PHYS 109: PHYSICS AND THE ARTS

Citrus College Course Outline of Record

Heading	Value
Effective Term:	Fall 2021
Credits:	3
Total Contact Hours:	54
Lecture Hours :	54
Lab Hours:	0
Hours Arranged:	0
Outside of Class Hours:	108
Strongly Recommended:	MATH 160; ENGL 101.
District General Education:	B2. Natural Sciences - Physical Sciences
Transferable to CSU:	Yes
Transferable to UC:	No
Grading Method:	Standard Letter

Catalog Course Description

A one semester course for non-science majors covering fundamental physics principles and their application to the fine and performing arts as well as theater technology situations. 54 lecture hours.

Course Objectives

- Waves
- Understand what is meant by a crest, trough and a wave front.
- Understand how a mechanical wave travels through a medium and how the wave speed is related to the properties of the medium.
- Understand the basic properties of waves such as wave speed, wavelength and frequency for sinusoidal waves.
- Distinguish between the concepts of power and intensity; understand the decibel scale for sound intensity.
- Understand that a standing wave is the result of the superposition of two traveling waves.
- Understand the generation of sound by musical instruments.
- Understand beats as the superposition of two waves of nearly unequal frequency and calculate the beat frequency between two nearly equal frequencies.
- Light
- Distinguish between additive and subtractive color mixing.
- Understand objects as either reflectors, absorbers and/or sources of light and that filters only allow transmission of only a few chosen wavelengths; understand the formation of shadows.
- Use ray tracing, the thin lens equation, the lensmaker's equation and/or the the thin mirror equation to predict and/or explain the formation of images.
- Understand and apply the law of reflection and Snell's Law in image formation.
- Understand the basic properties of mirrors and lenses such as radius of curvature, index of refraction, near and far focal points and focal length.
- Use ray tracing and the thin lens equation to understand and quantitatively analyze image formation in multi-lens systems, such as cameras and the human eye.
- Understand and calculate properties of optical systems such as f-number, numerical aperture, and power of a lens.
- Describe various types of aberrations that affect optical images.
- Understand how light interacts with pigments (transmission and/or reflection)
- Kinematics & Dynamics
- Differentiate between the concepts of position, velocity, and acceleration and recognize the relationship between velocity and acceleration when an object is speeding up, slowing down, curving, or at a turning point.
- Use kinematics to describe and/or predict an object's motion verbally, pictorially, graphically and mathematically.
- Solve quantitative kinematics problems for linear motion, projectile motion and circular motion and interpret the results.
- Identify forces acting on an object and calculate the net force on the object.
- Analyze the connection between force and motion by applying Newton's laws of motion to predict and/or explain the behavior of physical systems.
- Identify the center of gravity and qualitatively and quantitatively describe balance; understand the conditions for equilibrium.
- Energy & Momentum
- Identify forms of energy as mechanical potential energy (elastic and gravitational), chemical potential energy, kinetic energy, thermal energy and radiation.
- Distinguish between the concepts of momentum and impulse.
- Use the Impulse-Momentum Theorem/conservation of momentum to describe and/or predict the behavior of physical systems
- Predict and/or explain the behavior of physical systems using the law of conservation of energy.
- Electromagnetism
- Use the charge model and Coulomb's Law to explain basic electric phenomena.
- Describe how a battery creates a current in a circuit and the energy transfers as charge moves through simple circuits.
- Understand and analyze basic DC circuits containing resistors in series and parallel.
- Understand how electrical power gets to and is used in regular wall outlets.
- Understand and reason about basic magnetic phenomena using a dipole model of magnetism, analogous to the charge model of electricity.
- Understand the magnetic fields due to currents in wires, loops, and solenoids; understand various applications of magnetic fields.
- Thermodynamics
- Distinguish between the concepts of heat (thermal energy transfer) and temperature.
- Contrast the three heat transfer mechanisms (conduction, convection, and radiation).
- Describe physical changes of matter resulting from heat transfer (e.g. temperature change or phase change).
- Use the laws of thermodynamics to explain various physical phenomena

- Modern Physics
- Understand how we know about the structure of atoms and describe atomic structure using both the Bohr model of the atom and the quantum mechanical/shell model of the atom.
- Understand the structure and composition of the nucleus.
- Understand the forces that hold the nucleus together and under what circumstances it might break apart.
- Develop a basic understanding of some applications of nuclear & particle physics in areas such as the arts.
- Use the concept of half life to determine the age of a radioactive sample.

Major Course Content

1. Mechanical Waves
    a. Longitudinal & Transverse Waves
    b. Sinusoidal Waves
        i. Wavelength, wavespeed & frequency
    c. Wave Superposition & Standing Waves
        i. Harmonics/Resonance Modes for Strings
        ii. Harmonics/Resonance Modes for Pipes
    d. Applications to Musical Instruments
        i. String Instruments
        ii. Wind Instruments
        iii. Percussion Instruments
        iv. Singing
2. Light
    a. Light & Color
        i. Light Sources & the Electromagnetic Spectrum
        ii. Subtractive & Additive Mixing
        iii. Shadows
    b. Law of Reflection
    c. Refraction & Dispersion
    d. Interference & the Optics of Paint films
        i. Colorants/Pigments/Paints
        ii. Varnishes/Glazes
        iii. Pigment Response to Infra-red & x-rays
        iv. Hiding Thickness & Underdrawings
    e. Diffraction & Optical Recording
    f. Image Formation with Mirrors & Lenses
        i. Thin lens Equation; Lensmaker's equation; Magnification
        ii. Aberrations
        iii. Photography
        iv. Camera Obscura & 17th Century Paintings
    g. Stage Lighting
3. Modern Physics
    a. Structure of Matter
    b. Nuclear Decay Mechanisms/Radioactivity
    c. Nuclear Techniques in Art History & Authentication
        i. Pigment Response to Neutrons
        ii. X-ray-, Electron-, and Proton-induced X-ray emission
        iii. Radiocarbon Dating
    d. Quantum Mechanics & Relativity
        i. Intro to Probability & Quantum Mechanics
        ii. Modern Physics & Modern Art
4. Motion
    a. Describing Motion
    b. Newton's Laws of Motion
    c. Center of Mass
    d. Rotational Motion & Dynamics
    e. Energy & Momentum
    f. Applications to Dance
        i. Balance
        ii. Spinning
        iii. Jumping/Leaping/Landing
        iv. Partnering
    g. Technical Theater Applications
        i. Simple Machines
        ii. Wagons & Skids
        iii. Static Rigging
        iv. Dynamic Rigging
        v. Turntables & Jacknives
5. Electricity & Magnetism
    a. Electrical Potential Energy & Voltage
    b. Simple DC Circuits & Ohm's Law
    c. Magnetism & Induction
    d. Introduction to AC Circuits
    e. Generators & Transformers
    f. Microphones
6. Thermodynamics
    a. Heat and Temperature
    b. Phases & Phase Transitions
    c. Energy Transfer Mechanisms
    d. Laws of Thermodynamics
    e. Sintering of Ceramics

Suggested Reading Other Than Required Textbook

The Physics of Theatre: Mechanics by Verda Beth Martell & Eric C. Martell ISBN-13: 978-1515333883
Physics and the Art of Dance: Understanding Movement 2nd Edition by Kenneth Laws ISBN-13: 978-0195341010
Physics in the Arts: Revised Edition (Complementary Science) by P.U.P.A. Gilbert and Willy Haeberli ISBN-13: 978-0123918789

Examples of Required Writing Assignments

Short answer questions on in-class assignments, homework, and exams such as: Describe a situation where the color of an object appears to change as the light used to illuminate the object is changed.

Examples of Outside Assignments

Students will watch web-based presentations and complete short online quizzes. Students will answer short answer questions such as: A flute, modeled as an open-open pipe, has a hole drilled in the middle of it. Draw the fundamental for this flute and explain your drawing. Students will answer calculation problems such as: In many 'Peter Pan" systems, to make Peter Pan "take off", a stagehand jumps off a ladder to send Peter flying. If Peter weighs 90lbs and accelerates into the air at a rate of 8ft/

s^2, how much does the stagehand weigh? Assume that there is no counterweight, friction, or mechanical advantage/disadvantage."

Instruction Type(s)

Lecture, Online Education Lecture