1. **Course number and name - CHBE 2130 – Chemical Engineering Thermodynamics I** ***(required)***

2. **Credits and contact hours** - 2 credit hours, 2 lecture hours (2-0-0-2)

3. **Instructor's or course coordinator's name -** Dr. Tom Fuller

4. **Textbook, title, author, and year**
   Introduction to Chemical Engineering Thermodynamics; Smith, Van Ness, Abott, and Swihart, 8^{th} Edition, , McGraw-Hill, 2017 (6^{th} and 7^{th} edition also suitable)

5. **Specific course information**
   a. **Catalog Description -** Basic principles of chemical engineering thermodynamics including first and second laws, equations of state, PVT properties, power cycles and refrigeration. Credit not allowed for both CHBE 2130 and CHBE 2110.
   b. **Prerequisites or co-requisites** - CHBE 2100 Chemical Process Principles (minimum grade "C" or better); BIOL 1107+1107L (co-requisite; previously BIOL 1510)
   c. **Required, elective, or selected elective course** (as per Table 5-1) – Required

6. **Specific goals for the course**
   a. **Specific outcomes of instruction**:
   By the end of this course, a student should be able to:
      1) Extend the systems analysis method to define complex thermodynamic systems including transient materials and energy balances for open and closed systems.
      2) Be able to correctly use the First Law of Thermodynamics to find heat, work, and changes in internal energy and enthalpy for the analysis of any system, open or closed, undergoing irreversible processes.
      3) Apply the Second Law of Thermodynamics and the concept of entropy production to the analysis of reversible and real systems.
      4) Use equations of state for gases and liquids to determine changes in PVT properties. Understand the molecular concepts.
      5) Understand the relationships among the interval energy, enthalpy, heat capacities, entropy, Gibbs and Helmholtz free energies. Be able to calculate these energy functions from equations of state and heat capacity data.
      6) Perform thermodynamic analysis of Carnot, Rankine, Brayton, Otto, and Diesel cycles and be able to calculate ideal efficiencies for these cycles.
      7) Design and analyze refrigeration cycles and gas liquefaction processes.

b. **Connection with Student Outcomes**

CHBE 2130							
	Student Outcomes						
Course Outcomes	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Course Outcome 1	**X**						
Course Outcome 2	**X**						
Course Outcome 3	**X**						
Course Outcome 4	**X**						
Course Outcome 5	**X**						
Course Outcome 6	**X**	**X**					
Course Outcome 7	**X**	**X**					

Student Outcomes

(1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

(2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

(3) an ability to communicate effectively with a range of audiences

(4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

7. **Brief list of topics to be covered**

   a. First Law: Energy balance in open, closed, and isolated systems; steady state and transient processes
   b. Second Law: reversible and irreversible processes; entropy balance for open, closed, and isolated systems
   c. Third Law: molecular basis for zero entropy at zero temperature
   d. Properties of pure fluids: phase diagrams, equations of state, compressibility factor, generalized correlations, residual properties, equations of state for liquids
   e. Ideal gas and real fluids: cubic equations; departure functions
   f. Relationship among thermodynamic functions: fundamental relationships between thermodynamic properties; Maxwell equations; thermodynamic property calculations
   g. Thermodynamics of fluid flow and devices: expansion and compression of fluids; turbines, tubes, throttling, nozzles, pumps
   h. Supersonic flow of ideal gases
   i. Thermodynamics of energy conversion: power production (e.g. Carnot cycle; Rankine cycle, internal combustion engine; Diesel engine)
   j. Refrigeration and liquefaction: Carnot and actual cycles; vapor compression and absorption; refrigerants; liquefaction of gases.