# COURSE OUTLINE

## OXNARD COLLEGE

I. Course Identification and Justification:

A. Proposed course id: PHYS R132
Banner title: Science/Engineering Physics 2
Full title: Physics for Scientists and Engineers 2

Previous course id: PHYS R132
Banner title: Science/Engineering Physics 2
Full title: Physics for Scientists and Engineers 2

B. Reason(s) course is offered:
This course and its prequel and sequel, PHYS R131 and PHYS R133, are aimed at students planning to major in physical sciences, engineering, mathematics, computer science, or similar technical majors; the sequence formed by these courses is thus the deepest and most rigorous of the three physics sequences that Oxnard College offers, and is the only one of the three that should be considered a “majors” sequence. Virtually all universities offering undergraduate majors in physics or engineering have a comparable sequence for their freshmen and sophomores. The goal of the sequence is to provide students contemplating technical majors with analytical and conceptual skills that relate to the behavior of physical systems and are needed to succeed in upper-division course work (or beyond). Like the PHYS R121/R122 sequence, this sequence is calculus based; however, its focus is directed at imparting a deep understanding of fundamental physical theory, rather than concentrating on applications of physical theory to the life sciences. Also, this course is required for the TMC in Physics for the CSU system (C-ID Descriptor for this course is PHYSICS 210).

C. Reason(s) for current outline revision:
Course Modification

II. Catalog Information:

A. Units:
*Current:* 5.00
*Previous:* 5.00

B. Course Hours:
1. In-Class Contact Hours:
   Lecture: 70 Activity: 0 Lab: 52.5
2. Total In-Class Contact Hours: 122.5
3. Total Outside-of-Class Hours: 140
4. Total Student Learning Hours: 262.5

C. Prerequisites, Corequisites, Advisories, and Limitations on Enrollment:
1. Prerequisites
   *Current:*
   PHYS R131: Physics for Scientists and Engineers 1 and
   MATH R121: Calculus with Analytic Geometry II
2.
   *Previous:*
   PHYS R131: Physics for Scientists and Engineers 1 and
   MATH R121: Calculus with Analytic Geometry II

3. Corequisites
   *Current:*
   *Previous:*

4. Advisories:
   *Current:*
   *Previous:*

5. Limitations on Enrollment:
   *Current:*
   *Previous:*

D. Catalog description:
*Current:*
A continuation of PHYS R131, this course is an introduction to electricity and magnetism along with thermodynamics, with emphasis on understanding field theory, the behavior of simple electrical circuits, heat exchange, the laws of thermodynamics and thermodynamic processes. Central topics include gravitational, electric, and magnetic fields; the laws of Coulomb, Gauss, Ohm, Kirchhoff, Ampere, Biot-Savart, and Faraday; simple circuit analysis; Maxwell equations; heat, entropy, thermodynamic processes, and the thermodynamic laws. Although the course emphasizes conceptual understanding, students also learn to apply mathematical techniques such as vector algebra, vector differentiation and integration, binomial approximations, and linear differential equations to the solution of problems. The laboratory provides students with opportunities to learn and apply the scientific method through investigations of the phenomena discussed in lecture. The course is appropriate for students majoring in the physical sciences, engineering, mathematics, computer science, and related fields.

*Previous, if different:*
A continuation of PHYS R131, this course is an introduction to electricity and magnetism, with emphasis on understanding field theory and the behavior of simple electrical circuits. Central topics include gravitational, electric, and magnetic fields; the laws of Coulomb, Gauss, Ohm, Kirchhoff, Ampere, Biot-Savart, and Faraday; simple circuit analysis; and the Maxwell equations. Although the course emphasizes conceptual understanding, students also learn to apply mathematical techniques such as vector algebra, vector differentiation and integration, binomial approximations, and linear differential equations to the solution of problems. The laboratory provides students with opportunities to learn and apply the scientific method through investigations of the phenomena discussed in lecture. The course is appropriate for students majoring in the physical sciences, engineering, mathematics, computer science, and related fields.

III. Course Objectives:
Upon successful completion of this course, the student should be able to:

A. Draw a diagram or cartoon that clearly and usefully depicts the salient features and characteristics of electromagnetic and thermodynamic systems, 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.
B. Analyze simple thermodynamic and electromagnetic systems to identify applicable principles (e.g., conservation laws) that may be used to predict the future behavior or evolution of the system.

C. Solve conceptual and numerical problems related to the behavior or evolution of a thermodynamic or electromagnetic system by applying those principles identified above.
D. Employ appropriate mathematical tools, up to and including vector differentiation and integration, binomial approximations, and linear differential equations, to solve a variety of equations encountered in the study of physics, including geometric/graphical approaches, approximation techniques, and/or numerical methods.
E. Argue for or against a scientific hypothesis, supporting his/her conclusions by describing how various physical principles might apply to a novel situation.
F. Identify the names and major contributions of notable historical and present-day physicists whose work has expanded humankind's understanding of electromagnetic and thermodynamic systems.

IV. Course Content:

Topics to be covered include, but are not limited to:

Lecture topics:

A. Electrostatics
    1. Coulomb's law
    2. Electric field E near point, sphere, line, and surface charges
    3. Gauss's law, electric flux, calculation of electric fields using Gauss's law
    4. Lines of force
    5. Integration methods for computing the electric field
B. Electric potential
    1. Definition of electric potential
    2. Integration methods for computing the electric potential
    3. Use of the gradient to obtain the electric field from the potential
C. Capacitance
    1. Definition of capacitance
    2. Dielectrics
        a. Polarization
        b. Gauss's law as applied to dielectrics
    3. Capacitor circuits
D. Electric current, resistance, and DC circuits
    1. Definitions of current, resistance, and resistivity
    2. Ohm's law and electric power
    3. DC circuits and Kirchhoff's laws
        a. Multiloop circuits
        b. RC circuits
E. Magnetic fields and forces
    1. Definitions of magnetic field and magnetic flux
    2. Motion of charged particles in magnetic fields and comparison with motion in electric fields
F. Sources of the magnetic field
    1. Calculating the magnetic field for simple geometries
        a. Ampere's law
        b. The Biot-Savart law
    2. Magnetic force between current-carrying conductors
G. Electromagnetic induction and inductance
    1. Faraday's law
    2. Lenz's law

        3. Inductance, self-inductance, and back-EMF
        4. (Optional) Diamagnetic, paramagnetic, and ferromagnetic materials
    H. Electromagnetic oscillations and AC circuits
        1. LC circuits
        2. RLC circuits
            a. Damped and driven
            b. Resonance and power
    I. The Maxwell equations and electromagnetic waves
        1. The Ampere-Maxwell law and displacement current
        2. The Maxwell equations
        3. Production of electromagnetic waves by accelerating charges
        4. The electromagnetic spectrum
        5. The Poynting vector and intensity
        6. Radiation force and pressure
        7. Light
            a. Speed measurements
            b. Doppler effect
    J. Thermal physics
        1. Heat vs. temperature
        2. Thermal expansion of matter
        3. Heat, work, and thermal conduction
        4. Kinetic theory of gases
        5. Thermodynamic processes
        6. Heat engines
            a. The Carnot cycle
            b. Entropy
        7. The laws of thermodynamics

V. Lab Content:

Labs will include detailed investigations of typical physical systems. Written reports for the labs will include explanations of the theory, the set-up, the procedure, data and observations, graphs, and conclusions based on the results.

Laboratory topics (typical):

    A. Electrostatics investigations
    B. Visualizing fields
    C. Electric field mapping and equipotentials
    D. The voltmeter, ammeter, and multimeter
    E. Ohm's law
    F. Resistances in series and parallel
    G. Multiloop circuits: Kirchhoff's rules
    H. The RC time constant
    I. Electromagnetic induction
    J. Electric motors and generators
    K. Measurement of e: Millikan experiment
    L. Introduction to the oscilloscope
    M. Phase measurements and resonance in AC circuits
    N. The thermal coefficient of linear expansion
    O. Specific heat

VI. Methods of Instruction:

Methods may include, but are not limited to:

A. Discussing basic physical principles and theory, and the theorists who discovered or proposed them.
B. Discussing problem-solving techniques, including preparation of diagrams, modeling of physical systems, and setting up and solving equations.
C. Questioning students and encouraging them to predict the outcomes of hypothetical and actual experiments.
D. Discussing the results of pivotal experiments that shaped the history of physics, including information about the experimenters themselves.
E. Exhibiting demonstrations to reinforce students' conceptual understanding, including hands-on class participation exercises when feasible.
F. Deriving important theoretical results from first principles.
G. Introducing new mathematical techniques as needed to solve certain classes of problems, including but not limited to appropriate use of electronic calculators or computers for complex numerical computations.
H. Solving example problems and discussing questions that arise from the homework exercises.

VII. Methods of Evaluation and Assignments:

A. Methods of evaluation for degree-applicable courses:
   Essays [X]
   Problem-Solving Assignments (Examples: Math-like problems, diagnosis & repair) [X]
   Physical Skills Demonstrations (Examples: Performing arts, equipment operation) [ ]

   For any course, if "Essays" above is not checked, explain why.

B. Typical graded assignments (methods of evaluation):
   1. Homework exercises, assigned approximately weekly, that include both explanatory (conceptual) and computational questions, that require students to use a variety of techniques to complete, including diagramming, modeling, application of physical intuition, problem-solving, and/or appropriate mathematical methods, and which may be evaluated on the basis of students' mastery of physical concepts and use of appropriate computational methods
   2. Additional homework exercises asking the student to support or refute claims of observed phenomena related to principles covered during the course, evaluated on the basis of students' abilities to develop and follow physical arguments or valid lines of physical reasoning, and then to formulate reasonable conclusions therefrom
   3. Periodic examinations that mirror the homework exercises described above, insofar as they may contain both conceptual (short-essay answer format) and computational questions; answers may be evaluated on the basis of students' demonstrated understanding of concepts, use of appropriate physical and mathematical techniques, and computational accuracy
   4. Short talks summarizing additional in-depth research that students have performed on a topic of interest to them, or on the life of a historical figure in physics
   5. (Optional, at instructor's discretion) Participation in volunteer activities that benefit the campus or community, possibly including a short written report describing the student's participation in these activities

C. Typical outside of classroom assignments:

1. Reading
   a. Selections from the textbook, typically requiring at least one to two hours per week of study, that apply to current course topics; the breadth of a weekly reading might encompass topic titles such as “The Electric Field”, “Current and Resistance”, or “Heat and the First Law of Thermodynamics”
   b. Selections from the laboratory manual describing the theory and experimental methods applicable to the current week’s experiment
   c. Occasional supplemental handouts, provided by the instructor, that provide additional information, insight on important topics, or practice/review exercises that may not be available in the textbook; sample titles might include “Electric Fields, Forces, Potentials, and Capacitance” or “Summary of Series AC Circuit Parameters”
   d. Journal articles (typically, one or two library and/or Internet research assignments during the semester); for example, students might be asked to read the article:
      i. Jefimenko, Oleg, and David K. Walker. “Electrostatic Motors.” Phys. Teach. 9 (1971): 121.
2. Writing
   a. 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, typically assigned weekly; a typical question might be “An electric dipole is placed at rest in a uniform external electric field and released. Discuss its subsequent motion.”
   b. 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
   c. Answers to questions relating to journal articles read
3. Other
   a. Calculating answers to computational questions from the textbook, often assigned from among those at the end of each chapter or posed by the instructor, typically assigned weekly; a sample of such a question might be “A charge q is distributed uniformly throughout a spherical volume of radius R. Setting V = 0 at infinity, find the potential at a distance r from the center of the sphere, where r < R.”
   b. Using a computer to assist with the analysis of data obtained from the laboratory experiments
   c. Preparing for brief oral class presentation on a topic related to physics (often provided as an extra credit assig

VIII. Textbooks and Instructional Materials:

A. Textbooks/Resources:

1. Serway, R.A., and Jewett, J.W. (2014). Physics for Scientists and Engineers with Modern Physics (9th/e). Belmont, CA Brooks/Cole.
2. Wilson, J.D., and Hernandez, C.A. (2014). Physics Laboratory Experiments (8th/e). Boston Brooks/Cole.

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

B. Other Instructional Materials:

IX. Minimum Qualifications And Additional Certifications:

A. Minimum Qualifications:

1. Physics/Astronomy (Masters Required)

B. Additional Certifications:

1. Description of certification requirement:
2. Name of statute, regulation, or licensing/certification organization requiring this certification:

X. Approval Dates

CC Approval Date: 10/28/2015
Board Approval Date: 10/28/2015
Course ID: 1787