I. **Course Title**
   Physical Chemistry - Thermodynamics

II. **Course Prefix/Number**
    CHEM 431

III. **Credit Hours**
    3

IV. **Prerequisites**
    CHEM 131, 132; MATH 120; PHYS 221-224 or PHYS 230-233

V. **Catalog Description**
   Thermodynamics as applied to chemistry. Specific topics include the laws of thermodynamics, thermochemistry, reaction and phase equilibrium, and solutions. An introduction to chemical kinetics is included.

VI. **Curricular Relationships**
    Required course for BA chemistry, BA chemistry (science education), BS chemistry, BS biochemistry, and BS chemical physics.

VII. **Student Learning Outcomes**

   - Students will be able to state the basic laws, assumptions, definitions, and concepts of thermodynamics and kinetics and their significance.

   - Students will be able to derive various mathematical relationships from the laws and assumptions of thermodynamics.

   - Students will be able to determine numerical values for various functions from experimental data.

   - Students will be able to apply calculus to problems in chemistry.

   - Students will be able to relate and apply the concepts of thermodynamics to problems in all areas of science and technology.
• Students will be able to discuss the historical development of thermodynamics and kinetics.
• Students will be able to articulate and present solutions to difficult problems in a clear, logical, and precise manner.

VIII. Content Outline

• Gas laws for ideal and non-ideal systems.
• Zeroth law and temperature.
• First law and applications to thermochemical calculations.
• Joule and Joule Thompson experiments and consequences.
• Second Law, entropy.
• Third law; Gibbs and Helmholtz free energies with applications.
• Fundamental equations of state and manipulations to solve problems.
• Applications to phase equilibrium, Gibbs phase rule.
• Applications to non-ideal solutions, colligative properties.
• Applications to reaction equilibrium.
• Rate laws and their manipulation to obtain orders and constants from data.
• Temperature dependence of rates and activation energy.
• Mechanisms and obtaining rate laws from mechanisms.
• Absolute reaction rate theories.

IX. Course Procedures/Policies/Grading Scale

• Homework is assigned, collected and graded for each chapter. 4 exams are given in class; most include several take-home questions of a longer or more difficult nature. The ACS standardized exam in thermodynamics constitutes the final and the raw score is converted into a number that reflects a regular exam. All five exams plus the average of the homework count equally.
• Grading Scale: >87 = A; 75-86 = B; 60-74 = C; 50-59 = D; <50 = F

IX. Required/Recommended Readings

Typical texts include Physical Chemistry, by Laidler, Meiser, and Sanctuary; Physical Chemistry, by Mortimer; Physical Chemistry, by Atkins

XI. Issues Unique to this Course

None

XII. Additional Departmental Issues

None