**Course Syllabus**
**Southeast Missouri State University**

**Department of Physics** — **Course No. EP361/EP501**
**Title of Course: Thermal Analysis** — **Revision: Spring, 1999**

## I. Catalog Description

Thermodynamic laws and processes. Applications to heat engines, turbines, refrigeration, and thermodynamic cycles. Kinetic theory and applications. Fall of even years only. Prerequisites: PH231, MA245. (3)

## II. Prerequisites

PH231 General Physics II
MA245 Vector Calculus

## III. Course Objectives

A. Introduce the student to the general laws of thermodynamics, kinetic theory and heat transfer and their applications to physics and engineering problems.

B. Introduce the student to the methods of thermal analysis as applied to heat engines, refrigeration cycles, turbines, and other devices.

C. Develop the ability of the student to solve selected problems in physics and engineering with the aid of tables, charts, and supplied engineering software.

## IV. Expectations of Student

A. All students

1. The student is expected to gain an understanding of the basic laws of thermodynamics, kinetic theory and heat transfer mechanisms.

2. The student is expected to demonstrate the ability to analyze selected thermal engineering problems and obtain reasonably accurate solutions with the aid of engineering data (charts, graphs, etc.) and available approximate thermodynamic equations.

3. The student is expected to gain an understanding of the range of applicability of the various formulations and empirical laws of thermodynamics to various physical and engineering systems.

4. The student is expected to gain a general knowledge of the current topics of research in the field of thermal analysis through literature made available during the semester.

B. Graduate students - Demonstrate research ability by submitting an original term project related to thermal analysis. The project will involve (1) computer programming (2) use of selected periodicals in the field of thermal analysis (3) technical writing. The completed project report will be due one week before the final exam.

## V. **Course Outline** (Class Hours)

A. Basic concepts and definitions; thermodynamics systems; control volume analysis; thermodynamic properties, equation of state, processes and cycles, energy and temperature; pressure and mean kinetic energy of atoms and molecules. (5)

B. Thermodynamic properties of pure substances; vapor-liquid phases; equations of phase change, thermodynamic properties of refrigerates; tables of thermophysical data. (5)

C. Hour examination (1)

D. First law of thermodynamics; work-energy relations at a moving boundary; compressible and incompressible flow; quasi-equilibrium processes; heat, internal energy and enthalpy, specific heat of real gases, thermophysical partial derivatives and their relation to empirical data; use of thermophysical data in engineering problem solving. (5)

E. First law analysis for a control volume; conservation of mass and the control volume analysis; momentum equation in compressible fluid flow; first law analysis of Steady-State Steady-Flow (SSSF) process; problems dealing with gas, vapor turbine, diffusers, subsonic nozzles, jet engines, condensers, steam power plant, vapor-liquid compressors, refrigeration systems, Uniform-State Uniform-Flow (USUF) processes and their applications to engineering problems. (6)

F. Hour examination (1)

G. Second law of thermodynamics; interpretations of Kelvin and Clausius statements; concepts of irreversibility and entropy changes, heat engines and refrigeration cycles, Carnot cycle, efficiencies of actual thermodynamic devices, entropy as a thermodynamic property; charts of entropy and enthalpy; entropy changes in various reversible processes. (5)

H. Second law analysis for a control volume; entropy in SSSF process, control volume analysis for USUF process, control volume analysis (second law) of subsonic nozzles, jet engines, diffusers, refrigeration process, schematic diagrams and their analysis in engineering, power, and refrigeration cycles; Rankin, Otto and Diesel cycles, Brayton and gas-turbine cycles, use of tables of refrigerates. (5)

I. Hour examination (1)

J. Kinetic theory and its applications; basic assumptions; velocity distribution function, average kinetic energy of molecules; equipartition of energy; Lagrange's method; Maxwell-Boltzman distribution function; Fermi-Dirac and Bose-Einstein statistics and their applications, specific heat using Einstein and Debye models. (5)

K. Heat transfer mechanics; basic laws of heat transfer; combined heat-transfer mechanisms; heat-conduction and convection across structures of simple geometries; heat transfer across composite structures. (5)

L. Hour examination (1)

**Total Hours: 45**

## VI. Textbook and Reference Materials

A. *Fundamentals of Engineering Thermodynamics*, 1998 by J. R. Howell, R. O. Buckius, MacMillan Publishing Co.

B. Charts of thermophysical properties will be supplied during the semester.

C. Articles of current interest will be selected from physics and engineering journals available in Kent Library.

D. IBM PC software disks.

## VII. Basis of Student Evaluation

A. Undergraduate students
   1. Three 1-hour exams (120 points)
   2. Final exam (80 points)
   3. Short tests and homework (100 points)

   **Total: 300 points**

B. Graduate students
   1. Three 1-hour exams (90 points)
   2. Final exam (80 points)
   3. Homework (80 points)
   4. Term project (50 points)

   **Total: 300 points**