ILLINOIS VALLEY COMMUNITY COLLEGE

COURSE OUTLINE

DIVISION: Natural Sciences & Business

COURSE: PHY 2004 General Physics II: Electricity, Magnetism, Optics, and Modern Physics

Date: Spring 2023

Credit Hours: 5

Complete all that apply or mark "None" where appropriate:

Prerequisite(s): PHY 2003 with a C or better

Enrollment by assessment or other measure? ☐ Yes ☒ No
If yes, please describe:

Corequisite(s): None

Pre- or Corequisite(s): None

Consent of Instructor: ☐ Yes ☒ No

Delivery Method:		
☒ **Lecture**	**3 Contact Hours**	**(1 contact = 1 credit hour)**
☒ **Seminar**	**1 Contact Hours**	**(1 contact = 1 credit hour)**
☒ **Lab**	**2 Contact Hours**	**(2-3 contact = 1 credit hour)**
☐ **Clinical**	**0 Contact Hours**	**(3 contact = 1 credit hour)**

Offered: ☐ **Fall** ☒ **Spring** ☐ **Summer**

CATALOG DESCRIPTION and IAI NUMBER (if applicable):
This is the second in sequence of general physics course using a non-calculus-based approach for majoring in (some engineering and technology programs), the life sciences, preprofessional health programs, agriculture, veterinary medicine and the arts. This course includes electric forces and fields, electric potential, electric circuits, magnetic forces and fields, geometrical optics, and modern physics.

ACCREDITATION STATEMENTS AND COURSE NOTES:
None

COURSE TOPICS AND CONTENT REQUIREMENTS:

17. Wave Optics
- 17.1 What Is Light?
- 17.2 The Interference of Light
- 17.3 The Diffraction Grating
- 17.4 Thin-Film Interference
- 17.5 Single-Slit Diffraction
- 17.6 Circular-Aperture Diffraction

18. Ray Optics
- 18.1 The Ray Model of Light
- 18.2 Reflection
- 18.3 Refraction
- 18.4 Image Formation by Refraction
- 18.5 Thin Lenses: Ray Tracing
- 18.6 Image Formation with Spherical Mirrors
- 18.7 The Thin-Lens Equation

19 Optical Instruments
- 19.1 The Camera
- 19.2 The Human Eye
- 19.3 The Magnifier
- 19.4 The Microscope
- 19.5 The Telescope
- 19.6 Color and Dispersion
- 19.7 Resolution of Optical Instruments

20. Electric Fields and Forces
- 20.1 Charges and Forces
- 20.2 Charges, Atoms, and Molecules
- 20.3 Coulomb's Law
- 20.4 The Concept of the Electric Field
- 20.5 The Electric Field of Multiple Charges
- 20.6 Conductors and Electric Fields
- 20.7 Forces and Torques in Electric Field

21. Electric Potential
- 21.1 Electric Potential Energy and Electric Potential
- 21.2 Sources of Electric Potential
- 21.3 Electric Potential and Conservation of Energy
- 21.4 Calculating the Electric Potential
- 21.5 Connecting Potential and Field
- 21.6 The Electrocardiogram
- 21.7 Capacitance and Capacitors
- 21.8 Energy and Capacitors

22. Current and Resistance
- 22.1 A Model of Current
- 22.2 Defining and Describing Current
- 22.3 Batteries and emf
- 22.4 Connecting Potential and Current

22.5 Ohm's Law and Resistor Circuits
22.6 Energy and Power

23. Circuits
23.1 Circuit Elements and Diagrams
23.2 Kirchhoff's Laws
23.3 Series and Parallel Circuits
23.4 Measuring Voltage and Current
23.5 More Complex Circuits
23.6 Capacitors in Parallel and Series
23.7 RC Circuits
23.8 Electricity in the Nervous System

24. Magnetic Fields and Forces
24.1 Magnetism
24.2 The Magnetic Field
24.3 Electric Currents Also Create Magnetic Fields
24.4 Calculating the Magnetic Field Due to a Current
24.5 Magnetic Fields Exert Forces on Moving Charges
24.6 Magnetic Fields Exert Forces on Currents
24.7 Magnetic Fields Exert Torques on Dipoles
24.8 Magnets and Magnetic Materials

25. EM Induction and EM Waves
25.1 Induced Currents
25.2 Motional emf
25.3 Magnetic Flux and Lenz's Law
25.4 Faraday's Law
25.5 Electromagnetic Waves
25.6 The Photon Model of Electromagnetic Waves
25.7 The Electromagnetic Spectrum

26. AC Electricity
26.1 Alternating Current
26.2 AC Electricity and Transformers
26.3 Household Electricity
26.4 Biological Effects and
26.5 Capacitor Circuits
26.6 Inductors and Inductor Circuits
26.7 Oscillation Circuits

27. Relativity
27.1 Relativity: What's It All About?
27.2 Galilean Relativity
27.3 Einstein's Principle of Relativity
27.4 Events and Measurements
27.5 The Relativity of Simultaneity
27.6 Time Dilation
27.7 Length Contraction
27.8 Velocities of Objects in Special Relativity
27.9 Relativistic Momentum
27.10 Relativistic Energy

28. Quantum Physics
28.1 X Rays and X-Ray Diffraction

28.2 The Photoelectric Effect
28.3 Photons
28.4 Matter Waves
28.5 Energy Is Quantized
28.6 Energy Levels and Quantum Jumps
28.7 The Uncertainty Principle
28.8 Applications and Implications of Quantum Theory

29. Atoms and Molecules

29.1 Spectroscopy
29.2 Atoms
29.3 Bohr's Model of Atomic Quantization
29.4 The Bohr Hydrogen Atom
29.5 The Quantum-Mechanical Hydrogen Atom
29.6 Multi-electron Atoms
29.7 Excited States and Spectra
29.8 Molecules
29.9 Stimulated Emission and Las

30. Nuclear Physics

30.1 Nuclear Structure
30.2 Nuclear Stability
30.3 Forces and Energy in the Nucleus
30.4 Radiation and Radioactivity
30.5 Nuclear Decay and Half-Lives
30.6 Medical Applications of Nuclear Physics
30.7 The Ultimate Building Blocks of Matter

INSTRUCTIONAL METHODS:

1. Lectures and lecture demonstrations. Interactive Lecture Demonstration (ILDs), Activity – based physics learning styles, and utilizing other audiovisual aids and technologies
2. Outside of class problem assignments and in class problem discussion sessions.
3. Micro-computer-based laboratory exercises.
4. Examinations and quizzes

EVALUATION OF STUDENT ACHIEVEMENT:

Reading of textbook, note taking, and participation in classroom discussions as well as performing laboratory experiments are required of the students. Students are assigned approximately 15 homework problems per Chapter. Solutions of graded problems are discussed after grading if and when necessary.
Evaluation of the students will include written problem class tests and one problem-orientated comprehensive final exam, written reports of laboratory experiments, quizzes and homework assignments, and class participation.

A = 90 -100
B = 80 – 89
C = 70 – 79
D = 60 – 69
F = 59 and below

INSTRUCTIONAL MATERIALS:

Textbooks

1. College Physics, a strategic approach 4th ed (with mastering physics and student work book), Knight, Jones and Field
2. Physics Laboratory Experiments, 6th edition, Jerry D Wilson and Cecilia A. Hernandez
3. Real Time Physics (Active Learning Laboratories), 3rd ed, David R. Sokoloff, Ronald K. Thornton, Priscilla W. Laws
4. Advance physics laboratory exercises and physics with video analysis by Vernier Science Education

Resources

University Physics with Modern Physics with Mastering Physics, 13/E, Hugh D. Young, Roger A. Freedman
Classical Dynamics of particles and systems, Thornton and Marion, Brooks/Cole
The Mechanical Universe and Beyond the Mechanical Universe
Physics Demonstration series, by Physics Curriculum and Instruction,

LEARNING OUTCOMES AND GOALS:

Institutional Learning Outcomes

☐ 1) Communication – to communicate effectively;
☒ 2) Inquiry – to apply critical, logical, creative, aesthetic, or quantitative analytical reasoning to formulate a judgement or conclusion;
☐ 3) Social Consciousness – to understand what it means to be a socially conscious person, locally and globally;
☐ 4) Responsibility – to recognize how personal choices affect self and society.

Course Outcomes and Competencies

Upon completion of the course, the student will be able to:
Outcome 1 – Students will be able to demonstrate a basic understanding of electric fields including the sources of the fields and the concept of electrical potential.
Competency 1.1 Students will be able to explain and use Coulomb's Law to solve problems.
Competency 1.2 Students will be able to explain the difference between a conductor and an insulator, and various ways how an object can receive a net charge
Competency 1.3 Students will be able to explain what is meant by an electric field and determine values for electric fields mathematically.
Competency 1.4 Students will be able to define electric potential and electric potential energy and solve problems involving these concepts.
Competency 1.5 Students will be able to explain what is meant by a capacitor and the term capacitance; determine the capacitance of a capacitor; combine capacitors which are in series or in parallel; and determine the energy stored in a charged capacitor.
Competency 1.6 Students will be able to explain what is meant by a dielectric and how a dielectric affects the capacitance of a capacitor and the energy stored in a capacitor.

Outcome 2 – Students will be able to demonstrate a basic understanding of resistive and R-C circuits, power, and basic circuit design.

Competency 2.1 Students will be able to define the terms: current, electrical resistance, electromotive force, electric work and power, and solve problems involving these concepts, especially problems involving Ohm's Law.

Competency 2.2 Students will be able to combine resistors in series and in parallel and solve problems involving D.C. circuits by applying Kirchoff's Laws.

Competency 2.3 Students will be able to explain the principles of operation and uses of ammeters, voltmeters, ohmmeters, potentiometers, and solve problems involving these instruments.

Competency 2.4 Students will be able to solve problems involving R-C series circuits.

Outcome 3 – Students will be able to demonstrate a basic understanding of magnetic fields including the sources of the fields and the effects they have on moving particles.

Competency 3.1 Students will be able to compute the force on a charged particle due to a magnetic field and determine the motion of a charged particle in a magnetic field.

Competency 3.2 Students will be able to compute the magnetic force on a current carrying wire or coil and the magnetic torque on a current-carrying coil.

Competency 3.3 Students will be able to compute the magnetic field produced by a current-carrying conductor.

Outcome 4 – Students will be able to demonstrate a basic understanding of dynamic electromagnetic fields and their applications to simple electronics.

Competency 4.1 Students will be able to describe what is meant by, and compute, a nonelectrostatic field and an induced electric field.

Competency 4.2 Students will be able to know and apply Faraday's Law and Lenz's Law to the solution of problems involving induced electric fields, including motional emfs.

Competency 4.3 Students will be able to solve simple problems involving transformers.

Competency 4.4 Students will be able to define mutual and self inductance and the energy associated with an inductor.

Competency 4.5 Students will be able to solve problems involving R-L and L-C circuits.

Outcome 5 – Students will be able to demonstrate a basic understanding of geometrical optics including refraction, reflection, lenses, mirrors, and various optical devices.

Competency 5.1 Students will be able to know and apply the laws of reflection and refraction of light to the solution of problems.

Competency 5.2 Students will be able to describe the dispersion of light by a prism and by lenses.

Competency 5.3 Students will be able to describe total internal reflection of light and solve problems involving total internal reflection.

Competency 5.4 Students will be able to describe, in words and determine graphically and mathematically, the formation of images by a single reflection or refraction at a plane or spherical surface. This includes determining the position and size of any image formed.

Competency 5.5 Students will be able to describe in words and compute mathematically and graphically the position and size of images formed by lenses and various optical instruments, including the eye, the magnifier, the camera, the compound microscope, and the telescope.

Outcome 6 – Students will be able to demonstrate a basic understanding of the wave nature of light and its effects

Competency 6.1 Students will be able to be able to describe in words and mathematically the diffraction and interference of light by a single slit, a double slit, and a diffraction grating.

Competency 6.2 Students will be able to describe in words and mathematically the interference of light from coherent sources, by thin films, and by the Michelsen interferometer.

Competency 6.3 Students will be able to describe in words what is meant by a polarized light and four ways (reflection, double refraction, absorption, and scattering) in which light may be polarized; solve simple problems involving polarized light.

Outcome 7 – Students will be able to demonstrate a basic understanding modern physics including, quantum mechanics, wave/particle duality, atomic physics, nuclear physics, and relativity

Competency 7.1 Students will be able to describe, in words, the photoelectric effect, the Compton effect; solve problems based on the photoelectric effect and the Compton effect.

Competency 7.2 Students will be able to describe, in words and mathematically, the structure of the atom, based on Bohr’s model

Competency 7.3 Students will be able to describe the process of nuclear decay, its causes and resulting particles.

Competency 7.4 Students will be able to mathematically determine the energy of decaying particles and mass defect associated with nuclear decay

Competency 7.5 Students will be able to describe and mathematically use the concepts of special relativity for discussions and problem solving.