J. Sargeant Reynolds Community College
Course Content Summary

Course Prefix and Number: PHY 241 **Credits: 4**

Course Title: University Physics I

Course Description:

Covers classical mechanics and thermodynamics. Includes kinematics, Newton's laws of motion, work, energy, momentum, rotational kinematics, dynamics and static equilibrium, elasticity, gravitation, fluids, simple harmonic motion, calorimetry, ideal gas law, and the laws of thermodynamics. Part I of II. This is a UCGS transfer course. Prerequisite: MTH 263 with a grade of C or better. Lecture 3 hours. Laboratory 3 hours. Total 6 hours per week. 4 credits.

General Course Purpose:

PHY 241 is a first semester of a two-semester calculus-based introductory physics with laboratory sequence. It provides the student with a broad understanding of the general concepts and principles of the physical universe, and prepares the student for advanced study in physical sciences and engineering through development of skills in problem solving, critical thinking and quantitative reasoning, and an understanding of the methods of scientific inquiry and experiments.

Course Prerequisites and Co-requisites:

MTH 263 with a grade of C or better

Student Learning Outcomes:
Upon completing the course, the student will be able to:

Measurements, Units and Vectors

- Define base physical quantities and derived quantities
- Report measurements of physical quantities using proper number of significant figures and units
- Convert between different units in the same system, and between different systems of units
- Differentiate between scalar and vector quantities
- Define vectors using unit vectors
- Add and subtract vectors graphically and by component resolution
- Perform multiplications of vectors by scalars and vectors (scalar and vector products)

Kinematics: Motion in One and Two Dimensions

- Define and calculate displacement, average velocity and average acceleration
- Differentiate between average and instantaneous quantities
- Interpret and analyze kinematic graphs, and relate position, velocity and acceleration graphs to each other
- Derive kinematic equations for motion with constant acceleration
- Identify and use appropriate equations of motion to describe motion in one dimension (including objects falling under the influence of gravity) and two dimensions (including projectile motion and uniform circular motion)

Newton’s Laws of Motion

- Explain Newton’s three laws of motion
- Differentiate among mass, weight and apparent weight
- Draw free-body diagrams for a given physical system
- Describe general characteristics of static and kinetic friction
- Apply Newton’s laws to a variety of systems including multiple bodies undergoing linear or uniform and non-uniform circular motions involving horizontal, vertical and inclined planes, strings, and pulleys

Work and Energy

- Define and calculate work done by a constant force and by a variable force
- Calculate work done by a force from force vs position graphs
- Define kinetic energy, gravitational potential energy near the Earth’s surface and elastic potential energy
- Distinguish between conservative and non-conservative forces
- Apply Work-Energy principle and conservation of mechanical energy principle
- Define and calculate power

Collision and Linear Momentum

- Define and calculate linear momentum and impulse
- State the condition for conservation of momentum
- Define elastic, inelastic and completely inelastic collisions
- Apply conservation of momentum and conservation of momentum in conjunction with the conservation of energy to systems in 1-D and 2-D collision and explosion
- Define and calculate center-of-mass of a system of many point masses as well as for bodies with continuous distribution of mass

Kinematics and Dynamics of Extended Body Undergoing Rotation and Elasticity

- Define and calculate angular displacement, average angular velocity, and average angular acceleration
- Differentiate between average and instantaneous quantities
- Relate linear and angular quantities to each other
- Define and calculate moment of inertia and rotational kinetic energy
- Find the moment of inertia of an extended body about an axis of rotation
- Apply conservation of energy to rotating rigid bodies
- Define and calculate torque and angular momentum
- Apply Newton's laws of motion to rotational systems
- Apply the conservation of angular momentum principle to rotational systems
- Explain and apply the conditions of static equilibrium
- Define and calculate different types of strain, stress, and modulus

Gravitation

- Explain Newton’s law of gravitation
- Calculate the gravitational force between objects
- Define and calculate gravitational potential energy
- Calculate the velocity and period of a satellite in a circular orbit
- Explain Kepler’s laws of planetary motion

Oscillatory Motion

- Define oscillation and mathematically describe simple harmonic motion
- Define amplitude, frequency, period and phase of Simple Harmonic Motion (SHM)
- Apply conservation of energy principle in a simple harmonic motion
- Application of SHM to simple pendulum and physical pendulum

- Describe damped harmonic oscillators

Fluid Mechanics
- Define density and pressure and calculate pressure in a fluid
- Explain and apply Pascal's and Archimedes' principles
- Describe and apply equation of continuity and Bernoulli's equation to fluid in motion

Thermodynamics
- Describe various temperature scales and convert between different temperature scales
- Define and calculate linear and volume thermal expansion
- Define heat capacity and latent heats, and calculate energy needed to change temperature of a substance and of phase change
- Apply calorimetry principle to thermal system
- Explain mechanisms of conduction, convection, and radiation and calculate heat transfer rates
- Explain ideal gas law
- Define different thermodynamic processes and internal energy
- Calculate heat transfer and work done by and on an ideal gas during thermodynamic processes
- Explain the laws of thermodynamics
- Apply the First Law of Thermodynamics to analyze systems consisting of one or more thermodynamic processes and cyclic processes
- Define and calculate entropy

Laboratory Experience
- Connect topics discussed in lecture to the lab observations
- Work in the lab safely: follow instructions and proper safety procedures
- Recognize and be able to use basic laboratory equipment
- Report measurements using the correct units and number of significant figures
- Use technology for data acquisition and analysis
- Be able to create a graph/chart or diagram to report data
- Interpret graphs, tables and charts
- Demonstrate written, visual and/or oral presentation skills to communicate scientific knowledge

Major Topics to Be Included:

- Measurements, Units and Vectors
- Kinematics: Motion in One and Two Dimensions
- Newton's Laws of Motion
- Work and Energy
- Collision and Linear Momentum
- Kinematics and Dynamics of Extended Body Undergoing Rotation and Elasticity
- Gravitation
- Oscillatory Motion
- Fluid Mechanics
- Thermodynamics
- Laboratory Experience

Effective Date/Updated: February 1, 2023