Progressive Science Initiative® (PSI®)
PHYS6657: Learning & Teaching AP Physics 2: Electricity & Magnetism

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Course Credit: 3.0 NJCTL credits

Dates & Times:
This is a 3-credit, self-paced course, covering 7 modules of content. The exact number of hours that you can expect to spend on each module will vary based upon the module coursework, as well as your study style and preferences. You should plan to spend approximately 15 hours per credit working online, and up to 30 hours per credit working offline.

Graduate Student Handbook: www.njctl.org/graduate-handbook/

COURSE DESCRIPTION:
This course is designed for those who are learning to teach Algebra-Based Physics and Trigonometry-Based Physics for middle school or high school students, focusing on conveying physics and mathematical concepts. Underlying themes are physics connections to everyday life, applications of algebra and trigonometry in physics, problem solving, and hands-on laboratory experience. The course presents physics as the foundation for studying chemistry, biology and advanced mathematics. Technology serves as a tool to establish these connections through exploration, problem solving, formative assessment, presentation, and communication.

This course covers fluids, thermal physics, two-dimensional electricity and magnetism topics including electric force and field, electric potential and capacitors, and magnetism.

STUDENT LEARNING OUTCOMES:
Upon completion of the course, the student will be able to:

1. Demonstrate an understanding of advanced electricity and magnetism topics, detailed in the module learning outcomes below.
2. Integrate PSI materials (including presentations, labs, practice problems, etc.) to support student learning and deliver effective instruction.

3. Create a social constructivist learning environment through the use of formative assessment questions, interpreting the results of this assessment to effectively facilitate student-led discussions that support deeper understanding of the content.
4. Integrate multiple attempts to demonstrate student mastery of content knowledge, as encouraged/fostered by the PSI pedagogy.
5. Implement learning plans that are aligned to NGSS standards and allow for differentiation based on the needs of learners.

TEXTS, READINGS, INSTRUCTIONAL RESOURCES:
Required Texts:
- PSI AP Physics 2 uses a free digital textbook accessible at: https://njctl.org/materials/courses/ap-physics-2/
- Participants will download SMART Notebook presentations, homework files, labs, and teacher resources from the PSI Algebra-Based Physics Course

Recommended Texts:

Giancoli (2005). *Physics: Principles with Applications / Edition 6* ISBN-13: 9780130352569

Holton, G. J., Brush, S. G., & Holton, G. J. (2001). *Physics, the Human Adventure: From Copernicus to Einstein and Beyond*. New Brunswick, N.J: Rutgers University Press. ISBN-13: 9780813529080

COURSE REQUIREMENTS:
In order to receive a Passing grade, the participant must complete the following course requirements:

1. Activities: A number of different learning activities will ensure participant engagement and learning in the course. These include:
   - Engage in video module lessons which demonstrate minimized direct instruction followed by frequent formative assessment
   - Completion of formative assessments aligned to learning objectives which include detailed analysis when answered incorrectly.
   - Interaction with module discussion boards that allow conversation with peers and course instructors about the module's content, delivering that content to students. Discussion boards also serve as a place to ask and answer questions related to the module's content.
2. Short Answer Assignment: Each module requires one (1) original response to a given prompt. These prompts are typically based upon course lessons and require teachers to analyze, reflect, and make connections between the module's content and their own classroom practice.
3. Mastery Exercises: For each module, these multiple-choice question quizzes assess the content knowledge gained in a module. Participants have the opportunity to retake; random questions are pulled from a larger question bank on each attempt ensuring varied questions.
4. Virtual Labs: In each module, a virtual lab write-up will be submitted. Virtual Labs are interactive lab simulations that promote a deeper understanding of the content knowledge being learned through real-world applications and analysis.
5. Module Exam: One is completed at the end of each module. It is a culminating exam consisting of multiple choice and free response questions aligned to the standards and objectives of the module.
6. Reflection Paper: At the end of the course, participants are required to reflect on the knowledge taught in the course, make connections, and compare/contrast their current pedagogy with new strategies gained in this assignment.

7. Final Exam: At the end of the course, a comprehensive exam consisting of Multiple Choice and Free Response questions assesses the content knowledge learned throughout the course and aligns to the AP College Board Exams.

GRADE DISTRIBUTION AND SCALE:

Grade Distribution:

Module Exams	70%
Final Exam	10%
Labs	6%
Short Answer Assignments	6%
Mastery Exercises	6%
Reflection Paper	2%

Grade Scale:

A	93 – 100
A-	90 – 92
B+	86 – 89
B	83 – 86
B-	80 – 82
C+	77 – 79
C	73 – 76
C-	70 – 72
D	60.0 – 69.9
F	59.9 or below

GRADING RUBRIC:

The following rubric is used to score:

- Short Answer Assignment – 6% of grade
- Reflection Paper – 2% of grade

The minimum possible score for this rubric is 4 points, and the score will be converted to the minimum grade available in this module (which is zero unless the scale is used). The maximum score 25 points will be converted to the maximum grade.

Intermediate scores will be converted respectively and rounded to the nearest available grade. If a scale is used instead of a grade, the score will be converted to the scale elements as if they were consecutive integers.

	Meets Expectation	**Approaches Expectation**	**Below Expectation**	**Limited Evidence**
	7 points	***5 points***	***3 points***	***1 point***

Content	• Demonstrates excellent knowledge of concepts, skills, and theories relevant to topic.	• Demonstrates fair knowledge of concepts, skills, and theories.	• Demonstrates incomplete or insubstantial knowledge of concepts, skills, and theories.	• Demonstrates little or no knowledge of concepts, skills, and theories.
Depth of Reflection	• Content is well supported and addresses all required components of the assignment.	• Content is partially supported; addresses most of the required components of the assignment.	• Content contains major deficiencies; addresses some of the required components of the assignment.	• Content is not supported and/or includes few of the required components of the assignment.
Evidence and Practice	• Response shows strong evidence of synthesis of ideas presented and insights gained throughout the entire course. The implications of these insights for the respondent's overall teaching practice are thoroughly detailed, as applicable.	• Writing is mostly clear, concise, and well organized with good sentence/paragraph construction. Thoughts are expressed in a coherent and logical manner. There are no more than five spelling, grammar, or syntax errors per page of writing.	• Response is missing some components and/or does not fully meet the requirements indicated in the instructions. Some questions or parts of the assignment are not addressed. Some attachments and additional documents, if required, are missing or unsuitable for the purpose of the assignment.	• Response excludes essential components and/or does not address the requirements indicated in the instructions. Many parts of the assignment are addressed minimally, inadequately, and/or not at all.
	4 points	***3 points***	***2 points***	***1 point***
Writing Quality	• Writing is well-organized, clear, concise, and focused; no errors.	• Some minor errors or omissions in writing organization, focus, and clarity.	• Some significant errors or omissions in writing organization, focus, and clarity.	• Numerous errors in writing organization, focus, and/or clarity.

The following rubric is used to score:

- Labs – 6% of grade

The minimum possible score for this rubric is 2 points, and the score will be converted to the minimum grade available in this module (which is zero unless the scale is used). The maximum score 14 points will be converted to the maximum grade.

Intermediate scores will be converted respectively and rounded to the nearest available grade. If a scale is used instead of a grade, the score will be converted to the scale elements as if they were consecutive integers.

	Meets Expectation	**Approaches Expectation**	**Below Expectation**	**Limited Evidence**
	7 points	***5 points***	***3 points***	***1 point***
Completeness	● Lab write-up is complete with no missing fields.	● Lab write-up has 1-2 missing fields.	● Lab write up has 3-5 missing fields.	● There are more than 5 missing fields on the lab write-up.
Calculations	● All answers are calculated correctly.	● Most answers are calculated correctly, but there are 1-2 minor calculation errors.	● Most answers are calculated correctly, but there are multiple minor calculation errors, or 1-2 gross miscalculations.	● There are calculation errors throughout the lab.

The remaining types of assignments are not scored using a rubric. These assignments are scored using percentage correct to assign a letter grade. The assignments in this manner are as follows:

- Mastery Exercises – 6% of grade
- Module Exams – 70% of grade
- Final Exam – 10% of grade

Mastery Exercises can be retaken as many times as desired to ensure a high score. Due to the nature of these assignments, each time they are taken, they will be composed of unique questions pulled randomly from a larger question bank.

Module and Final Exams are scored using a curve, which allows us to keep content exams rigorous. Module Exams can be retaken one time. Final Exams cannot be retaken.

ACADEMIC STANDING:
NJCTL has established standards for academic good standing within a student's academic program. Students enrolled in any NJCTL online course must receive an 80 or higher to successfully complete a course and receive credit for that course. An 80 is equivalent to a GPA of 2.7 or B-. Additionally, students in an endorsement program must receive a cumulative GPA of 3.0 for all courses combined in order to successfully complete the program.

ACADEMIC INTEGRITY:
Students must assume responsibility for maintaining honesty in all work submitted for credit and in any other

work designated by the instructor of the course. Academic dishonesty includes cheating, fabrication, facilitating academic dishonesty, plagiarism, reusing /repurposing your own work, unauthorized possession of academic materials, and unauthorized collaboration.

CITING SOURCES WITH APA STYLE:
All students are expected to follow proper writing and APA requirements when citing in APA (based on the APA Style Manual, 6th edition) for all assignments.

DISABILITY SERVICES STATEMENT:
We are committed to providing reasonable accommodations for all persons with disabilities. Any student with a documented disability requesting academic accommodations should contact the Dean of Students, Melissa Axelsson, for additional information to coordinate reasonable accommodations for students with documented disabilities (melissa@njctl.org).

NETIQUETTE:
Respect the diversity of opinions among the instructor and classmates and engage with them in a courteous, respectful, and professional manner. All posts and classroom communication must be conducted in accordance with the student code of conduct. Think before you push the Send button. Did you say just what you meant? How will the person on the other end read the words?

Maintain an environment free of harassment, stalking, threats, abuse, insults or humiliation toward the instructor and classmates. This includes, but is not limited to, demeaning written or oral comments of an ethnic, religious, age, disability, sexist (or sexual orientation), or racist nature; and the unwanted sexual advances or intimidations by email, or on discussion boards and other postings within or connected to the online classroom.

If you have concerns about something that has been said, please let your instructor know.

CLASS SCHEDULE:

Module	Module Learning Outcomes	Assignments
1 - Fluids	● Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. ● Use Lenz's law to determine the direction of induced currents. ● Depict coupled currents and explain the term coefficient of coupling. ● Understand the effect that inductance has on steady direct current, and direct current that is changing in magnitude.	● Short Answer ● Lab ● Mastery Exercises ● Module Exam
2 - Thermal Physics	● Apply principles of electromagnetic induction to explain how a generator and motor work. ● Understand basic applications of electromagnetic induction to technology.	● Short Answer ● Lab ● Mastery Exercises ● Module Exam

3 - Electric Force & Field	• Make claims about natural phenomena based on conservation of electric charge. • Construct an explanation of the two-charge model of electric charge based on evidence produced through scientific practices. • Make a qualitative prediction about the distribution of positive and negative electric charges within neutral systems as they undergo various processes. • Calculate any one of the variables - electric force, electric charge and electric field - at a point given the values and sign or direction of the other two quantities. • Explain the inverse square dependence of the electric field surrounding a spherically symmetric electrically charged object. • Predict the direction and the magnitude of the force exerted on an object with an electric charge placed in an electric field using the mathematical model of the relation between an electric force and an electric field. • Qualitatively and semi-quantitatively apply the vector relationship between the electric field and the net electric charge creating that field. • Distinguish the characteristics that differ between monopole fields and dipole fields and make claims about the spatial behavior of the fields using qualitative or semi-quantitative arguments based on vector addition of fields due to each point source, including identifying the locations and signs of sources from a vector diagram of the field. • Apply mathematical routines to determine the magnitude and direction of the electric field at specified points in the vicinity of a small set (2-4) of point charges, and express the results in terms of magnitude and direction of the field in a visual representation by drawing field vectors of appropriate length and direction at the specified points. • Create representations of the magnitude and direction of the electric field at various distances (small compared to plate size) from two electrically charged plates of equal magnitude and opposite signs and is able to recognize that the assumption of uniform field is not appropriate near edges of plates. • Calculate the magnitude and determine the direction of the electric field between two electrically charged parallel plates, given the charge of each plate, or the electric potential difference and plate separation. • Represent the motion of an electrically charged particle in the uniform field between two oppositely charged plated and express the connection of this motion to the projectile motion of an object with mass in the Earth's gravitational field.	• Short Answer • Lab • Mastery Exercises • Module Exam

4 – Electric Potential	• Calculate the magnitude and determine the direction of the electric field between two electrically charged parallel plates, given the charge of each plate, or the electric potential difference and plate separation. • Construct or interpret visual representations of the isolines of equal gravitational potential energy per unit mass and refer to each line as a gravitational equipotential. • Determine the structure of isolines of electric potential by constructing them in a given electric field. • Explain the relationship between electric field, electric potential energy and potential, and calculate electric potential energy and electric potential. • Write and apply expressions for calculating the dielectric constant as a function of the voltage, the electric field or the capacitance. • Qualitatively use the concept of isolines to construct isolines of electric potential in an electric field and determine the effect of that field on electrically charged objects and compare to gravitational field analogue. • Apply mathematical routines to calculate the average value of the magnitude of the electric field in a region from a description of the electric potential in that region using the displacement along the line on which the difference in potential is evaluated. • Apply the concept of the isoline representation of electric potential for a given electric charge distribution to predict the average value of the electric field in the region.	• Short Answer • Lab • Mastery Exercises • Module Exam
5 – Electric Current	• Analyze data to determine the effect of changing the geometry and/or materials on the resistance or capacitance of a circuit element and relate results to the basic properties of resistors and capacitors. • Make and justify a quantitative prediction of the effect of a change in values or arrangements of one or two circuit elements on the currents and potential differences in a circuit containing a small number of sources of emf, resistors, capacitors and switches in a series and/or parallel. • Make claims about natural phenomena based on conservation of electric charge. • Make predictions, using the conservation of electric charge about the sign and relative quantity of net charge of objects or systems after various charging processes, including conservation of charge in simple circuits. • Write and apply expressions for calculating the dielectric constant as a function of the voltage, the electric field or the capacitance. • Qualitatively use the concept of isolines to construct isolines of electric potential in an electric field and determine the effect of that field on electrically charged objects and compare to gravitational field analogue. • Apply mathematical routines to calculate the average value of the magnitude of the electric field in a region from a description of the electric potential in that region using the displacement along the line on which the difference in potential is evaluated. • Apply the concept of the isoline representation of electric potential for a given electric charge distribution to predict the average value of the electric field in the region.	• Short Answer • Lab • Mastery Exercises • Module Exam

6 - Magnetism	• Apply mathematical routines to express the force exerted on a moving charged object by a magnetic force. • Create a verbal or visual representation of a magnetic field around a long straight wire or a pair of parallel wires. • Describe the orientation of a magnetic dipole placed in a magnetic field in general and the particular cases of a compass in the magnetic field of the Earth and iron filings surrounding a bar magnet. • Use the representation of magnetic domains to qualitatively analyze the magnetic behavior of a bar magnet composed of ferromagnetic materials. • Use right-hand rules to analyze a situation involving a current-carrying conductor and a moving electrically charged object to determine the direction of the magnetic force exerted on the charged object due to the magnetic field created by the current-carrying conductor. • Plan a data collection strategy appropriate to an investigation of the direction of the force on a moving electrically charged object caused by a current in a wire in the context of a specific set of equipment and instruments and analyze the resulting data to arrive at a conclusion. • Connect the strength of electromagnetic forces with the spatial scale of the situation, the magnitude of the electric charges, and the motion of the electrically charged objects involved. • Apply Newton's 2nd Law and derived magnetic force formulas to solve magnetic force and field problems.	• Short Answer • Lab • Mastery Exercises • Module Exam
7 – Final Exam & Reflection	• Review topics from course modules • Zoom meetings with instructor and discussion board posts, as needed	• Reflection Paper • Final Exam