**Course Syllabus for Engineering Thermodynamics (30140444)**

Tsinghua University, Fall 2024

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**Textbook:** Cengel and Boles, Thermodynamics: An Engineering Approach, 7th Ed., McGraw-Hill, 2011, ISBN 978-0-07-352932-5

**Description:** The course covers basic thermodynamic concepts and principles, properties of matter and their evaluation, and analysis of processes and cycles, as detailed below.

**Outcomes:** Upon completion of the course, students will be able to model simple thermodynamic systems and cycles; calculate properties of a pure substance and understand their origin for ideal gases and incompressible substances; and use mass, energy, entropy, and exergy balances to perform analyses of common power generation, automotive, aerospace and refrigeration cycles.

**Grading policy:** quizzes 20%, homework assignments 20%, midterm exam 30%, final exam 30%.

**Week 1:**

(**Chapter 1. Introduction and basic concepts**) systems, properties, state and equilibrium, processes and cycles, temperature, pressure.

**Week 2:**

(**Chapter 2. Energy, energy transfer, and general energy analysis**) energy types, internal energy, heat and work, the first law of thermodynamics, energy conversion efficiencies.

**Week 3:**

(**Chapter 3. Properties of pure substances**)phases, phase change, property diagrams, property tables, equations of state, compressibility factor.

**Week 4:**

(**Chapter 4. Energy analysis of closed systems**; **Chapter 5. Mass and energy analysis of control volumes**) moving boundary work, polytropic process, energy balance, specific heat, enthalpy, properties of liquids and gases; conservation of mass principle, flow rate, flow work and the energy of a flowing fluid, energy analysis of steady-flow systems.

**Week 5:**

(**Chapter 5. Mass and energy analysis of control volumes; Chapter 6. The second law of thermodynamics**)steady-flow devices: diffuser, nozzle, turbine, compressor, pump, heat exchanger, unsteady-flow processes; Kelvin-Plank and Clausius statements, reversible and irreversible processes, the Carnot cycle and Carnot principles, Kelvin scale, Carnot heat engines, refrigerators and heat pumps.

**Week 6:**

(**Chapter 7. Entropy**) definition of entropy, Clausius inequality, increase of entropy principle, entropy change of pure substances, *T*d*s* relations, *T*-*s* diagrams, isentropic processes, entropy change during phase change.

**Week 7:**

(**Chapter 7. Entropy**; **Chapter 8. Exergy**) analysis of open systems: turbines, compressors, nozzles, isentropic efficiencies, entropy balance; exergy, reversible work, exergy destruction, second-law efficiency.

**Week 8:**

(**Chapter 9. Gas power cycles**) ideal Otto and Diesel cycles, air-standard analysis, thermal efficiency, the ideal Brayton cycle.

**Week 9:**

(**Midterm exam**, Chapter 9. Gas power cycles) the Brayton cycle with intercooling, reheating, and regeneration, ideal jet-propulsion cycles.

**Week 10:**

(**Chapter 10. Vapor and combined power cycles**) ideal Rankine vapor power cycles, reheat and regenerative cycles, combined cycles.

**Week 11:**

(**Chapter 11. Refrigeration cycles**) vapor-compression refrigeration cycles, innovative vapor-compression refrigeration systems, gas refrigeration systems, absorption-refrigeration systems.

**Week 12:**

(**Chapter 12. Thermodynamic property relations**) calculus theorems, Gibbs equations, Maxwell relations, the Clapeyron equation, general relations, the Joule-Thomson coefficient.

**Week 13:**

(**Chapter 13. Gas mixtures**; **Chapter 14. Gas-vapor mixtures and air-conditioning**) mixture properties, mole, mass and volume fractions, partial pressure, energy and exergy analysis of mixing processes, specific humidity, relative humidity and dew-point temperature, adiabatic saturation temperature.

**Week 14:**

(**Chapter 14. Gas-vapor mixtures and air-conditioning**; **Chapter 15. Chemical reactions**) psychrometric chart, air-conditioning processes; fuel and combustion, enthalpy of formation, adiabatic flame temperature, entropy changes of reaction systems.

**Week 15:**

(**Chapter 16. Chemical and phase equilibrium**) equilibrium criterion for reacting systems, chemical equilibrium constants for ideal-gas mixtures, phase equilibrium, Gibbs phase rule.