your everyday life with PHY 424/ELE 324 harder.

**Other study hints**

It is best if you read the section of the textbook that we will be covering any given day before we discuss that material in class. This will help familiarize you with the concepts to be discussed in lecture. If you do not understand the material after reading and the lecture, ask questions. Questions are welcome during the lecture or during my office hours. Work all of the **homework problems** and, if possible, look at a few other problems. **Experience with solving problems will greatly help on exams!!**

**We wish you best of success with PHY 424/ELE 324 in Fall 2009 semester!**

**Other good sources of Electricity and Magnetism:**

There is a plethora of other useful textbooks for their different emphasis on Electricity and Magnetism, the applications chosen and the level of their presentation. Here, I list just a few, if your curiosity will go beyond "Griffiths".


1. George E. Owen, Introduction to Electromagnetic Theory, Dover Publications, Inc., Mineola, New York, 2003.
2. Wolfgang Pauli, Electrodynamics, Pauli Lectures on Physics, Volume 1, Dover Publications, Inc., Mineola, New York, 1973.
3. Melvin Schwartz, Principles of Electrodynamics, Dover Publications, Inc., New York, 1972.
4. Richard Becker, Electromagnetic Fields and Interactions, Dover Publications, Inc., New York, 1964.
5. David M. Cook, The Theory of the Electromagnetic Field, Dover Publications, Inc., Mineola, New York, 1975.
6. Albert Shadowitz, The Electromagnetic Field, Dover Publications, Inc., New York, 1975.
7. Mark A. Heald and Jerry B. Marion, Classical Electromagnetic Radiation, Third Edition, Brooks/Cole Thomson Learning, 1995.
8. Robert H. Good, Classical Electromagnetism, Thomson Brooks/Cole, Belmont, CA, 1999.
9. John R. Reitz, Frederick J. Milford and Robert W. Christy, Foundations of Electromagnetic Theory, Pearson/Addison Wesley, San Francisco, CA, 2009.
10. Umran S. Inan and Aziz S. Inan, Electromagnetic Waves, Prentice Hall, Upper Saddle River, New Jersey 07458.
11. John D. Kraus and Daniel A. Fleisch, Electromagnetics with Applications, Fifth Edition, WCB McGraw-Hill, Boston, MA, 1999.
12. Sir James Jeans, The Mathematical Theory of Electricity and Magnetism, Cambridge University Press, Cambridge, 1963.
13. W.N. Cottingham and D.A. Greenwood, Electricity and Magnetism, Cambridge University Press, Cambridge, 1991.
14. Wolfgang K.H. Ponofsky and Melba Phillips, Classical Electricity and Magnetism, Dover Publications, Inc., Mineola, New York, 2005.
15. I.S. Grant and W.R. Phillips, Electromagnetism, Second Edition, John Wiley & Sons, New York, 2008.
16. John David Jackson, Classical Electrodynamics, Third Edition, John Wiley & Sons, New York, 1999.
17. Edward M. Purcell, Electricity and Magnetism, Berkeley Physics Course, Volume 2, McGraw-Hill, Boston, 1985
18. Gerald L. Pollack and Daniel R. Stump, Addison/Wesley, San Francisco, 2002.
19. Jerrold Franklin, Classical Electromagnetism, Pearson/Addison Wesley, San Francisco, 2005.
20. Jean Van Bladel, Electromagnetic Fields, Second Edition, Wiley-Interscience, John Wiley & Sons, San Francisco, 2007.
21. James Clerk Maxwell, A Treatise on Electricity and Magnetism, Volumes One and Two, Clarendon Press, Oxford University Press, Oxford, 2002