Course information:

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1. Course name: Intro to Classical Physics

2. Department: Physics

3. Number: 115

4. Cluster requirement: Science in the Engaged Community

Faculty information:

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5. Name: Alan Hirshfeld

6. Email: [ahirshfeld@umassd.edu](mailto:ahirshfeld@umassd.edu)

7. Phone: 8715

Required components:

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8. Master syllabus: [http:///webroots/www.umassd.edu/genedchecklist/holding/us\_phy115syllabus2b.docx](http://webroots/www.umassd.edu/genedchecklist/holding/us_phy115syllabus2b.docx)

9. Course overview statement:

An introduction to a variety of topics in classical physics for physics majors and minors, with attention to applications of physics in social, environmental, and economic contexts. In studying these basic physics principles, students will learn how to apply scientific theories and knowledge to real‐world problems. Questions will be posed that require extended written answers to help students learn how to effectively communicate scientific information. Tests and a final exam will also be used to assess student mastery of the subject matter.

The course examines the behavior of aggregate systems of many particles, that is, gases, fluids, and solids. When viewed in aggregation, these assemblies of atoms and molecules exhibit the ability to oscillate in collective waves. In addition, bulk physical matter has new properties not seen in single particle system, including heat, pressure, and entropy. The laws governing these new properties of matter in bulk are the purview of thermodynamics, the fundamentals of which students will master after completing this course. Lastly, students will master the fundamentals of how light waves interact with bulk assemblies of gases and solid matter, by either reflecting or slowing down (or refracting). The laws governing the interaction of light are the subject of optics, the fundamentals of which students will also have mastered upon completion of this course. In all of these areas, real-world applications will be studied, along with appropriate problem-solving experience.

The pedagogical approach of this course and its prerequisites are being revised for Fall 2013 such that it will serve as:

(i) the initial technical course in the physics curriculum for first-year majors and minors (formerly PHY 111/113); and

(ii) the course that physics majors and minors take to fulfill the University Studies 2B Science in the Engaged Community requirement.

Assessment of these learning outcomes is conducted throughout the semester, by direct faculty interaction with individual students as they work through in-class activities and as they carry out assigned homework problems, including questions that require students to communicate scientific information in writing. Tests, quizzes, and a final exam are also used in the assessment process.

10. Signed faculty and chair sponsor sheet: sent separately.

11. Official course catalog description for the course:

PHY 115 - Introduction to Classical Physics

3 credits 2A

4 hours lecture and recitation

Prerequisites: PHY 111 or 113

This course treats topics in classical physics from the areas of waves, optics, and thermodynamics.

12. Course approval form: not entered.

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**Master Syllabus**

**Course: PHY 115, Introduction to Classical Physics**

**Cluster Requirement: 2B, Science in the Engaged Community**

This University Studies Master Syllabus serves as a guide and standard for all instructors teaching an approved in the University Studies program. Individual instructors have full academic freedom in teaching their courses, but as a condition of course approval, agree to focus on the outcomes listed below, to cover the identified material, to use these or comparable assignments as part of the course work, and to make available the agreed-upon artifacts for assessment of learning outcomes.

**Course Overview:**

An introduction to a variety of topics in classical physics for physics majors and minors, with attention to applications of physics in social, environmental, and economic contexts. In studying these basic physics principles, students will learn how to apply scientific theories and knowledge to real‐world problems and how to effectively communicate scientific information in writing. Topics covered in the course include temperature, heat and thermodynamics, fluids, waves and oscillations, as well as geometrical and wave optics. Weekly problem sets combining theoretical and applied physics are assigned, along with reading check-point quizzes. Some of the problems include questions that require extended written answers to help students learn how to effectively communicate scientific information. Tests and a final exam will also be used to assess student mastery of the subject matter.

Most recent instructor: Prof. Marguerite Zarrillo, SENG 203B, x9268, mzarrillo@umassd.edu.

**Learning Outcomes:**

Course-Specific Learning Outcomes:

After completing this course, students will have gained and understanding of:

• temperature and its relationship to heat, the relationship between heat, work and energy, the laws of thermodynamics, and their application to theoretical and real-world heat engines and other thermal systems;

• pressure and pressure measurements, buoyancy and Archimedes’ Principle, Bernoulli's equation and fluid dynamics, plus their applications to real-world systems;

• simple harmonic motion, damped and forced oscillations, wave propagation including energy transfer and wave speed, superposition and standing waves, plus their applications to real-world systems;

• geometrical optics and image formation, the thin-lens formula, interference and diffraction patterns and polarization, plus their applications to real-world systems.

University Studies Learning Outcomes:

After completing this course, students will be able to:

1. Analyze and evaluate the use of scientific information in the context of social, economic, environmental or political issues.

2. Apply scientific theories and knowledge to real‐world problems.

3. Effectively communicate scientific information in writing.

**Examples of Texts and/or Assigned Readings:**

The required text for this course is *Fundamental of Physics, Part 2* by Halliday, Resick & Walker.

**Example Assignment:**

PHY 115, Introduction to Classical Physics

Thermodynamics, Temperature and Heat Transfer

1. In a paragraph, explain why a real heat engine can never have 100% efficiency for extracting energy from its fuel source. Please refer to any appropriate thermodynamics concepts and equations in your answer. *[2B OUTCOMES 1, 2, 3]*

**[The work done by a heat engine is the difference between the heat taken in from the hot reservoir and the heat expelled to the cold reservoir W = |Qhot|- |Qcold|. Unless the cold reservoir is at a temperature of absolute zero the heat engine efficiency ε = 1-Tc/Th must be less than 1. Since a temperature of absolute zero can never be achieved, the efficiency of a heat engine can never be 100%.]**

2. In some large electric generator plants, the exhaust heat energy is carried by "cooling water" into a nearby body of water (a lake or the ocean). Due to the higher temperatures around the outlet, plants and animals will often congregate around the outlet port and can impede the water flow. Explain why this can reduce the electric power output of the generating station. *[2B OUTCOMES 1, 2, 3]*

**[Since the efficiency of a heat engine depends on the temperature difference between the hot reservoir and the cold reservoir ε = 1-Tc/Th. By impeding the flow of warm water away from the outlet, the temperature of the cold reservoir is increased which lowers the efficiency of the generator system, reducing its power output.]**

3. In an effort to lower emissions of C02 and other greenhouse gases, many electric utilities are replacing coal-burning generators (which use coal to boil water and produce steam at a temperature of about 450° C to turn the generator) with gas turbine generators (which use the exhaust gases from the gas burner with a temperature of over 800° C to turn the generator).

a)Explain why this change reduces the amount of C02 released per unit of electrical energy generated. (This reduction is better still since natural gas has less carbon than coal for a given energy release). *[2B OUTCOMES 1, 2]*

b) Write a letter to the president of a local hospital or college, or to the editor of the local paper explaining why replacing an existing coal-fired generator with a modern gas-turbine generator would be a effective way to improve an organization's sustainability. *[2B OUTCOMES 1, 2, 3]*

**[Since the efficiency of a heat engine depends on the temperature difference between the hot reservoir and the cold reservoir ε = 1-Tc/Th. By increasing the temperature of the hot reservoir (the input temperature for the generator) the efficiency of the electric generation process is improved.**

**The letter should refer to the improved thermodynamic efficiency of the gas turbine generator vs. the coal fired boiler resulting in reduced CO2 emissions as well as cost savings due to the reduction in fuel usage.]**

**Outcomes Mapping**

The above example assignment addresses all of the Cluster 2B Outcomes 1, 2, and 3:

1. Analyze and evaluate the use of scientific information in the context of social, economic, environmental or political issues.

2. Apply scientific theories and knowledge to real-world problems.

3. Effectively communicate scientific information in writing.

In responding to the above assignment questions, students will have learned about the laws of thermodynamics, how they may be used to determine the work done by heat engines and the Carnot cycle which defines the theoretical maximum efficiency for such an engine. They will use these physics concepts to analyze and reach conclusions about real-world applications related to energy generation. The topics in PHY 115 are ideally suited to the study of practical, real-world physics. Similar assignments to will be introduced on a weekly basis throughout the semester to address social, economic, and environmental issues through the lens of physics, including properties of gases (atmospheric pressure and motions, airships, etc.), laws of thermodynamics, fluids and waves (ocean waves, sound waves, tsunamis, etc.), and optical phenomena (rainbows, telescopes, etc.). Questions addressing the 2B outcomes will also be included on the quizzes and tests. Note: The current course prerequisites are being changed to allow first-year students to take this class.  **Sample Course Outline:**

**PHY 115, Introduction to Classical Physics**

Week 1 and 2: Chapter 18 Temperature, Heat and the First Law of Thermodynamics

Temperature

The Zeroth Law of Thermodynamics

Measuring Temperature

The Celsius and Fahrenheit Scales

Thermal Expansion

Temperature and Heat

The Absorption of Heat by Solids and Liquids

A Closer Look at Heat and Work

The First Law of Thermodynamics

Heat Transfer Mechanisms

Real-World Applications of Thermodynamics

Week 3 and 4: Chapter 19 The Kinetic Theory of Gases

Avogadro's Number

Ideal Gases

Pressure, Temperature and RMS Speed

Translational Kinetic Energy

Mean Free Path

Distribution of Molecular Speeds

The Adiabatic Expansion of an Ideal Gas

Real-World Applications of the Properties of Gases

Week 5 and 6: Chapter 20 Entropy and the Second Law of Thermodynamics

Irreversible Processes and Entropy

Change in Entropy

The Second Law of Thermodynamics

Entropy in the Real World: Engines

Entropy in the Real World: Refrigerators

The Efficiencies of Real Engines

A Statistical View of Entropy

Real-World Applications of the Second Law of Thermodynamics

Week 7: Chapter 14 Fluids

What is a Fluid

Density and Pressure

Fluids at Rest

Measuring Pressure

Pascal's Principle

Archimede's Principle

Ideal Fluids in Motion

The Equation of Continuity

Bernoulli's Equation

Real-World Applications of Fluids

Week 8 and 9: Chapter 16 Waves - I

Types of Waves

Transverse and Longitudinal Waves

Wavelength and Frequency

The Speed of a Traveling Wave

Wave Speed on a Stretched String

Energy and Power of a Wave in a String

The Wave Equation

Superposition of Waves

Interference of Waves

Standing Waves and Resonance

Real-World Applications of Wave Properties I

Week 10: Chapter 17 Waves - II

Sound Waves

The Speed of Sound

Traveling Sounds Waves

The Doppler Effect

Real-World Applications of Wave Properties II

Week 11 and 12: Chapter 34 Images

Two Types of Images

Plane Mirrors

Spherical Mirrors

Images from Spherical Mirrors

Spherical Reflecting Surfaces

This Lenses

Optical Instruments

Three Proofs

Real-World Applications of Optics I

Week 13: Chapter 35 Interference

Light as a Wave

Diffraction

Young's Interference Experiment

Intensity in Double-Slit Interference

Interference from Thin Films

Michelson's Interferometry

Real-World Applications of Optics II

Week 14: Chapter 36 Diffraction

Diffraction and the Wave Theory of Light

Diffraction by a Single Slit: Locating the Minima

Intensity in Single-Slit Diffraction

Diffraction by a Circular Aperture

Diffraction by a Double Slit

Diffraction Gratings

Real-World Applications of Optics III