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Course Outline for PHYS 8A

GENERAL PHYSICS

Effective: Fall 2010

I. CATALOG DESCRIPTION:
PHYS 8A — GENERAL PHYSICS — 5.00 units

Introduction to the principles of Newtonian Mechanics and analytical methods of physics using calculus as needed. Vectors, kinematics, dynamics, energy, momentum, rotation. gravitation and fluid mechanics.

4.00 Units Lecture 1.00 Units Lab

Prerequisite
MATH 1 - Calculus I
with a minimum grade of C

Grading Methods:
Letter Grade

Discipline:

	MIN
Lecture Hours:	72.00
Lab Hours:	54.00
Total Hours:	126.00

II. NUMBER OF TIMES COURSE MAY BE TAKEN FOR CREDIT: 1

III. PREREQUISITE AND/OR ADVISORY SKILLS:

Before entering the course a student should be able to:

A. MATH1
1. Determine whether a function is continuous at a point or an interval;
2. Find and interpret average and instantaneous rates of change;
3. State the definition of the derivative as the limit of a difference quotient and use the definition to find the derivative of a function;
4. Interpret the derivative as the slope of a tangent line and find the equation of a tangent line to a function;
5. Explain the definitions of velocity and acceleration and use the derivative to find the velocity and acceleration of an object in motion, given the position function for the object;
6. State and apply the rules for differentiating algebraic, trigonometric, inverse, exponential and logarithmic functions;
7. Utilize the chain rule when differentiating functions;
8. Work with differentials and their applications;
9. Use calculus-based methods to analyze functional behavior;
10. Sketch the graphs of algebraic, rational and transcendental functions using the methods of calculus;
11. Find all maxima, minima and points of inflection of a function;
12. Use implicit differentiation;
13. Evaluate the limit of a function at infinity;
14. Apply differentiation to solve related rate and optimization problems;
15. Apply the Mean Value Theorem;
16. Utilize Newton's Method;
17. Evaluate a definite integral as the limit of a Riemann sum;
18. Apply the Fundamental Theorem of Integral Calculus;
19. Evaluate integrals by the method of substitution;
20. Find areas between curves and volumes of solids of revolution;
21. Use logarithmic differentiation.

IV. MEASURABLE OBJECTIVES:

Upon completion of this course, the student should be able to:

A. analyze and solve a variety of problems often using calculus in topics such as:
1. Addition, subtraction, dot product and cross product of vectors
2. Linear and rotational kinematics
3. Dynamics
4. Momentum
5. Work, kinetic energy

6. Potential energy and energy conservation
7. Collisions in one- and two-dimensions
8. Rotational kinematics and dynamics
9. Static equilibrium
10. Universal gravitation
11. Fluid dynamics.

B. operate standard laboratory equipment, including computer based data acquisition systems; such as:
1. Universal Laboratory interface (ULI) and/or LabPro data collection interface
2. Logger Pro (computer-based data acquisition program by Vernier)
3. Motion Detector
4. Photogate
5. Air Track
6. Projectile Apparatus
7. Interactive Physics (computer-based simulation program)
8. Physlet Physics (interactive computer-based illustrations and explorations)
9. Vernier Calipers
10. Micrometer

C. analyze and present laboratory data using, as necessary, computer- and calculator-based analytic, spreadsheet and graphing applications such as:
1. Graphical Analysis (computer –based data analysis program by Vernier)
2. MS Excel
3. MS Word

D. write comprehensive laboratory reports, including the following sections:
1. Introduction
2. Data
3. Data Analysis (a.) Sample Calculations (b.) Uncertainty Analysis {i.} Does the theoretical or accepted value fall within the range of experimental values (max-min/2)? {ii.} Calculate the standard deviation for a Gaussian distribution of data points.
4. Conclusion/Summary

V. CONTENT:

A. Physics and Measurement
1. Standards of Length, Mass and Time
2. Matter and Model Building
3. Density and Atomic Mass
4. Dimensional Analysis
5. Conversion of Units
6. Estimates and Order-of-Magnitude Calculations
7. Significant Figures

B. Motion in One Dimension
1. Position, Velocity, and Speed
2. Instantaneous Velocity and Speed
3. Acceleration
4. Motion Diagrams
5. One-Dimensional Motion with Constant Acceleration
6. Freely Falling Objects
7. Kinematic Equations Derived from Calculus
8. General Problem-Solving Strategy

C. Vectors
1. Coordinate Systems
2. Vector and Scalar Quantities
3. Some Properties of Vectors
4. Components of a Vector and Unit Vectors

D. Motion in Two Dimensions
1. The Position, Velocity and Acceleration Vectors
2. Two-Dimensional Motion with Constant Acceleration
3. Projectile Motion
4. Uniform Circular Motion
5. Tangential and Radial Acceleration
6. Relative Velocity and Relative Acceleration

E. The Laws of Motion
1. The Concept of Force
2. Newton's First Law and Inertial Frames
3. Mass
4. Newton's Second Law
5. The Gravitational Force and Weight
6. Newton's Third Law
7. Some Applications of Newton's Laws
8. Forces of Friction

F. Circular Motion and Other Applications of Newton's Laws
1. Newton's Second Law Applied to Uniform Circular Motion
2. Non-uniform Circular Motion
3. Motion in Accelerated Frames
4. Motion in the Presence of Resistive Forces
5. Numerical Modeling in Particle Dynamics

G. Energy and Energy Transfer
1. Systems and Environments
2. Work Done by a Constant Force
3. The Scalar Product of Two Vectors
4. Work Done by a Varying Force
5. Kinetic Energy and the Work-Kinetic Energy Theorem
6. The Nonisolated System – Conservation of Energy
7. Situations Involving Kinetic Friction
8. Power
9. Energy and the Automobile

H. Potential Energy
1. Potential Energy of a System
2. The Isolated System – Conservation of Mechanical Energy

3. Conservative and Non-conservative Forces
4. Changes in Mechanical Energy for Non-conservative Forces
5. Relationship Between Conservative Forces and Potential Energy
6. Energy Diagrams and Equilibrium of a System

I. Linear Momentum and Collisions
1. Linear Momentum and Its Conservation
2. Impulse and Momentum
3. Collisions in One Dimension
4. Two-Dimensional Collisions
5. The Center of Mass
6. Motion of a System of Particles
7. Rocket Propulsion

J. Rotation of a Rigid Object around a Fixed Axis
1. Angular Position, Velocity and Acceleration
2. Rotational Kinematics: Rotational Motion with Constant Angular Acceleration
3. Angular and Linear Quantities
4. Rotational Kinetic Energy
5. Calculation of Moments of Inertia
6. Torque
7. Relationship Between Torque and Angular Acceleration
8. Work, Power and Energy in Rotational Motion
9. Rolling Motion of a Rigid Object

K. Angular Momentum
1. The Vector Product and Torque
2. Angular Momentum
3. Angular Momentum of a Rotating Rigid Object
4. Conservation of Angular Momentum
5. The Motion of Gyroscopes and Tops
6. Angular Momentum as a Fundamental Quantity

L. Static Equilibrium and Elasticity
1. The Conditions of Equilibrium
2. More on the Center of Gravity
3. Examples of Rigid Objects in Static Equilibrium
4. Elastic Properties of Solids

M. Universal Gravitation
1. Newton's Law of Universal Gravitation
2. Measuring the Gravitational Constant
3. Free-Fall Acceleration and the Gravitational Force
4. Kepler's Laws and the Motion of Planets
5. The Gravitational Field
6. Gravitational Potential Energy
7. Energy Considerations in Planetary and Satellite Motion

N. Fluid Mechanics
1. Pressure
2. Variation of Pressure with Depth
3. Pressure Measurements
4. Buoyant Forces and Archimedes' Principle
5. Fluid Dynamics
6. Bernoulli's Equation
7. Other Applications of Fluid Dynamics

VI. METHODS OF INSTRUCTION:
A. **Demonstration** -
B. Laboratory experimentation
C. **Discussion** -
D. Internet and other computer-based simulations and instructional multi-media
E. Problem solving
F. **Lecture** -

VII. TYPICAL ASSIGNMENTS:
A. Weekly homework assignments from textbook 1. Assigned Problems (not to be turned in): a. Chapter 4 – Questions 1, 9, 12, 13, 14, 17, 19, 21, 22, 23 b. Chapter 4 – Problems 7, 19, 23, 33, 37 2. Homework Assignment (to be turned in): a. Chapter 3 -- Problem 63 b. Chapter 4 – Problems 3, 9, 13, 17, 25, 27, 31, 43, 47; B. Laboratory reports (individual and group), including computer-based data acquisition and analysis 1. Acceleration in One Dimension: In this lab you will use an ultrasonic motion detector with a computer interface to measure the position of a moving cart as a function of time. In Part A of this experiment, you will measure the velocity of the cart on a level track, with no acceleration. In Part B, you will angle the track so that gravity accelerates the cart. 2. Conservation of Momentum II: In this lab you will verify the principles of conservation of momentum and kinetic energy in elastic and inelastic collisions, and explore collisions in the center of mass frame. C. Special exercise worksheets, problem review, and computer simulations and tutorials; both individual and group activities 1. Web assignment: Cannon Applet. Complete sections (a) through (f) and turn in with laboratory report for lab Projectile Motion. 2. Complete Exponential Growth and Population assignment listed in online syllabus. Work together in groups of two or three and turn in with report on lab Newton's Laws and Atwood's Machine. Be sure to include an Excel spreadsheet and graph with your report. 3. From the Physlet Physics manual, complete Exploration 9.1: Compare Momentum in Different Frames, Exploration 9.2: Compare Energy in Different Frames, and Exploration 9.3: Compare Relative Motion in Different Frames. Turn in your work with the Chapter 12 homework set.

VIII. EVALUATION:
A. **Methods**

1. Exams/Tests
2. Quizzes
3. Home Work

B. **Frequency**

1. Frequency
   a. Recommend bi-weekly or tri-weekly quizzes and final exam (or) two or three midterm (unit) exams and final exam.
   b. Weekly or bi-weekly homework assignments (as described above).

c. Weekly or bi-weekly laboratory reports (as described above).
d. Two or more collaborative laboratory assignments per semester (as described above).
e. Two or more computer assignments per semester (as described above).

IX. TYPICAL TEXTS:

1. R. Knight *Physics for Scientists and Engineers.* 2nd ed., Pearson Education, 2009.
2. Christian and Belloni *Physlet Physics: Interactive Illustrations, Explorations, and Problems for Introductory Physics.* 1st ed., Pearson Education, 2004.
3. D.C. Baird. *Experimentation: An Introduction to Measurement Theory and Experiment Design.* . 3rd ed., Prentice-Hall Inc, 1995.
4. Las Positas College Physics 8A Laboratory Manual available online in PDF format.

X. OTHER MATERIALS REQUIRED OF STUDENTS:

A. Programmable scientific calculator capable of graphing
B. Campus print card