THE GOVERNOR'S SCHOOL for SCIENCE AND TECHNOLOGY

Engineering Physics Strand: Physics II with Calculus

Academic Year 2025–2026

Instructor Information

- **Instructor:** Dr. Al Amin Kabir
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- **Office Hours:** Open Door Policy
- **Location: Room#**A30

Course Description

This course provides a comprehensive exploration of electricity, magnetism, electromagnetic waves, optics, and modern physics. Students will develop proficiency in analytical problem-solving, laboratory experimentation, scientific communication, and the application of physical models to real-world systems.

Prerequisites

- Successful completion of Calculus II (Math 264)
- Successful completion of Physics I with calculus

Required Textbooks and Resources

- *Physics for Scientists and Engineers* (4th Edition) – Randall D. Knight
- *Concepts of Modern Physics* (6th Edition) – Arthur Beiser
- Supplemental materials provided via the course platform.

Course Objectives

By the end of the course, students will be able to:

- Solve advanced problems in electrostatics, circuits, magnetism, and electromagnetic waves.
- Apply Maxwell's equations to analyze electric and magnetic fields in complex systems.
- Design and interpret optical systems using geometrical and wave optics principles.
- Understand and apply the core ideas of special relativity and quantum mechanics.
- Conduct rigorous laboratory experiments using scientific apparatus and modern techniques.
- Perform detailed error analysis and produce professional-grade scientific reports.
- Develop critical thinking and rational problem-solving skills, utilizing the scientific method to address novel challenges.

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Grading Policy

Component	Weight
Exams	35%
Quizzes	20%
Laboratory Work	25%
Homework Assignments	20%

Grading Scale:
A (90–100%) | B (80–89%) | C (70–79%) | D (60–69%) | F (<60%)

Assignments

- **Homework:** Weekly
- **Quizzes:** Bi-weekly

Examination Dates

- **Midterm 1:** October 2nd, 2025
- **Midterm 2:** December 2nd, 2025
- **Midterm 3:** March 3rd, 2025
- **Final Exam:** May 19th, 2026

Topical Outline of Course Content

This course is organized into five major units that build sequentially, from the foundational principles of electricity and magnetism to their modern applications in optics and quantum physics.

Unit 1: Electrostatics and DC Circuits

This foundational unit explores the principles governing stationary electric charges and their application in direct current (DC) circuits.

- **Fundamental Concepts of Electrostatics**
  - Review of vector calculus and coordinate systems.
  - Introduction to electric charge, Coulomb's Law, and electric fields.
- **Electric Fields and Potential**
  - Applications of Gauss's Law to symmetric charge distributions (spheres, cylinders, planes).

  - Electric potential, potential energy, capacitors, and energy storage in electric fields.
- **DC Circuit Analysis**
  - Electric current, resistance, and Ohm's Law.
  - Kirchhoff's Laws and energy considerations in circuits.

Unit 2: Magnetism and Electromagnetic Induction

Building on electrostatics, this unit investigates the relationship between electricity and magnetism, culminating in the principles of electromagnetic induction and its technological applications.

- **Magnetostatics**
  - Magnetic forces on moving charges and currents.
  - Analysis of magnetic dipoles and torque.
  - The Biot–Savart Law and Ampère's Law for calculating magnetic fields from currents.
- **Electromagnetic Induction**
  - Faraday's Law and Lenz's Law of induction.
  - Self- and mutual inductance and magnetic energy storage.
  - Analysis of RL circuits and their time constants.

Unit 3: AC Circuits and Electromagnetic Waves

This unit advances circuit analysis to alternating currents (AC) and unifies electricity and magnetism through Maxwell's equations to describe the nature of light as an electromagnetic wave.

- **Alternating Current (AC) Circuit Analysis**
  - Characteristics of AC circuits, including impedance and phase relationships.
  - RLC circuit analysis, resonance phenomena, and energy transfer.
- **Electromagnetic Waves**
  - An introduction to Maxwell's equations.
  - The physics of electromagnetic wave propagation.

Unit 4: Optics

This module examines the behavior and properties of light, covering both the particle-like ray model (geometric optics) and the wave model (wave optics).

- **Geometric Optics**
  - Principles of reflection and refraction.
  - Image formation using the thin lens equation and the design of optical instruments.
- **Wave Optics**
  - Phenomena of interference, diffraction, and polarization.

Unit 5: Modern Physics

The course concludes with an introduction to the two foundational pillars of modern physics: special relativity and quantum mechanics, exploring realms where classical physics is insufficient.

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- **Special Relativity**
  - Einstein's postulates, simultaneity, time dilation, and length contraction.
  - Relativistic energy and momentum.
- **Quantum Foundations**
  - The photoelectric effect and the concept of matter waves.
  - The Schrödinger equation and its applications.
  - Atomic models, including Bohr's hydrogen atom.
  - An introduction to Nuclear Structure and the Standard Model of Particles.

Experiments and Laboratory Investigations

Hands-on, inquiry-based activities during the class period will be offered. These labs allow you to discover various aspects aligned with physics concepts learned in the class. Labs will vary in length and complexity and will be done in groups.

1. Measurements, data modeling, and error analysis
2. Coulomb's Law verification
3. Ohm's Law and linear circuit analysis
4. Series and parallel capacitor/resistor networks
5. Kirchhoff's Laws for complex circuits
6. RC circuit time constants
7. Resonance phenomena in RLC circuits
8. AC filter circuits (low-pass, high-pass, band-pass)
9. Faraday's Law and magnetic field mapping
10. Charge-to-mass ratio of the electron
11. Laws of reflection and refraction
12. Image formation by mirrors and lenses
13. Diffraction and interference using lasers
14. Photoelectric effect and measurement of Planck's constant
15. Analysis of emission spectra

Formal laboratory reports will be required, emphasizing scientific writing, data interpretation, and error analysis.

Group Work

You will be assigned to a group for collaborative work. Your group assignment will be announced near the beginning of the school year. If you are not satisfied with the way your group is working, first try to discuss it with your group members. If you cannot arrive at a satisfactory solution, then discuss the problems with your instructor.

Students are also expected to work on their EDIE lab assignment, which will be guided each Wednesday.

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Classroom Expectations

- Students must arrive promptly and be prepared for all lectures, labs, and examinations.
- Homework assignments are due by the posted deadlines; late work may not be accepted.
- Academic integrity is strictly enforced. All work must be individual unless specified otherwise.
- All major assessments (exams and tests) are proctored in-person. Only non-programmable scientific calculators are permitted; no additional devices are allowed.
- Plagiarism or academic misconduct will be handled per the institution's disciplinary policies.

Contact and Communication

All course announcements, assignments, laboratory schedules, and grades will be posted on the Canvas. Students are expected to monitor Canvas and email daily for updates.

Dual Enrollment Option for PHY 242 through Virginia Peninsula Community College

Students have the opportunity to dual-enroll in PHY 242 via Virginia Peninsula Community College. Enrollment in a dual-credit course is a significant academic decision that warrants careful consideration. Students are strongly encouraged to review the Dual Enrollment (DE) Module available through the Faculty Advising Canvas course for detailed guidance.

Prior to enrolling, students should contact their prospective colleges or universities to inquire about how dual-enrollment coursework may impact their future academic plans, particularly if course performance falls below expectations. Please note that enrollment in a dual-credit course generates a permanent college transcript that will record all attempted courses, regardless of final performance.

Students are also advised to consult the Dual Enrollment Student Guide provided by Transfer Virginia to better understand the implications of their enrollment choices.

Students opting to dual-enroll must vigilantly monitor their academic performance throughout the course. If at any point a student determines that their performance does not meet their standards for a permanent college record, they are encouraged to take appropriate action by either:

- Dropping the dual-enrollment portion of the course **prior to the official Add/Drop deadline**, or
- Withdrawing from the dual-enrollment portion **prior to the Withdrawal deadline**.

Dropping a course will result in no record appearing on the student's college transcript. Withdrawing will result in a "W" notation, indicating a withdrawal without a recorded grade, but will remain on the college transcript. Students will continue to receive high school credit for the course in either case.

Decline or withdrawal forms can be requested directly from the course instructor or from Mrs. Yee.

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Important Dual Enrollment Deadlines

Fall 2025:

- Last day to register: 09/26/2025
- Last day to drop: 10/08/2025
- Last day to withdraw: 11/25/25
- Grades due: 01/26/2026

Please Note: PHY 242 (Physics II) is available for dual enrollment **only during the Fall semester**.