MOHAWK VALLEY COMMUNITY COLLEGE

UTICA AND ROME, NEW YORK

PHYSICAL SCIENCE, ENGINEERING & APPLIED TECHNOLOGIES DEPARTMENT

COURSE OUTLINE

MODERN PHYSICS AND THERMODYNAMICS

PH265

REVIEWED AND FOUD ACCEPTABLE BY ***SHAHIDA DAR 09/25/2014***

I. CATALOG DESCRIPTION:

PH265 MODERN PHYSICS AND THERMODYNAMICS C‑3, P‑3, CR‑4

This standard calculus-based physics course in 20th century physics and Thermodynamics is for physics and engineering students. It covers topics in heat, kinetic theory, thermodynamics, Einstein’s special theory of relativity, quantum nature of light, wave nature of particles, atomic structure, molecular physics, nuclear physics, particle physics, and cosmology.

Final grade will be based upon a minimum of three one- hour exams, laboratory reports, and a departmental final exam. Students pay a computer users fee.

Perquisites: MA253- Calculus 3, PH262-Engineering Physics 2

II. MATERIALS:

Texts: Fundamentals of Physics, latest Edition, Halliday, Resnick, Walker, John Wiley & Sons

Modern Physics, Thornton and Rex, current edition, Cengage Learning.

III. STUDENT LEARNING OUTCOMES:

This calculus based course provides an introduction to thermodynamics as well as an overview of major developments in physics from the early 20th century through today. The course serves to lay a foundation for continuing studies in science and engineering. At the conclusion of the course, the students will be able to:

1. Apply the rule for temperature scale conversion to any combination of said scales.
2. Apply the principle of thermal expansion, both linear and volume, to natural situations.
3. Apply the definitions of heat and work to various thermodynamic systems.
4. Apply the First Law of Thermodynamics to various systems.
5. Derive the equation for heat conduction through several geometries.
6. Apply the concept of molar specific heat at constant pressure and molar specific heat at constant volume to adiabatic processes.
7. Apply the Second Law of Thermodynamics to heat engines and refrigerators, especially the Carnot cycle.
8. Apply the concept of entropy to various thermodynamic systems.
9. Describe physical events as defined by space and time. Explain why time is not the same for observers moving relative to each other.
10. Explain the connection between mass and energy.
11. Explain that nature exhibits a wave particle duality.
12. Distinguish that light is created by accelerated charged particles.
13. Identify that matter (particles) possess a wave nature.
14. Distinguish between the consequences of classical and quantum physics.

IV. DETAILED COURSE OUTLINE:

1. Relativity

a. Principle of Relativity

b. Michelson Morley Exp't.

c. Einstein Postulates

d. Time Dilation

e. Length Contraction

f. Simultaneity

g. Doppler Effect

h. Relativistic Addition of Velocities

i. Relativistic Dynamics - fission, fusion, pair production

j. General Relativity

2. Kinetic Theory

a. Equipartition Theorem and specific heats at constant volume of both bases and solids and the inadequacy of classical physics.

b. Maxwell Boltzmann Distribution Function

3. Old Quantum Theory (1900 to 1922) (Topics not chronological)

a. Measurement of e and e/m and the quantization of charge

b. Blackbody radiation - the Rayleigh Jeans relations, Planck's quantization of energy

c. Photoelectric effect and the quantization of the electro-magnetic field - the photon

d. X-rays and their quantal aspect - Compton scattering

e. The quantal approach of Einstein and Debye to specific heats of solids

f. The empirical spectral formulas of Balmer, etc.

g. Rutherford scattering and the nuclear model

h. Bohr theory of hydrogen

4. New Quantum Theory (1924 - )

a. deBroglie relationship and the Davisson and Germer experiment

b. The wave function and its probability interpretation

c. Uncertainty Principle

d. Wave-Particle Duality

e. Schrodinger equation in one dimension and its application to an infinite square well potential and quantum mechanical tunneling

f. Schrodinger equation, the hydrogen atom and quantum numbers and electron spin

g. Periodic Table

5. Some properties of solids

a. Structure of solids

b. Classical free electron theory of metals

c. Quantum theory of conduction

d. Band theory of solids

e. Impurity semiconductors

f. Semiconductor junctions and devices

g. Superconductivity

6. Elementary Particles

a. Position and other antiparticles

b. Discovery of the Neutrino

c. Mesons

d. Basic interactions and classification of particles

e. Conservation laws

7. Temperature

a. Macroscopic and Microscopic Descriptions

b. Thermal Equilibrium - The Zeroth Law of Thermodynamics

c. Measuring Temperature

d. Ideal Gas Temperature Scale

e. The Celsius and Fahrenheit Scales

f. The International Practical Temperature Scale

g. Thermal Expansion

8. Heat and the First Law of Thermodynamics

a. Heat, a form of energy

b. Quantity of heat and specific heat

c. Heat conduction

d. The mechanical equivalent of heat

e. Heat and work

f. The First Law of Thermodynamics

g. Some applications of the First Law of Thermodynamics

9. Kinetic Theory of Gases

a. Ideal Gas-A Macroscopic Description

b. Ideal Gas-A Microscopic Description

c. Kinetic Calculation of Pressure

d. Kinetic Interpretation of Temperature

e. Specific Heats of an Ideal Gas

f. Equipartition of Energy

g. Mean Free Path

h. Distribution of Molecular Speeds

10. Entropy and the Second Law of Thermodynamics

a. Reversible and Irreversible Processes

b. The Carnot Cycle

c. The Second Law of Thermodynamics

d. The Efficiency of Engines

e. Entropy--Reversible Processes

f. Entropy--Irreversible Processes

g. Entropy and the Second Law

V. LABORATORY EXPERIMENTS:

Laboratory Topics may include but not be limited to the following areas:

1. Linear Expansion
2. Calorimetery
3. Boyle’s Law
4. Heat Exchange or Cooling Curves
5. Joule’s Mechanical Equivalent of Heat
6. Effects of Special theory of relativity
7. Photoelectric effect and determination of Planck's Constant
8. Frank-Hertz experiment
9. Determination of e/m for the electron.
10. LEDs and Planck’s Constant
11. Measurement of radioactivity and absorption.
12. Study of spectra, prism spectrometer
13. Electron Spin Resonance Demonstration
14. Michelson’s Interferometer

Each experiment will involve a three-hour lab session. In addition, videos from the Mechanical Universe Series may be shown before lab experiments as appropriate.