THE GOVERNOR'S SCHOOL for SCIENCE AND TECHNOLOGY

Engineering Physics Strand: Physics II with Calculus

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Course Text: Physics for Scientists and Engineers (4th edition) by Randall D. Knight

What is Physics (and this course): "The whole of science is nothing more than a refinement of everyday thinking." (Einstein) Physics is the study of nature – it is a *living* discipline, not a collection of facts. It is the science of daily existence and is something you know a great deal about. You have direct experience with the nature of forces, how things respond to those forces, the conservation of mass, energy, momentum, and some aspects of gravity. The formal study of physics should guide and clarify your understanding to build a consistent basis of fundamentals that allow you to build models for describing the physical behavior of unfamiliar or complex systems. Physics is about reasoning, making connections, and understanding what will happen in a situation, and why it happens.

In order to do physics in a genuine sense, it is necessary to be able to apply the skills used within the discipline to new situations. When dealing with new situations, we use mathematical models to describe them – and applying these models often requires simplifications or assumptions about the physical situation. It is necessary to become proficient with the use of models, their applicability when they are not appropriate (and why), and to be able to analyze situations in multiple ways. My goal is for you to be able to leave the course with a set of skills and tools that you can use to analyze any basic system and to understand what the next step would need to be to address a more complex aspect of that system.

My job is therefore not to tell you information - my job is to help you make sense of the information and help you develop the tools and skills needed to model and understand the physical world... i.e., not to just know ABOUT physics but to be able to DO physics.

1. Course Specific Requirements/Student Responsibilities:
Prerequisites/Corequisite: Math 264 (Calculus II)
Required Materials:

- Notebook (3-ring binder preferred) – Students will be expected to keep a binder or section exclusively for use in this class. The binder should be a comprehensive, well-organized record of your work in physics.
- Composition Lab notebook (graph ruled preferred)
- Pencil(s) (with eraser), loose-leaf paper
- Scientific Calculator (e.g. TI-30, Casio fx-300, or better)

Effective organization is important in a student's success in physics. Consistent organization can make a difficult course manageable and raise a marginal grade to an excellent grade.

Classroom Expectations:

- Be On Time: Students are expected to be in the room and seated when the bell
- Be Ready to Learn: Bring ALL required materials to
- Be Respectful: Take RESPONSIBILITY for your own actions, and THINK before you
- Show Effort: Do your homework and adequately prepare for all tests and
- Ask for Help: Ask questions when needed and/or arrange for a time to come and see me

2. Academic Integrity:

Any cheating on any exams or quizzes will result in a grade of "0" for that test. Cheating is defined as either the giving or the receiving of unauthorized help. Any indication of cheating will result in a grade of zero for the exam; **a second violation and there will be conferencing with the director**. A one-sided 3x5 NOTE CARD WILL SOMETIMES BE PERMITTED.

3. Grading:

Final course grades will be assigned using the following scale as a guide:

- 90-100 A
- 80-89 B
- 70-79 C
- 60-69 D
- 0-59 F

4. Evaluation:

Each semester will consist of classwork and labs, homework, exams, and quizzes. Grading is done via the point system. Points are assigned for each given assignment, quiz, test, etc… All points will be pooled by category. The category weights are listed below:

- 50% Exams and quizzes
- 30% Laboratory work
- 15% Homework
- 5% Classroom Participation and work

A special note about grades: Although I know that your grade is important to you, I have found that focusing on it is actually counterproductive. If you focus on mastering physics, then the grade **always** takes care of itself. So, the next time you find yourself worried about your grade in my class, ask yourself instead *what you need to learn or master,* and you will be on the right path.

5. Course Outline:

Quarter I: Electricity

Unit 1: Electric Field and Gauss' Law (3 weeks)

- Coulomb's Law
- Field Distributions of Systems of Particles
- Electric Flux
- Gauss' Law and various charge distributions

Unit 2: Electric Potential (3 weeks)

- Potential difference
- Potential difference in Electric Fields
- Potential difference of systems of particles (discrete and continuous)
- Capacitance
- Electric Potential Energy

Unit 3: Current, Resistance, DC Circuits (3 weeks)

- Current and Resistance

- Ohm's Law
- Circuit Elements and Diagrams
- Kirchhoff's Law
- EMF and internal resistance
- RC Circuits

Quarter II Magnetism

Unit 4: Magnetic Fields (3 weeks)

- Magnetism
- The source of the Magnetic field
- Magnetic Dipoles
- Ampere's Law
- Toroids / Solenoids
- Forces and Torques on Current Loops

Unit 5: Electromagnetic Induction (3 weeks)

- Induced Currents
- Magnetic Flux
- Faraday and Lenz's Law
- Inductors
- RLC Circuits

Unit 6: AC Circuits (3 weeks)

- AC Sources and Phasors
- RC filter circuits
- Power in AC Circuits

Quarter III: Waves and Optics

Unit 7: Electromagnetic Fields and Optics (4 weeks)

- The wave model
- Principle of Superposition
- Electromagnetic spectrum
- Light and Optics
- Diffraction
- Interference

Unit 8: Ray Optics (4 weeks)

- The Ray Model of Light
- Reflection
- Refraction
- Thin lens equation
- Lenses in combination
- Optical equipment (lasers)

Quarter IV: Modern Physics

Unit 9: Relativity (2 weeks)

- Principles of Relativity
- Relativity of Simultaneity
- Time Dilation
- Length Contraction
- Relativistic Energy and Momentum

Unit 10: The Foundations of Modern Physics (2 weeks)

- Matter and Light
- Emission and Absorption of Light
- Discovery of the Electron
- Discovery of Nucleus
- Classical Physics at the Limit

Unit 11: Quantization (3 weeks)

- The photoelectric Effect

- Matter waves and Energy Quantization
- Bohr Hydrogen Atom
- Waves, particles, and the Double-Slit Experiment

6. Labs:

Labs are an essential portion of the course and will require 20%- 25% of the course time. Labs are crucial in making connections between real world applications, the vocabulary of physics, curricular learning, and problem-solving skills learned in class. All labs are designed to be guided inquiry. These hands-on investigations allow students the chance to practice critical thinking skills that are crucial to learning to be a scientist. Students will play a role in developing the experimental question and shaping or modifying the experimental design or procedure. A variety of lab tools and techniques such as video analysis, data logging equipment, motion sensors, and electronic apparatus will be introduced.

Many units begin with a laboratory investigation preceding any other instruction. The subject of the lab is designed to introduce one or more concepts important in the unit. These labs begin with a demonstration for the students to discuss. In the discussion, they are prompted to brainstorm variables that might be reasonably presumed to govern the behavior of the demonstration apparatus. They then design and investigate to find relationships between the variables. A class discussion follows in which the class describes models for the behavior observed. Afterward, the model becomes explanatory and can be invoked in explaining concepts and solving problems.

Other labs are presented as open-ended lab problems where students are allowed to use the equipment available to them and design experimental procedures to find relevant relationships between variables and are guided to see the underlying physical principles. Some labs are virtual simulations that allow for review and reinforcement of concepts learned in class. These virtual labs are listed for completeness but are not included in the lab time estimation. All labs will require written work both in keeping a lab notebook as well as some full laboratory write-ups. A few labs are jumping off points for longer-term projects or competitions (~1 week) subject to student interest and equipment availability.

Labs Listings (tentative, subject to change):

- Van-der-Graaf Generator
- Capacitance
- E-field Mapping
- Capacitor network
- Electric Field Hockey
- Current and Resistance
- DC Circuits
- RC Circuits
- Magnetic Field Mapping
- Magnetic Collisions
- Forces and Torques on Current Loops
- Magnetic Induction
- Inductors
- RLC Circuits
- AC Sources and Phasors
- RC filter circuits
- AC RLC Circuits
- Sources of Light
- Single Slit Experiment
- Double Slit Experiment
- Michelson Interferometer

- Reflection and Refraction
- Mirrors in Combination
- Lenses in Combination
- Optical Instruments
- Speed of Light
- Energy, momentum, mass
- Mean Lifetime
- Rolling with Rutherford
- The photoelectric Effect
- Atomic Spectrum
- Millikan Oil Experiment

Note: *Every effort was made to correctly reflect the lecture topics and the lab activities of this course. Any changes will be communicated through the announcements.*

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

Dual Enrollment of PHY 242 via Virginia Peninsula Community College:

The decision to dual-enroll in a course requires careful consideration. You have options, as you can see from the DE Module on Faculty Advising Canvas course. You may wish to contact your top choice colleges to ask what the impact of taking a dual-enrollment course might be for your goals, particularly if you do not perform to your expectations in the course. Please be aware that you are generating a permanent college transcript with all the courses for which you are dual-enrolled. You can also use the dual-enrollment student guide from Transfer Virginia to help you determine the potential impact.

If you choose to dual-enroll, you must monitor your course grade. If you find you are not earning grades you want to have on your permanent college transcript, you may consider dropping the dual-enrollment portion prior to the Add/Drop date for the term of the course, or to withdraw from the dual-enrollment portion prior to the Withdrawal date. If you choose to withdraw from dual enrollment for the class, you will still earn high school credit and can plan to be well-prepared for the class in college. Dropping will have no record on your transcript, while withdrawal will leave a note on your college transcript indicating you withdrew, but no grade will be recorded on your college transcript. You can request a decline or withdrawal form from me or from Mrs. Yee.

Important Dual enrollment dates are as follows:
• Fall 2024
– Last day/date to register: Friday 9/27/2024
– Last day/date to drop: Thursday 10/3/2024
– Last day/date to withdraw: Monday 12/2/2024
– Grades Due: Friday 1/31/2025
• Spring 2025
– Last day/date to register: Friday 2/7/2025
– Last day/date to drop: Friday 2/14/2025
– Last day/date to withdraw: Wednesday 4/16/2025
– Grades Due: Friday 6/13/2025

Note that this course, Physics 242, is only dual enrolled in the spring.

No matter what you choose to do, I will respect your wishes. I want to work with you to support your learning, but I cannot learn the information for you; you will need to invest the requisite effort in the course in order to succeed. This may require you to learn new learning strategies that you haven't used in the past. I will do my utmost to support your personal learning in the class and encourage you to pursue your goals.