# Physics 412: "Mechanics, Electricity and Magnetism"

*As part of the Science Literacy Program we will pay special attention to uncovering the ways that science is connected to larger societal issues and big ideas across and within the discipline. SLP courses include General Education courses for non-science majors and courses for science majors taught by teams of faculty, graduate fellows, and undergraduate scholars, who will include opportunities during classtime for you to engage with the class topics through a variety of activities. For more information about the program scilit.uoregon.edu*

**Instructors and Office Hours:**
Prof. Stephanie Majewski, smajewsk@uoregon.edu, 402 WIL, Fri 2-3pm
Prof. Tien-Tien Yu, tientien@uoregon.edu, 474 WIL, Fri 4-5pm
We are here to help guide your learning and to help you succeed. Outside of the above times please contact either of us to make an appointment.

**SLP Fellow Contact Information:**
Alice Greenberg, aliceg@uoregon.edu, 78 WIL
Tutorial session: Thursday TBA
Tutorial session: Thursday TBA

**GTF Contact Information and Office Hours:**
Cameron Dennis, rdennis@uoregon.edu, 373 WIL, Fri 3-4pm

**Course (CRN 15054):**
Lectures: MWF 11:00-11:50am in Price Science Commons B040
Required Materials
Textbook: David J. Griffiths, Introduction to Electrodynamics, 4th ed. (2013)
iClicker: available at the Duck store, will be used every lecture
Prerequisite: Math 281 or equivalent

**Course Website:**
At https://canvas.uoregon.edu you may login and access course documents such as this syllabus. In addition, you may view announcements, course materials including preflights and homework assignments, and your grades at any time.

**Overview:** This course is the first term of a three-term sequence of classical electromagnetism. You will use the tools of vector calculus to solve for the static and dynamic properties of electromagnetic fields. PHYS 412 includes static charge distributions (electrostatics), time-independent current distributions (magnetostatics, to be continued in PHYS 413), electric and magnetic properties of matter (dielectrics in PHYS 412 and magnetic media in PHYS 413), and initial coverage of fully time-dependent problems (Maxwell's equations, covered in PHYS 413 and PHYS 422).

**Course Learning Goals:**

1. Students will gain content and mathematical skill mastery, including:
   a) The ability to translate a physical description in an electromagnetism problem to the mathematical equation(s) necessary to solve the problem.
   b) The ability to explain the physical meaning of the mathematical formulation of and solution to electromagnetism problems.
   c) The ability to achieve physical insight through the mathematics of a problem.
   d) The ability to visualize physical parameters (e.g., E/B fields, charge distributions, polarization).
2. Students will be able to organize their knowledge and make connections / links between different concepts.
3. Students will be able to justify and explain an approach to a problem or physical situation.
4. Students will develop specific problem-solving techniques such as use of approximations, series expansions, symmetries, integration, and superposition.
5. Students will be able to draw upon organized content knowledge and apply problem-solving techniques to that knowledge in order to carry out long analyses of physical problems, including connecting the pieces of the problem to reach the solution and persistence in working toward the solution even though the path may be unclear.

**How will you be graded?**

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| Pre-lecture questions (on Canvas): | 5% |
| Clicker participation: | 5% |
| Homework (due Mondays): | 35% |
| Exam 1 (in class): | 15% |
| Exam 2 (in class): | 15% |
| Final Exam: | 25% |

**Final Grade:**

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|---|---|
| A | 90% to 100% |
| B | 80% to 90% |
| C | 70% to 80% |
| D | 60% to 70% |
| F | lower than 60% |

**How you'll know you're learning:**

- Reading the textbook **before** class is very important. The purpose of the class time activities are to clarify your understanding & to help you make sense of the material. We will assume you have done the required readings in advance!
- Pre-lecture questions will be given through canvas, based on the reading assignment. Use these to distill the information you've learned through reading, and identify what topics/concepts are important. Questions will be graded for completeness (assuming a good-faith effort was made to answer the questions). **Your two lowest pre-lecture question scores will be dropped.**
- Class participation is more than sitting as a warm body in the class. Please come to class prepared to participate in clicker questions (used to track attendance), group work, and class discussions. Participation includes respect for your learning community by coming to class on team, turning off cell phones, and paying attention during class. **Your two lowest participation scores will be dropped.**
- Homework is due every Monday (except exam weeks) at the *start* of class. Late homework will not be accepted except in case of extenuating circumstances. **Your lowest homework score will be dropped.** Homework is exceedingly important for

developing an understanding of the course material, not to mention building skills in complex physical and mathematical problem solving. Homework problems will require considerable time and personal effort! Most students reported spending a minimum of 10 hours per week on the homework (!!), but reported learning a tremendous amount.

- Collaboration is an essential skill in science and engineering (and highly valued by employers!). However, it is also important that you OWN the material. We strongly suggest you start homework by yourself (and that means really making an extended effort on every problem). Then work with a group, and finally, finish up on your own - write up your own work, in your own way. *For all assignments, the work you turn in must in the end be your own: in your own words, reflecting your own understanding.*
  [If, at any time, you feel isolated, contact us and we can discreetly try to help arrange study groups.]
- Tutorial sessions and office hours are to facilitate your learning. We strongly encourage attendance - plan on working in small groups; our role will be as learning coaches. Tutorial sessions may involve special problems and activities designed to help you understand current material, and set you up for the upcoming homework. These will be held on Thursdays, as listed above.
- Exam dates are listed on the schedule below, and will given in class. There will be no makeup exams. *You may not miss any exam* except for reasons beyond your control, approved by Prof. Majewski or Yu (usually a confirmed medical issue with written documentation).

**A few things to help you succeed in this course:**

1. Read the textbook carefully before coming to class, and make an honest effort to answer the pre-lecture questions on canvas to the best of your ability.
2. Use the classroom activities (e.g., clicker questions, group work) to assess your learning and understanding of the material.
3. Attend the tutorial sessions. The problems given there are designed to prepare you for the homework.
4. Start the homework on your own several days before the deadline. Once you have made an extended effort on a problem, if you are stuck collaborate with others and/or ask questions in office hours.

**Campus resources to support your learning:**

**Instructional Accommodations**:
The Accessible Education Center (http://aec.uoregon.edu) exists to help students achieve access to educational resources. If there are aspects of the instruction or design of this course that result in barriers to your participation, please contact us *as soon as possible* so we may discuss your situation. Please let us know by the end of week 2 of the term if you need an exam-related accommodation so we can make the appropriate arrangements.

**Counseling Center:**
Call anytime to speak with a therapist who can provide support and connect you with resources. Located on the 2nd Floor of the Health Center (541) 346-3227.

**Inclusivity:**
Open inquiry, freedom of expression, and respect for difference are fundamental to a comprehensive and dynamic education. We are committed to upholding these ideals by encouraging the exploration, engagement, and expression of divergent perspectives and diverse identities.

**Academic Integrity:**
All students are expected to complete assignments in a manner consistent with academic integrity. Academic dishonesty devalues the reputation of our institution, its faculty, its students, and the degrees we offer. Moreover, academic misconduct is particularly unfair for the students who do their work with integrity and honor. Students can find more complete information about the University of Oregon's Policy on Academic Dishonesty in the University of Oregon *Student Handbook*. Suspected academic dishonesty will be reported.

**Course Learning Objectives:**
Students will be able to…
- Compute gradient, divergence, curl, and Laplacian in cartesian, spherical, and cylindrical coordinates
- Evaluate line, surface, and volume integrals in cartesian, spherical, and cylindrical coordinates
- Apply the fundamental theorem for divergences in specific situations
- Apply the fundamental theorem for curls in specific situations
- Apply Coulomb's Law and the superposition principle to calculate the electric field due to a continuous charge distribution
- Apply Gauss's Law to compute the electric field due to a symmetric charge distribution
- Calculate the electric field from electric potential and vice versa
- Compute the potential of a localized charge distribution
- Determine the surface charge distribution on a conductor in equilibrium
- Use the method of images to determine the potential in a region
- Solve Laplace's equation to determine the potential in a region given the potential or charge distribution at the boundary (cartesian, spherical and cylindrical coordinates)
- Use multipole expansion to determine the leading contribution to the potential at large distances from a charge distribution
- Calculate the field of a polarized object
- Find the location and amount of all bound charges in a dielectric material
- Describe similarities and differences between a conductor and a dielectric
- Articulate the difference between a linear and nonlinear dielectric
- Interpret Maxwell's Equations for electrostatics

**Important Dates:** (**academic calendar**)

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|---|---|---|
| Oct | 1st | Last day to drop without a "W" |
| Oct | 3rd | Last day to add a class |
| Nov | 11th | Last day to withdraw (drop with a "W") or change grading option to P/N |

## Physics 412 - *Tentative* Course Schedule

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|---|---|---|---|---|
| Week 1 | M | Sept | 24 | Lecture |
| | W | Sept | 26 | Lecture - Griffiths 1.1-1.3, 2.1 |
| | F | Sept | 28 | Lecture - Griffiths 2.1, cont. |
| Week 2 | M | Oct | 1 | Lecture - Griffiths 1.4-1.6, 2.2 [HW #1 Due] |
| | W | Oct | 3 | Lecture - Griffiths 2.2, cont. |
| | F | Oct | 5 | Lecture - Griffiths 2.2, cont. |
| Week 3 | M | Oct | 8 | Lecture - Griffiths 2.3 [HW #2 Due] |
| | W | Oct | 10 | Lecture - Griffiths 2.3, cont. |
| | F | Oct | 12 | Lecture - Griffiths 2.4 |
| Week 4 | M | Oct | 15 | Lecture - Griffiths 2.5 [HW #3 Due] |
| | W | Oct | 17 | Lecture - Griffiths 2.5, cont. |
| | F | Oct | 19 | Lecture - Review for Exam 1 [HW #4 Due - Ungraded] |
| Week 5 | M | Oct | 22 | **Exam 1 (in class)** |
| | W | Oct | 24 | Lecture - Griffiths 3.1 |
| | F | Oct | 26 | Lecture - Griffiths 3.2 |
| Week 6 | M | Oct | 29 | Lecture - Griffiths 3.3 [HW #5 Due] |
| | W | Oct | 31 | Lecture - Griffiths 3.3, cont. |
| | F | Nov | 2 | Lecture - Griffiths 3.3, cont. |
| Week 7 | M | Nov | 5 | Lecture - Griffiths 3.3, cont. [HW #6 Due] |
| | W | Nov | 7 | Lecture - Griffiths 3.4 |
| | F | Nov | 9 | Lecture - Review for Exam 2 [HW #7 Due - Ungraded] |
| Week 8 | M | Nov | 12 | **Exam 2 (in class)** |
| | W | Nov | 14 | Lecture - Griffiths 4.1 |
| | F | Nov | 16 | Lecture - Griffiths 4.2 |
| Week 9 | M | Nov | 19 | Lecture - Griffiths 4.2-4.3 [HW #8 Due] |
| | W | Nov | 21 | Lecture - Griffiths 4.3 |
| | F | Nov | 23 | **No Lecture - Thanksgiving Holiday** |
| Week 10 | M | Nov | 26 | Lecture - Griffiths 4.4 [HW #9 Due] |
| | W | Nov | 28 | Lecture - Griffiths 4.4, cont. |
| | F | Nov | 30 | Lecture - Review for Final [HW #10 Due - Ungraded] |
| **Week 11** | **Th** | **Dec** | **6** | **Final Exam at 10:15am** |

The given schedule is tentative; changes will be discussed in class and posted online.