TAFT COLLEGE
West Kern Community College District

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Physics (PHYS) 2221 General Physics (Calculus) (4 Units) CSU:UC
[formerly Physics 4A]

Prerequisite: Successful completion of Mathematics 2100 with a grade of "C" or higher or concurrent enrollment in Mathematics 2100

Advisory: A year of high school physics or a prep course is recommended. Completion of 1 semester of calculus and concurrent enrollment in second semester calculus is highly recommended.

Prerequisite knowledge/skills: Before entering the course the student should be able to

1. understand the use of functional notation;
2. plot and interpret graphs of functions;
3. differentiate algebraic, trigonometric, exponential, logarithmic and hyperbolic functions,
4. apply derivatives;
5. find the integrals of basic functions (this topic is continued in Math 3B);
6. Complete items 1-5 above by both hand computations and computer assisted (Maple) Compute the limit of a function at a real number;
7. Determine if a function is continuous at a real number;
8. Find the derivative of a function as a limit;
9. Find the equation of a tangent line to a function;
10. Compute derivatives using differentiation formulas;
11. Use differentiation to solve applications such as related rate problems and optimization problems;
12. Use implicit differentiation;
13. Graph functions using methods of calculus;
14. Evaluate a definite integral as a limit;
15. Evaluate integrals using the Fundamental Theorem of Calculus; and
16. Use the definite integral to find areas and volumes.

Total Hours: 48 hours lecture; 48 hours lab (96 hours total)

Catalog Description: Demonstration lectures, problems, and laboratory work in the fundamentals of mechanics, properties of matter, wave and simple harmonic motion, including problems in forces, motion, energy, and gravitation are covered in this course which is designed for chemistry, physics, and engineering students. C-ID: PHYS 205

Type of Class/Course: Degree Credit

Texts: Young, Hugh and Roger Freedman. *University Physics with Modern Physics, Technology Update, Books a la Carte Plus Mastering Physics with eText*. 14th ed. Boston: Addison-Wesley, 2016. Print.

Lab Manual: Sokoloff, David R., Ronald K. Thorton and Priscilla W. Laws *Real Time Physics Active Learning*

Laboratories Module 1 Mechanics . 2nd ed. Danvers: John Wiley & Sons, 2011. Print.

Additional Materials: Scientific calculator required

Course Objectives:

By the end of the course, a successful student should be able to:

1. Apply the laws and principles of classical mechanics and statics to the analysis and solution of problems of force, linear and rotational motion under the action of forces and torques, motion in a plane under gravitational force, elastic and inelastic collisions, static equilibrium, work and energy under conservative and non-conservative forces, periodic motion, fluids, wave motion and vibrating bodies,
2. Predict the future trajectory of an object moving in two dimensions with uniform acceleration,
3. Analyze a physical situation with multiple constant forces acting on a point mass using Newtonian mechanics,
4. Analyze a physical situation with multiple forces acting on a point mass or extended object using concepts of work and energy,
5. Apply the concepts and techniques of calculus learned in a concurrent or prior calculus course, or presented in the physics course, to problems requiring them,
6. Analyze complex problems, each of which requires the identification of multiple applicablephysical concepts and their use in an appropriate manner and sequence,
7. Perform experiments in a reasonable manner, and prepare adequate experimental reports presenting the numerical results and analyzing the sources and significance of errors, and
8. Analyze real-world experimental data, including appropriate use of error propagation, units and significant figures,
9. List and discuss objectives of any experiment, the type of measurements made, why they were made, and how they entered into the determination of the desired result, and
10. Relate the results of experimental data to the physical concepts discussed in the lecture portion of the class.

Course Scope and Content:

Unit I — Units and Physical Quantities
- A. Standards of Length, Mass, and Time
- B. Dimensional Analysis

Unit II — Motion in One Dimension
- A. Position, Velocity, and Speed
- B. Acceleration

Unit III — Vectors
- A. Coordinate Systems
- B. Vector and Scalar Quantities

Unit IV — Motion in Two Dimensions
- A. Two Dimensional Motion with Constant Acceleration
- B. Projectile Motion

Unit V — The Laws of Motion
- A. The Concept of Force
- B. Newton's Laws

Unit VI Circular Motion
- A. Uniform Circular Motion
- B. Non-Uniform Circular Motion

Unit VII Energy of a System
- A. Systems and Environments
- B. Work-Kinetic Energy Theorem

Unit VIII Conservation of Energy
- A. Non-Isolated System Model
- B. Isolated System Model

Unit IX Linear Momentum and Collisions
- A. Linear Momentum
- B. Collisions in One and Two Dimensions

Unit X Rotation of Rigid Objects
- A. Rotational Kinetic Energy
- B. Moments of Inertia

Unit XI Angular Momentum
- A. Vector Product and Torque
- B. Angular Momentum of Rigid Objects

Unit XII Static Equilibrium and Elasticity
- A. Center of Gravity
- B. Elastic Properties of Solids

Unit XIII Universal Gravitation
- A. Newton's Law of Universal Gravitation
- B. The Gravitational Field

Unit XIV Fluid Mechanics
- A. Variation of Pressure
- B. Fluid Dynamics

Unit XV Oscillatory Motion
- A. Motion of Objects Attached to Springs
- B. Energy of the Simple Harmonic Oscillator

Unit XVI Wave Motion
- A. Propagation of a Disturbance
- B. Linear Wave Equation

Unit XVII Sound Waves
- A. Pressure Variations in Sound Waves
- B. Speed of Sound Waves

Unit XVIII Superposition and Standing Waves
- A. Wave Interference

B. Standing Waves

Lab Scope and Content:

Unit I Dimensional Analysis
- A. Conversion of Units
- B. Significant Figures

Unit II Introduction to Motion
- A. Motion Diagrams
- B. Using Statistics to Find Average Velocity

Unit III Changing Motion and Vectors
- A. Acceleration and Velocity Relationship
- B. Acceleration

Unit IV Force and Motion
- A. Force Measurement
- B. Newton's Second Law

Unit IV Two-Dimensional Motion
- A. Projectile Motion
- B. Motion in a Plane

Unit V Applications of Newton's Laws
- A. Combined Forces
- B. Circular Motion

Unit VI Work and Energy
- A. Work and Force Relationship
- B. Work-Energy Principle

Unit VII Energy in Systems
- A. Static and Kinetic Friction
- B. Power

Unit VIII One Dimensional Collisions
- A. Force and Time
- B. Impulse and Momentum Relationship

Unit IX Energy of Rotating Systems
- A. Angular Momentum
- B. Motion of Gyroscopes and Tops

Unit X Static Equilibrium
- A. Center of Gravity
- B. Rigid Objects

Unit XI Gravity
- A. Mass and Gravity Relationship
- B. Universal Law of Gravitation

Unit XII Fluid Mechanics
- A. Archimedes' Principle
- B. Bernoulli's Equation

Unit XIII Oscillatory Motion
- A. Mass-Spring System
- B. Damped Oscillations

Unit XIV Wave Motion
- A. Speed of Waves on Strings
- B. Reflection and Transmission

Unit XV Sound Waves
- A. Speed of Sound
- B. Doppler Effect

Learning Activities Required Outside of Class:

The students in this class will spend a minimum of 6 hours per week outside of the regular class time doing the following:

1. Studying
2. Completing required reading
3. Problem solving activity or exercise
4. Written work

Methods of Instruction:

1. Lectures, demonstrations, class discussions, and sample problems solved by the instructor with student involvement to illustrate the application of physical principles.
2. Laboratory experiments performed by the students. Written reports will by required on some but not all experiments. The principal objectives of the laboratory work are the demonstration of fundamental physical phenomena and the development of physical intuition based on hands-on experience with equipment in exploring these physical phenomena. High accuracy of measurements and development of sophisticated laboratory techniques are not emphasized, but the crucial role of experimental inquiry in the development of physical theory and in the refinement of our knowledge of physical constants and the behavior and properties of matter necessary as a foundation for technological progress are stressed.
3. Problem solving sessions under the direction of the instructor using whatever portion of laboratory time remains after performance of the experiments.
4. In both lecture and laboratory, emphasis will be placed on the development of an understanding of physical principles, and on the development of the thinking skills necessary to analyze increasingly complex problems and select an appropriate set and sequence of physical principles to solve them.
5. Maximum use will be made, where appropriate, of the students' developing mathematical capabilities to increase the generality and transparency of the physical presentations. This will include, where essential, the heuristic introduction of certain mathematical techniques in advance of their treatment in the calculus course sequence. Extensive use of vector notation is an example.

Methods of Evaluation:

1. Substantial writing assignments, including:

a. laboratory reports
b. brief expositions as part of exams

2. Computational or non-computational problem-solving demonstrations, including:
   a. exams
   b. homework problems
   c. laboratory reports
   d. class discussions

Laboratory Category: Extensive Laboratory

Pre delivery criteria: All of the following criteria are met by this lab.
1. Curriculum development for each lab.
2. Published schedule of individual laboratory activities.
3. Published laboratory activity objectives.
4. Published methods of evaluation.
5. Supervision of equipment maintenance, laboratory setup, and acquisition of lab materials and supplies.

During laboratory activity of the laboratory: All of the following criteria are met by this lab.
1. Instructor is physically present in lab when students are performing lab activities.
2. Instructor is responsible for active facilitation of laboratory learning.
3. Instructor is responsible for active delivery of curriculum.
4. Instructor is required for safety and mentoring of lab activities.
5. Instructor is responsible for presentation of significant evaluation.

Post laboratory activity of the laboratory: All of the following criteria are met by this lab.
1. Instructor is responsible for personal evaluation of significant student outcomes (lab exercises, exams, practicals, notebooks, portfolios, etc.) that become a component of the student grade that cover the majority of lab exercises performed during the course.
2. Instructor is responsible for supervision of laboratory clean up of equipment and materials.