PHYS R122: PHYSICS WITH CALCULUS 2

Originator
jwmiller

College
Oxnard College

Discipline (CB01A)
PHYS - Physics

Course Number (CB01B)
R122

Course Title (CB02)
Physics with Calculus 2

Banner/Short Title
Physics with Calculus 2

Credit Type
Credit

Start Term
Fall 2021

Catalog Course Description
This course is an introduction to electromagnetic theory, optics, and modern physics. Topics include electricity, magnetism, optics, quantum ideas, atomic and nuclear physics, and special relativity. The laboratory provides students with opportunities to learn and apply the scientific method through investigations of the phenomena discussed in lecture. It also provides students with additional exposure to methods of computer-assisted data analysis. The course is designed to meet the needs of students majoring in the biological sciences, although it may also be suitable for students in certain other majors. It is not appropriate for students planning to major in fields such as engineering, mathematics, the physical sciences, or computer science.

Taxonomy of Programs (TOP) Code (CB03)
1902.00 - Physics, General

Course Credit Status (CB04)
D (Credit - Degree Applicable)

Course Transfer Status (CB05) (select one only)
A (Transferable to both UC and CSU)

Course Basic Skills Status (CB08)
N - The Course is Not a Basic Skills Course

SAM Priority Code (CB09)
E - Non-Occupational

Course Cooperative Work Experience Education Status (CB10)
N - Is Not Part of a Cooperative Work Experience Education Program

Course Classification Status (CB11)
Y - Credit Course

Educational Assistance Class Instruction (Approved Special Class) (CB13)
N - The Course is Not an Approved Special Class

Course Prior to Transfer Level (CB21)
Y - Not Applicable

Course Noncredit Category (CB22)
Y - Credit Course

Funding Agency Category (CB23)
Y - Not Applicable (Funding Not Used)

Course Program Status (CB24)
1 - Program Applicable

General Education Status (CB25)
Y - Not Applicable

Support Course Status (CB26)
N - Course is not a support course

Field trips
Will not be required

Grading method
Letter Graded

Does this course require an instructional materials fee?
No

Repeatable for Credit
No

Is this course part of a family?
No

Units and Hours

Carnegie Unit Override
No

In-Class

Lecture
Minimum Contact/In-Class Lecture Hours
70
Maximum Contact/In-Class Lecture Hours
70

Activity

Laboratory
Minimum Contact/In-Class Laboratory Hours
52.5
Maximum Contact/In-Class Laboratory Hours
52.5

Total in-Class

Total in-Class
Total Minimum Contact/In-Class Hours
122.5
Total Maximum Contact/In-Class Hours
122.5

Outside-of-Class

Internship/Cooperative Work Experience

Paid

Unpaid

Total Outside-of-Class

Total Outside-of-Class
Minimum Outside-of-Class Hours
140
Maximum Outside-of-Class Hours
140

Total Student Learning

Total Student Learning
Total Minimum Student Learning Hours
262.5
Total Maximum Student Learning Hours
262.5

Minimum Units (CB07)
5
Maximum Units (CB06)
5

Prerequisites
PHYS R121 and MATH R121

Entrance Skills

Entrance Skills

Students are expected to have knowledge depicting and solving physical systems by use of diagrams, proper mathematics, and the laws of physics.

Prerequisite Course Objectives

PHYS R121-Draw a diagram or cartoon that clearly and usefully depicts the salient features and characteristics of a mechanical or thermodynamic system, and is labeled or annotated so that known and unknown quantities can readily be determined by examination of the diagram and other written information that accompanies it.
PHYS R121-Analyze a simple mechanical or thermodynamic system to identify applicable principles (e.g., conservation laws) that may be used to predict the future behavior or evolution of the system.
PHYS R121-Solve conceptual and numerical problems related to the behavior or evolution of a mechanical or thermodynamic system by applying those principles identified above.
PHYS R121-Employ appropriate mathematical tools, up to and including elementary derivatives and integrals, to solve a variety of equations encountered in the study of physics, including geometric/graphical approaches, approximation techniques, and/or numerical methods.
PHYS R121-Argue for or against a scientific hypothesis, supporting his/her conclusions by describing how various physical principles might apply to a novel situation.
PHYS R121-Identify the names and major contributions of notable historical and present-day physicists whose work has expanded humankind's understanding of mechanical and thermodynamic systems.

Entrance Skills

Students are expected to understand aspects of Calculus used in class to derive expressions and to make connections between graphical analyses and derivatives/integrals. Students are also expected to make use of Calculus throughout the class regarding definitions of quantities and problem solving.

Prerequisite Course Objectives

MATH R121-Evaluate definite and indefinite integrals using a variety of integration formulas and techniques

MATH R121-Apply integration to areas and volumes, and other applications such as work or length of a curve
MATH R121-Graph, differentiate and integrate functions in polar and parametric form

Requisite Justification

Requisite Type
Prerequisite

Requisite
MATH R121

Requisite Description
Course not in a sequence

Level of Scrutiny/Justification
Required by 4 year institution

Requisite Type
Prerequisite

Requisite
PHYS R121

Requisite Description
Course in a sequence

Level of Scrutiny/Justification
Required by 4 year institution

Student Learning Outcomes (CSLOs)

	Upon satisfactory completion of the course, students will be able to:
1	Student will be able to calculate the angular dispersion of white light passing through a triangular prism.
2	Students will be able to determine the resultant "Electric Field" at a location in the proximity of a distribution of point charges.
3	Students will be able to properly construct a ray diagram and use the information contained to determine the physical properties of the image produced by a lens.
4	Construct a graph of current versus the inverse of resistance to verify Ohm's Law.

Course Objectives

	Upon satisfactory completion of the course, students will be able to:
1	Draw a diagram or cartoon that clearly and usefully depicts the salient features and characteristics of an electromagnetic, optical, or relativistic system, and is labeled or annotated so that known and unknown quantities can readily be determined by examination of the diagram and other written information that accompanies it.
2	Analyze a simple electromagnetic, optical, atomic, or relativistic system to identify applicable principles (e.g., the laws governing circuits, lenses, quantum behavior, or motion at high speeds) that may be used to predict the future behavior or evolution of the system.
3	Solve conceptual and numerical problems related to the behavior or evolution of an electromagnetic, optical, atomic, or relativistic system by applying those principles identified above.
4	Employ appropriate mathematical tools, up to and including elementary derivatives and integrals, to solve a variety of equations encountered in the study of physics, including geometric/graphical approaches, approximation techniques, and/or numerical methods.
5	Apply the techniques listed in items A through D above to simple electromagnetic, optical, or modern physics problems involving biological systems (e.g., cells, muscles, blood vessels, etc.).
6	Argue for or against a scientific hypothesis, supporting their conclusions by describing how various physical principles might apply to a novel situation.

7	Identify the names and major contributions of notable historical and present-day physicists whose work has expanded humankind's understanding of electromagnetic and relativistic systems, optics, and atoms and atomic nuclei.

Course Content

Lecture/Course Content

1. Electrostatics
    a. Properties of electric charges
    b. Insulators and conductors
    c. Coulomb's law and the principle of superposition
    d. The electric field
        i. Definition
        ii. Field lines
        iii. Electrostatic equilibrium
    e. Experiments and tools
        i. Millikan oil drop experiment
        ii. Van de Graaff generators
        iii. Oscilloscopes
2. Electrostatic energy and capacitance
    a. Potential energy vs. potential
    b. Equipotential surfaces
    c. Capacitance
        i. Definition
        ii. Types of capacitors
        iii. Series and parallel arrangements
        iv. Energy storage and uses
3. Electric current and resistance
    a. Electric current
        i. Definition
        ii. Types of charge carriers
        iii. Drift speed of charge carriers
    b. Resistance
        i. Ohm's law
        ii. Resistivity
    c. Variation with temperature, electrical energy, and power
        i. Computing power
        ii. Applications of electrical energy
    d. Direct-current (DC) circuits
        i. Electrical safety
        ii. Sources of electromotive force (EMF)
        iii. Series and parallel arrangements of resistors
        iv. Kirchhoff's laws
        v. Resistor-capacitor (RC) circuits
4. Magnetism
    a. Basic properties of magnetism
        i. Magnetic poles
        ii. Magnetic field lines
        iii. Geomagnetism
    b. Interactions of the magnetic field
        i. Forces on moving electrically charged particles
        ii. Forces on current-carrying wires
        iii. Torques on current-carrying wire loops
    c. Applications
        i. Galvanometers
        ii. Mass spectrometers
    d. Sources of the magnetic field

        i. Ampere's law applied to straight wires, loops, and coils
        ii. Ferromagnetism
5. Electromagnetic induction
    a. Magnetic flux
        i. Definition
        ii. Flux changes
        iii. Induced EMFs
        iv. Faraday's law
        v. Lenz's law
    b. Applications
        i. Generators
        ii. Motors
        iii. Transformers
        iv. Tape recorders and computer hard drives
        v. Magnetic damping (eddy currents)
    c. Self-inductance
        i. Definition
        ii. Magnetic energy storage in inductors
        iii. Resistor-inductor (RL) circuits
6. Alternating-current (AC) circuits and electromagnetic waves
    a. Behavior of circuit elements in AC circuits
        i. Resistor-inductor-capacitor (RLC) circuits
        ii. Impedance
        iii. Power
        iv. Phase
        v. Resonance
    b. Maxwell and Hertz: Prediction and discovery of electromagnetic waves
    c. Electromagnetic waves
        i. Production
        ii. Characterization
        iii. The full electromagnetic spectrum
7. Geometric optics
    a. The nature of light
        i. Speed
        ii. Energy
        iii. Wave/particle properties
    b. Law of reflection and the ray approximation
    c. Law of refraction
        i. Huygens' principle
        ii. Snell's law
        iii. Dispersion and the rainbow
        iv. Total internal reflection and fiber optics
    d. Mirrors and lenses
        i. Ray diagrams
        ii. Sign conventions
        iii. Focal length
        iv. Lens aberrations
    e. Optical instruments
        i. Cameras
        ii. The eye
        iii. Simple magnifiers
        iv. Compound microscopes
        v. Telescopes
8. Wave optics
    a. Interference
        i. Young's experiment
        ii. Path differences
        iii. Phase changes due to reflection; thin films

        iv. Michelson interferometer
        v. Diffraction grating
    b. Diffraction
        i. Single slits
        ii. Multiple slits
        iii. Circular aperture
        iv. Limitation on resolution of optical instruments
    c. Polarization
        i. Polarization by selective absorption
            1. Polarizing filters; sunglasses
            2. Liquid crystal displays (LCDs)
        ii. Polarization by reflection
        iii. Polarization by scattering
        iv. Optical activity
9. Special relativity
    a. Postulates
        i. Einsteinian vs. Newtonian relativity
        ii. Inertial reference frames
    b. Historical aspects
        i. “Luminiferous ether”: an example of a powerful idea that was dead wrong
        ii. Michelson-Morley interferometer: an example of a “failed” experiment that led to new insights
    c. Consequences
        i. Simultaneity
        ii. Relativity of time
        iii. Time dilation
        iv. Length contraction
        v. Twin “paradox”
    d. Dynamic effects
        i. Relativistic mass
        ii. Relativistic momentum
        iii. Relativistic energy
        iv. Relativistic addition of velocities
10. Introduction to quantum physics
    a. Quantum phenomena
        i. Black-body radiation and Planck’s hypothesis
        ii. Photoelectric effect
        iii. Compton scattering
        iv. Pair production and annihilation
    b. X-rays
        i. Production and detection
        ii. Diffraction by crystals; determining protein structure
    c. Wave/particle duality
        i. Schrödinger wave function
        ii. Heisenberg uncertainty principle
11. Atomic physics
    a. Early atomic models
        i. The Thomson atom
        ii. Atomic spectra and the Bohr atom
        iii. DeBroglie waves
    b. Electronic quantum numbers in the atom
        i. Principal (n)
        ii. Orbital (l)
        iii. Orbital magnetic (m)
        iv. Spin (ms)
    c. Electron behavior
        i. Electron clouds
        ii. The exclusion principle
        iii. Characteristic X-rays
    d. Atomic transitions

         i. Lasers
         ii. Fluorescence
         iii. Phosphorescence
12. Nuclear and subnuclear physics
    a. Properties of nuclei
         i. Charge
         ii. Mass
         iii. Size
         iv. Stability and binding energy
         v. Radioactivity
    b. Radioactive decay processes
         i. Alpha decay
         ii. Beta decay
         iii. Gamma decay
         iv. Practical uses
         v. Natural radioactivity
    c. Nuclear reactions
         i. Nuclear energy
         ii. Fission
         iii. Fusion
    d. (If time permits) Elementary particles
         i. Classification
         ii. Conservation laws
    e. (If time permits) The fundamental forces in nature
         i. Quarks
         ii. The Standard Model
         iii. Relation to cosmology

Laboratory or Activity Content

1. Electrostatics investigations
2. Electric fields and equipotentials
3. Introduction to the oscilloscope
4. Ohm's law
5. Resistances in series and parallel
6. Multiloop circuits: Kirchhoff's rules
7. Electromagnetic induction
8. Reflection and refraction
9. Spherical mirrors and lenses
10. Polarized light
11. Optical instruments: The microscope and the telescope
12. The transmission diffraction grating: Measuring the wavelengths of light
13. Line spectra and the Rydberg constant
14. The mass of an electron: e/m measurement
15. Detection of nuclear radiation: The Geiger counter
16. Radioactive half-life

Methods of Evaluation

Which of these methods will students use to demonstrate proficiency in the subject matter of this course? (Check all that apply):

Problem solving exercises
Written expression

Methods of Evaluation may include, but are not limited to, the following typical classroom assessment techniques/required assignments (check as many as are deemed appropriate):

Computational homework
Essays
Laboratory activities
Laboratory reports
Objective exams

Problem-Solving Assignments
Problem-solving exams
Quizzes

Instructional Methodology

Specify the methods of instruction that may be employed in this course

Computer-aided presentations
Distance Education
Demonstrations
Instructor-guided interpretation and analysis
Laboratory activities
Lecture
Small group activities

Describe specific examples of the methods the instructor will use:

1. Computer aided presentation: The instructor may employ the computer to aid in the presentation of course materials which would include simulations of specific phenomena such as electric field contours due to specific charge distributions.
2. Demonstrations: The instructor will demonstrate physical principles by employing equipment and other items such as a Van de Graaff and Whilmhurst machine to show the effects of a collection of charge.
3. Distance Education (Lecture): When applicable, recordings of lectures will be used to convey subject matter. Also, the use of discussion boards and virtual meetings will be used to allow students to ask questions regarding the course and its material.
4. Distance Education (Lab): Laboratory activities, as noted below, will take place in a virtual setting. The experiments will be tailored to utilize computer simulations, prerecorded data acquisition, live online meetings, and message boards where questions can be asked and answered.
5. Instructor guided analysis: The instructor will work through physics problems during lecture that investigate a given system in which the students will follow along, answering questions posed by the instructor. This will also serve as a forum for students to ask particular questions regarding the logic and methods employed to come to certain conclusions regarding said problem/system.
6. Laboratory activities: Each week the students will perform a laboratory experiment investigating certain aspects of a system that has been discussed in lecture. These experiments will direct the students such that the intricacies of a given system are explored and compared to theoretical expectations.
7. Laboratory activities: Each week the students will perform a laboratory experiment investigating certain aspects of a system that has been discussed in lecture. These experiments will direct the students such that the intricacies of a given system are explored and compared to theoretical expectations. For instance, when studying Ohm's Law, students will construct a resistive DC circuit and make direct measurements of the current through a given resistor and the potential difference across the resistor to verify Ohm's law.
8. Lecture: The instructor will deliver the course subject matter via in person lectures to the students. For example, a lecture on the net electric field due to a distribution of point charges.
9. Small group activities (Lecture): These may be employed in the form of group quizzes where students work together in small groups to solve some physics problems regarding current material.
10. Small group activities (Lab): The students will work in small groups while performing the experiments where applicable.

Representative Course Assignments

Writing Assignments

1. Answers to short explanatory (conceptual) questions from the textbook, often assigned from among those at the end of each chapter or posed by the instructor, generally assigned weekly. A typical question might be "Explain how the capacitance of a parallel plate capacitor changes when either the plate area or the distance between the plates is varied."
2. Laboratory reports, including a brief interpretation of experimental results, answers to conceptual questions from the laboratory manual, and/or a conclusion describing how (or whether) the experimental results supported theoretical principles, typically assigned weekly.

Critical Thinking Assignments

1. Answering a wide array of homework, quiz, and exam questions requiring the analysis of a given physical system or circumstance in order to come to the correct conclusion and/or answer regarding the question and/or desired outcome. For instance, given 5 resistors of 1000 Ohms each and a capacitor of 470 micro Farads, what configuration of the resistors would produce an RC time constant nearest 1.00 seconds and what is the actual time constant of the configuration?

Reading Assignments

1. Regular textbook readings that reinforce the concepts discussed or demonstrated during the class meetings; these readings generally include theory and principles, descriptions of the results of important experiments, data tables, definitions, problem-solving examples, and practical applications of physics in everyday life and in specialized environments.
2. Library and other research needed to complete homework problems and/or prepare talks or reports.

Skills Demonstrations

None

Other assignments (if applicable)

None

Outside Assignments

Representative Outside Assignments

1. Assigned reading from the textbook typically amounting to one chapter a week. This amounts to 2 hours of reading per week.
2. Assigned conceptual and problem solving based homework that further investigates and explores the notions and theories discussed throughout the course. Typically, homework sets will require 6 hours to fully complete and will be due on a weekly basis.
3. Studying and preparing for quizzes and exams.

Articulation

Comparable Courses within the VCCCD

PHYS V03B - General Physics II: Calculus-Based
PHYS V03BL - General Physics II Laboratory: Calculus-Based

District General Education

A. Natural Sciences

B. Social and Behavioral Sciences

C. Humanities

D. Language and Rationality

E. Health and Physical Education/Kinesiology

F. Ethnic Studies/Gender Studies

CSU GE-Breadth

Area A: English Language Communication and Critical Thinking

Area B: Scientific Inquiry and Quantitative Reasoning

Area C: Arts and Humanities

Area D: Social Sciences

Area E: Lifelong Learning and Self-Development

Area F: Ethnic Studies

CSU Graduation Requirement in U.S. History, Constitution and American Ideals:

IGETC

Area 1: English Communication

Area 2A: Mathematical Concepts & Quantitative Reasoning

Area 3: Arts and Humanities

Area 4: Social and Behavioral Sciences

Area 5: Physical and Biological Sciences

Area 6: Languages Other than English (LOTE)

Textbooks and Lab Manuals

Resource Type
Textbook

Description
Serway & Jewett (2016). *Principles of Physics, A Calculus-Based Text* (5th). Boston, Brooks-Cole.

Resource Type
Manual

Description
Miller, J.W. (2020). *Physics Lab Experiments*. Oxnard, Justin Miller

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Resource Type
Other Resource Type

Description
Supplemental handouts on selected topics prepared by the instructor..

Distance Education Addendum

Definitions

Distance Education Modalities
Hybrid (51%–99% online)
Hybrid (1%–50% online)
100% online

Faculty Certifications

Faculty assigned to teach Hybrid or Fully Online sections of this course will receive training in how to satisfy the Federal and state regulations governing regular effective/substantive contact for distance education. The training will include common elements in the district-supported learning management system (LMS), online teaching methods, regular effective/substantive contact, and best practices.
Yes

Faculty assigned to teach Hybrid or Fully Online sections of this course will meet with the EAC Alternate Media Specialist to ensure that the course content meets the required Federal and state accessibility standards for access by students with disabilities. Common areas for discussion include accessibility of PDF files, images, captioning of videos, Power Point presentations, math and scientific notation, and ensuring the use of style mark-up in Word documents.
Yes

Regular Effective/Substantive Contact

Hybrid (1%–50% online) Modality:

Method of Instruction	Document typical activities or assignments for each method of instruction
Other DE (e.g., recorded lectures)	The students will watch recorded lecture videos that go over the pertinent subject matter of the course.
Synchronous Dialog (e.g., online chat)	The students will join live, online meetings in which they will receive instruction, be reminded of all upcoming assignments/events, and be allowed to ask questions pertaining to the lecture and lab material. Recordings will be made available of all live meetings. Students may also be put into small groups to discuss a given class material.
Asynchronous Dialog (e.g., discussion board)	Students will have access to a discussion board in which they can ask questions regarding the course material.
Face to Face (by student request; cannot be required)	Face to face meetings can be arranged when needed.
Other DE (e.g., recorded lectures)	Recordings of data acquisition and/or simulation use regarding a given lab experiment may be used.

Hybrid (51%–99% online) Modality:

Method of Instruction	Document typical activities or assignments for each method of instruction
Other DE (e.g., recorded lectures)	The students will watch recorded lecture videos that go over the pertinent subject matter of the course.
Synchronous Dialog (e.g., online chat)	The students will join live, online meetings in which they will receive instruction, be reminded of all upcoming assignments/events, and be allowed to ask questions pertaining to the lecture and lab material. Recordings will be made available of all live meetings. Students may also be put into small groups to discuss a given class material.
Asynchronous Dialog (e.g., discussion board)	Students will have access to a discussion board in which they can ask questions regarding the course material.
Face to Face (by student request; cannot be required)	Face to face meetings can be arranged when needed.

Other DE (e.g., recorded lectures)	Recordings of data acquisition and/or simulation use regarding a given lab experiment may be used.

100% online Modality:

Method of Instruction	Document typical activities or assignments for each method of instruction
Other DE (e.g., recorded lectures)	The students will watch recorded lecture videos that go over the pertinent subject matter of the course.
Synchronous Dialog (e.g., online chat)	The students will join live, online meetings in which they will receive instruction, be reminded of all upcoming assignments/events, and be allowed to ask questions pertaining to the lecture and lab material. Recordings will be made available of all live meetings. Students may also be put into small groups to discuss a given class material.
Asynchronous Dialog (e.g., discussion board)	Students will have access to a discussion board in which they can ask questions regarding the course material.
Other DE (e.g., recorded lectures)	Recordings of data acquisition and/or simulation use regarding a given lab experiment may be used.

Examinations

Hybrid (1%–50% online) Modality

Online
On campus

Hybrid (51%–99% online) Modality

Online
On campus

Primary Minimum Qualification

PHYSICS/ASTRONOMY

Review and Approval Dates

Department Chair

09/02/2020

Dean

09/02/2020

Technical Review

09/23/2020

Curriculum Committee

09/23/2020

Curriculum Committee

11/25/2020

CCCCO

MM/DD/YYYY

Control Number

CCC000174077

DOE/accreditation approval date

MM/DD/YYYY