College of San Mateo
Official Course Outline

1. **COURSE ID:** PHYS 220 **TITLE:** General Physics II **C-ID:** PHYS 110, PHYS 100S (PHYS 210 & PHYS 220)
   Units: 4.0 units **Hours/Semester:** 48.0-54.0 Lecture hours; 48.0-54.0 Lab hours; and 96.0-108.0 Homework hours
   Method of Grading: Letter Grade Only
   Prerequisite: PHYS 210

2. **COURSE DESIGNATION:**
   Degree Credit
   Transfer credit: CSU; UC
   AA/AS Degree Requirements:
   CSM - GENERAL EDUCATION REQUIREMENTS: E5a. Natural Science
   CSU GE:
   CSU GE Area B: SCIENTIFIC INQUIRY AND QUANTITATIVE REASONING: B1 - Physical Science
   CSU GE Area B: SCIENTIFIC INQUIRY AND QUANTITATIVE REASONING: B3 - Laboratory Activity
   IGETC:
   IGETC Area 5: PHYSICAL AND BIOLOGICAL SCIENCES: A: Physical Science
   IGETC Area 5: PHYSICAL AND BIOLOGICAL SCIENCES: C: Science Laboratory

3. **COURSE DESCRIPTIONS:**
   Catalog Description:
   Second semester of a two-semester sequence for students majoring in biological and other non-physical sciences. Topics covered include electricity and magnetism, light, and modern physics.

4. **STUDENT LEARNING OUTCOME(S) (SLO'S):**
   Upon successful completion of this course, a student will meet the following outcomes:
   1. Identify problems involving electric and/or magnetic fields and forces and correctly solve them.
   2. Analyze DC Circuits.
   3. Identify problems that should be solved using concepts of geometric and physical optics and correctly solve them. This includes but is not limited to image formation and interference problems.
   4. Identify problems involving quantization of energy and correctly solve them. This includes but is not limited to the photoelectric effect and energy levels in atoms.
   5. Identify problems involving the structure of the atom and the nucleus and correctly solve them. This includes but is not limited to the quantum-mechanical view of atoms and nuclear binding energy and radioactivity.
   6. Collect and analyze data to verify physics principles.

5. **SPECIFIC INSTRUCTIONAL OBJECTIVES:**
   Upon successful completion of this course, a student will be able to:
   Content-specific objectives: Upon completion of this course, students will have a working knowledge of the skills and concepts listed in the course outline. For example, they will be able to:
   1. Identify problems involving electric and/or magnetic fields and forces and correctly solve them
   2. Analyze DC circuits.
   3. Identify problems that should be solved using concepts of geometric and physical optics and correctly solve them. This includes but is not limited to image formation and interference problems.
   4. Identify problems involving quantization of energy and correctly solve them. This includes but is not limited to the photoelectric effect and energy levels in atoms.
   5. Identify problems involving the structure of the atom and the nucleus and correctly solve them. This includes but is not limited to the quantum-mechanical view of atoms and nuclear binding energy and radioactivity.
   6. Collect and analyze data to verify physics principles

   General objectives: Upon completion of this course, the student will be better able to:
   1. Recognize some of the fundamental laws of nature and express them in mathematical form.
   2. Apply the laws of nature to the solution of problems. State the range of validity of each law, express the relevant law(s) in mathematical form appropriate to the specific problem, and solve the resultant

equation(s) for the unknown quantity or quantities.
3. Use the language and notation of physics correctly. Communicate explanations of physical phenomena in writing.
4. Demonstrate good problem-solving habits, including: 1) organizing given information and determining which physical principles apply to the problem. 2) considering a variety of approaches to a given problem, and selecting one that is appropriate. 3) estimating solutions and recognizing unreasonable results. 4) interpreting solutions correctly, and answering the questions that were actually asked.
5. Develop skill in laboratory procedure. Explain the purpose of each experiment, correctly use laboratory equipment, record data with proper attention to units and significant figures. Analyze data and draw conclusions. Write clear and concise lab reports.

6. **COURSE CONTENT:**

Lecture Content:

Italicized topics are optional.
Typical hours listed for topics below.

1. **Electric Charge and Electric Field   3 to 5 lecture hours**
Electric charge and its conservation; insulators and conductors; induced charge; Coulomb's Law; electric field; field lines; electric fields and conductors, *Gauss's Law*.

2. **Electric Potential and Electric Energy; Capacitance   3 to 5 lecture hours**
Electric potential and potential difference; relation between electric potential and electric field; equipotential lines; the electron-volt, a unit of energy; electric potential due to point charges; electric dipoles; capacitance; dielectrics; storage of electric energy; *cathode ray tube; the electrocardiogram*.

3. **Electric Currents   3 to 5 lecture hours**
The electric battery; electric current; Ohm's law; resistance and resistors; resistivity; *superconductivity*; electric power; power in household circuits; alternating current; microscopic view of electric current; *the nervous system and nerve conduction*.

4. **DC Circuits   3 to 5 lecture hours**
Resistors in series and parallel; EMF and terminal voltage; Kirchhoff's rules; EMFs in series and parallel; capacitors in series and parallel; *heart pacemakers; electric hazards*; DC ammeters and voltmeters; effects of meter resistance.

5. **Magnetism   3 to 5 lecture hours**
Magnets and magnetic fields; electric currents produce magnetism; force on an electric current in a magnetic field; force on an electric charge moving in a magnetic field; magnetic field due to a straights wire; force between two parallel wires; definition of the ampere and the coulomb; Ampere's Law; torque on a current loop; magnetic moment; applications; galvanometers, motors, loudspeakers; *the Hall effect*; mass spectrometer; ferromagnetism; electromagnets and solenoids; magnetic fields in magnetic materials.

6. **Electromagnetic Induction, Faraday's Law, AC Circuits   3 to 5 lecture hours**
Induced EMF; Faraday's Law of induction; Lenz's law; EMF induced in a moving conductor; changing magnetic flux produces and electric field; electric generators; counter EMF and torque; eddy currents; transformers; applications of induction; inductance; energy stored in a magnetic field; *LR circuit; LRC series AC circuit; resonance in AC circuits; impedance matching*.

7. **Electromagnetic Waves   1 to 3 lecture hours**
Changing electric fields produce magnetic fields; Maxwell's equations; displacement current; production of electromagnetic waves; light as an electromagnetic wave and the electromagnetic spectrum; *measuring the speed of light; calculation of the speed of electromagnetic waves*; energy in EM waves.

8. **Light: Geometric Optics   4 to 6 lecture hours**
The ray model of light; reflection: image formation by a plane mirror; formation of images by spherical mirrors; index of refraction; Snell's Law; total internal reflection; thin lenses; ray tracing; the lens equation; problem solving for lenses; problem solving for combinations of lenses; the lensmakers; equation.

9. **The Wave Nature of Light   3 to 5 lecture hours**
Waves versus particles; Huygens' principle; interference: Young's double-slit experiment; the visible spectrum and dispersion; diffraction by a single slit or disk; diffraction grating; the spectrometer and

spectroscopy; interference by thin films; Michelson interferometer; polarization; *scattering of light by the atmosphere*.

10. **Optical Instruments 1 to 3 lecture hours**
    The camera; the human eye and corrective lenses; the magnifying glass; telescopes; aberrations of lenses and mirrors; limits of resolution: the Rayleigh criterion; resolution of telescopes and microscopes; resolution of the human eye;*specialty microscopes and contrast; X-rays and X-ray diffraction; X-ray imaging and computerized axial tomography (CAT scan).*

11. **Special Theory of Relativity 1 to 3 lecture hours**
    Postulates of the special theory of relativity; simultaneity; time dilation and the twin paradox; length contraction; four-dimensional space-time; momentum and mass; the ultimate speed; mass and energy; relativistic addition of velocities; the impact of special relativity.

12. **Early Quantum Theory and Models of the Atom 3 to 5 lecture hours**
    Discovery and properties of the electron; Planck's quantum hypothesis; photon theory of light and the photoelectric effect; photon interactions: Compton effect and pair production; wave-particle duality: the principle of complementarity; wave nature of matter; electron microscopes; early models of the atom; atomic spectra; the Bohr model; de Broglie's hypothesis applied to atoms.

13. **Quantum Mechanics of Atoms 2 to 4 lecture hours**
    Quantum mechanics-a new theory; the wave function and its interpretation: the double-slit experiment; the Heisenberg uncertainty principle; philosophical implications: probability versus determinism; quantum mechanical view of atoms; quantum mechanics of the hydrogen atom; complex atoms and the exclusion principle; the periodic table of the elements; X-ray spectra and atomic number; *fluorescence and phosphorescence; lasers; holography.*

14. **Nuclear Physics and Radioactivity 2 to 3 lecture hours**
    Structure and properties of the nucleus; binding energy and nuclear forces; radioactivity; alpha decay; beta decay; gamma decay; conservation of nucleon number and other conservation laws; half-life and rate of decay; decay series; radioactive dating; stability and tunneling; detection of radiation.

15. **Nuclear Energy: Effects and Uses of Radiation 2 to 3 lecture hours**
    Nuclear reactions and the transmutation of elements; nuclear fission; fusion; passage of radiation through matter; radiation damage; measurement of radiation; radiation therapy; tracers and imaging in research and medicine; *emission topography;* nuclear magnetic resonance and magnetic resonance imaging.

Lab Content:

The following is a list of the experiments in the current Physics 220 Laboratory Manual, CSM Physics Department. Students typically complete between 8 and 14 experiments per semester.

1. Coulomb's Law
2. Electric Field Plotting
3. Capacitance
4. Ohm's Law and Circuits
5. The Joule Constant
6. Kirchhoff s Rules
7. The Wheatstone Bridge
8. The Potentiometer
9. The RC Series Circuit
10. Magnetic Field Plotting
11. The Ratio of Charge to Mass for the Electron
12. The Current Balance
13. A Qualitative Study of Induced EMF
14. Ray Tracing
15. Thin Lenses
16. Newton's Rings
17. Interference Using Microwaves
18. The Photoelectric Effect
19. The Balmer Series of Hydrogen

7. **REPRESENTATIVE METHODS OF INSTRUCTION:**

Typical methods of instruction may include:
A. Lecture
B. Lab
C. Discussion
D. Experiments
E. Other (Specify): 1. Lecture: Introduce and explain the concepts, define the appropriate terms, provide examples and solve problems to illustrate the application of the concepts. 2. Demonstrations: Use physical demonstrations to reinforce the understanding of the physical concepts 3. Collaborative learning: Guided discussions and in class exercises, which lead to clarification of the concepts and sharpen the problem solving skills. 4. Homework assignments: Outside of classroom problem solving which helps further students understanding of concepts, including the range of validity, and develops their ability to apply the concepts. 5. Laboratory work: Group and individual work to investigate physical principles; observe, record, and analyze the results of experiments, which deepens the understanding of concepts introduced during in lecture.

8. **REPRESENTATIVE ASSIGNMENTS**
Representative assignments in this course may include, but are not limited to the following:
Writing Assignments:
Students complete written laboratory reports in which they analyze the results of experiments performed in the lab. This analysis requires critical thinking and requires students to connect lecture topics to the experiments performed. These assignments also require students to effectively communicate their ideas in writing.
Reading Assignments:
Reading the textbook prior to lectures to become familiar with the topics to be presented. Reading the textbook after lectures to review the key points and concepts.
Other Outside Assignments:
Solving textbook (or similar) problems after each lecture. Problems are of varying difficulty and are completed by students to help further their understanding of the concepts and to learn how physics formulas and mathematics are used to apply the concepts to specific situations.

The problems require critical thinking to determine what principles apply to the problem and may require mathematical techniques involving algebra and trigonometry.

9. **REPRESENTATIVE METHODS OF EVALUATION**
Representative methods of evaluation may include:
A. Class Participation
B. Exams/Tests
C. Homework
D. Lab Activities
E. Quizzes
F. 1. Tests are designed to assess students' conceptual understanding of the material as well as their problem solving skills, logical reasoning, and analytical thinking. 2. Lab reports assess students' methods, careful recording of observations and data measurements, correctness of calculations, and critical thinking to clearly evaluate conclusions. Furthermore, these reports evaluate students' ability to communicate their results in clear writing. 3. Out-of-class homework assignments are an important tool in student learning. Homework assignments allow students to receive feedback from instructors on their understanding of the material before they are required to demonstrate their understanding on the exams.

10. **REPRESENTATIVE TEXT(S):**
Possible textbooks include:
A. Cutnell, J. D. Johnson, K. W. Young, D. Slater, S.. *Physics*, 10th ed. Wiley, 2014
B. Giancoli, D. C.. *Physics, Principles with Applications*, 7th ed. Prentice Hall, 2014
Other:
A. CSM Physics Department, Physics 220 Lab Manual, CSM

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