ME 310: Thermodynamics I

Term: Fall 2026
Credits: 3.0
Lecture Times & Location: Tuesday & Thursday 9:30–10:45 a.m., Rowan Engineering Center 120
Modality: In-Person

Instructor Information

- **Instructor:** Dr. Gavin Doyle (Associate Professor of Mechanical Engineering)
- **Email:** gdoyle@university.alkimi.ai
- **Office:** Rowan Engineering Center 224
- **Office Hours:**
  - Wednesday & Friday: 3:30–5:00 p.m. (In person, Rowan Engineering Center 224)
  - Monday: 3:00–4:00 p.m. (Virtual via Zoom; link posted in Canvas)
  - Also available by appointment.

Course Description

Properties of pure substances, energy analysis of closed and open systems, the first and second laws, entropy, and power and refrigeration cycles. ME 310 introduces classical engineering thermodynamics with an emphasis on energy transformations, thermodynamic state determination, and conservation principles. Students examine the behavior of pure substances and ideal gases, formulate first-law energy balances for closed systems and open control volumes, and apply the second law of thermodynamics using the entropy concept. The course culminates in the thermodynamic evaluation and thermal efficiency optimization of gas power, vapor power, and refrigeration cycles essential to modern energy infrastructure.

Prerequisites

PHYS 121 and MATH 240.

Measurable Student Learning Outcomes

Upon successful completion of ME 310, students will be able to:

1. **Evaluate Thermodynamic Properties:** Determine thermodynamic properties of pure substances (water, refrigerants, and ideal gases) using property tables, Mollier and T-s diagrams, and equations of state with linear interpolation.
2. **Apply First Law to Closed Systems:** Calculate boundary work, heat transfers, and internal energy or enthalpy changes for closed systems executing polytropic and isothermal processes.
3. **Analyze Open Control Volumes:** Formulate steady-state and transient mass and energy conservation balances for engineering components including nozzles, diffusers, turbines, compressors, throttling valves, and heat exchangers.
4. **Implement the Second Law and Entropy Balances:** Apply the Clausius inequality and evaluate entropy generation, isentropic efficiencies, and reversible work limits for engineering processes.

5. **Analyze Power and Refrigeration Cycles:** Calculate thermal efficiencies, back-work ratios, and coefficients of performance for Brayton, Otto, Diesel, Rankine, and vapor-compression refrigeration cycles.

Required Course Materials & Approximate Costs

1. **Çengel, Yunus A., Michael A. Boles, and Mehmet Kanoğlu. *Thermodynamics: An Engineering Approach*. 9th ed., McGraw-Hill, 2019.** Approx. $80 digital rental ($190 purchase; reserve copies available in Alkimi Library).
2. **NIST WebBook Thermophysical Properties Database and EES/Python CoolProp libraries.** Free open-access online resources.
3. **Total estimated cost:** Approx. $0 (library reserve & open resources) to $80 (digital rental).

Generative AI Policy (AI Level 2: AI Permitted with Disclosure for Specified Tasks)

In accordance with Alkimi University Academic Policies (Student Handbook §5.8), ME 310 operates under **AI Level 2**.

- **What is permitted:** Students may consult approved AI tools to clarify fundamental definitions (such as intensive vs. extensive properties), explain phase diagram features, or assist in scripting thermodynamic property interpolations in Python or MATLAB.
- **What is prohibited:** AI models must not be used to solve assigned homework problems, perform control-volume mass and energy balances on homework sets, or generate derivations of thermodynamic relations. AI use is strictly prohibited during all quizzes and exams.
- **Disclosure:** Any code or computational script submitted for the thermodynamic cycle design project that incorporates AI-generated logic must include a prominent disclosure specifying the prompt and documenting how property outputs were validated against published NIST or textbook tables.

Grading Components and Weights

- **Weekly Problem Sets:** 15% (Due Wednesdays at 11:59 p.m. in Canvas (weeks 2–14; lowest dropped))
- **Biweekly Concept & Property Quizzes:** 10% (Administered in class on alternate Thursdays (weeks 3, 5, 9, 13; lowest dropped))
- **Midterm Exam 1 (Properties & First Law):** 20% (In class, Thursday, October 1)
- **Midterm Exam 2 (Control Volumes & Second Law):** 20% (In class, Thursday, November 5)
- **Rankine/Brayton Power Cycle Computational Project:** 10% (Due Friday, November 20 at 11:59 p.m.)
- **Comprehensive Final Examination:** 25% (Tuesday, December 15, 2026, 8:00–10:00 a.m.)

Grading Scale (Alkimi University Standard)

- **A:** 93–100% | **A-:** 90–92%
- **B+:** 87–89% | **B:** 83–86% | **B-:** 80–82%
- **C+:** 77–79% | **C:** 73–76% | **C-:** 70–72%
- **D+:** 67–69% | **D:** 60–66% | **F:** Below 60%
- **Extra credit:** No extra credit assignments are available in ME 310.

Course Schedule (Fall 2026)

Week	Dates	Topics & Readings	Assignments & Deadlines
Week 1	Aug 27	**Fundamental Concepts and Dimensions:** Thermodynamic systems and boundaries, state postulate, intensive vs. extensive properties, pressure measurement, manometers, and the Zeroth Law of Thermodynamics. *Reading: Çengel et al. Ch. 1*	*First day of classes: Wed Aug 26.*

Week	Dates	Topics & Readings	Assignments & Deadlines
Week 2	Sep 1, 3	**Energy Transfer and General Energy Analysis:** Forms of energy, heat transfer mechanisms, work modes (boundary work, shaft work, electrical work), and mechanical energy conservation fundamentals. *Reading: Çengel et al. Ch. 2*	*Wed Sep 2: Add/section change deadline.*
Week 3	Sep 8, 10	**Properties of Pure Substances and Phase Diagrams:** Pure substances, phase-change phenomena, compressed liquid, saturated mixture, superheated vapor, and P-v, T-v, and P-T property diagrams. *Reading: Çengel et al. Ch. 3.1–3.4*	*Mon Sep 7: Labor Day (no classes). Wed Sep 9: Census date (last day to drop without a W).*
Week 4	Sep 15, 17	**Property Tables and Ideal Gas Behavior:** Steam table lookups, compressed liquid approximations, dryness fraction (quality), ideal gas equation of state, and compressibility factor charts. *Reading: Çengel et al. Ch. 3.5–3.8*	—
Week 5	Sep 22, 24	**Energy Analysis of Closed Systems:** Moving boundary work in constant pressure, constant volume, and polytropic processes; internal energy, enthalpy, and specific heats of ideal gases, solids, and liquids. *Reading: Çengel et al. Ch. 4.1–4.5*	—
Week 6	Sep 29, Oct 1	**First Law for Closed Systems and Midterm Exam 1:** Complete energy balances for closed system cycles, problem synthesis, and administration of Midterm Exam 1 during Thursday class. *Reading: Çengel et al. Ch. 4*	**Midterm Exam 1 (Properties & First Law) (in class).**
Week 7	Oct 6, 8	**Mass and Energy Analysis of Open Control Volumes:** Conservation of mass, flow work, total energy of flowing fluids, and steady-flow energy equations for nozzles, diffusers, turbines, and compressors. *Reading: Çengel et al. Ch. 5.1–5.3*	—
Week 8	Oct 15	**Control Volume Applications and Unsteady Flow:** Throttling valves, mixing chambers, heat exchangers, pipe and duct flow, and charging/discharging unsteady-flow processes. *Reading: Çengel et al. Ch. 5.4–5.5*	*Oct 12–Oct 13: Fall break (no classes).*
Week 9	Oct 20, 22	**The Second Law of Thermodynamics and Heat Engines:** Thermal energy reservoirs, heat engines, thermal efficiency, Kelvin-Planck statement, refrigerators, heat pumps, COP, and Clausius statement. *Reading: Çengel et al. Ch. 6.1–6.6*	—
Week 10	Oct 27, 29	**Carnot Cycle and Reversible Principles:** Reversible and irreversible processes, Carnot heat engine, Carnot principles, thermodynamic temperature scale, and Carnot efficiency limits. *Reading: Çengel et al. Ch. 6.7–6.11*	—
Week 11	Nov 3, 5	**Entropy and T-s Diagrams:** Clausius inequality, definition of entropy, principle of entropy increase, T-ds relations, and administration of Midterm Exam 2 during Thursday class. *Reading: Çengel et al. Ch. 7.1–7.6*	*Fri Nov 6: Last day to withdraw (W) or elect Pass/No Pass.* **Midterm Exam 2 (Control Volumes & Second Law) (in class).**
Week 12	Nov 10, 12	**Isentropic Processes and Component Efficiencies:** Isentropic processes for ideal gases, relative pressure and volume, isentropic efficiencies of turbines, compressors, pumps, and nozzles, and entropy generation. *Reading: Çengel et al. Ch. 7.7–7.13*	—
Week 13	Nov 17, 19	**Gas Power Cycles: Brayton, Otto, and Diesel:** Air-standard assumptions, Otto and Diesel internal combustion engine cycles, gas-turbine Brayton cycles, and regeneration; Cycle Project due Friday. *Reading: Çengel et al. Ch. 9.1–9.9*	**Rankine/Brayton Power Cycle Computational Project due Fri Nov 20 at 11:59 p.m.**
Week 14	Nov 24	**Vapor Power Cycles: Rankine Cycle:** Ideal Rankine cycle, superheat and reheat Rankine cycles, regenerative feedwater heaters, and thermal efficiency improvements. *Reading: Çengel et al. Ch. 10.1–10.5*	*Nov 25–Nov 27: Thanksgiving break (no classes).*
Week 15	Dec 1, 3	**Refrigeration and Heat Pump Systems:** Reversed Carnot cycle, ideal and actual vapor-compression refrigeration cycles,	—

Week	Dates	Topics & Readings	Assignments & Deadlines
		refrigerant selection, and heat pump operating performance. *Reading: Çengel et al. Ch. 11.1–11.5*	
Week 16	Dec 8	**Course Synthesis and Final Examination Review:** Comprehensive review of property evaluations, open and closed first-law balances, entropy generation, and cycle efficiency calculations. *Reading: Review Çengel et al. Ch. 1–7, 9–11*	*Wed Dec 9: Last day of classes. Thu Dec 10: Reading Day.*
Finals	Dec 15	**Comprehensive Final Examination:** Tuesday, December 15, 2026, 8:00–10:00 a.m., Rowan Engineering Center 120.	Comprehensive.

Course Policies

Attendance Policy

Regular attendance at all lecture sessions is essential. Thermodynamics relies heavily on rigorous step-by-step problem formulations and property table lookups that require live practice and feedback. If an absence is unavoidable due to illness or collegiate conflict, notify Dr. Doyle before the scheduled class. Students who miss the first two class meetings without notifying the instructor may be dropped. Students may miss class for religious observance without penalty if they notify the instructor in writing within the first two weeks of the semester (by Wednesday, September 9, 2026). Absences for university-sponsored activities (athletics, performances, conferences) are excused with a letter from the sponsoring office at least one week in advance.

Late Work Policy

Weekly homework sets submitted past the deadline will receive a 15% penalty per 24 hours late, up to 48 hours. After 48 hours, solutions are posted and late submissions receive zero credit. The lowest homework set grade is dropped to cover unexpected illness. The cycle project loses 10% per day.

Final Exam Policy

The final examination (Tuesday, December 15, 2026, 8:00–10:00 a.m.) is scheduled by the University Registrar and can't be moved without the Dean's written approval (Faculty Handbook §5.5). A student with three or more final exams on the same calendar day may reschedule one of them. Requests go to the instructor of the middle exam by the last day of classes. For this term, send the request by Wednesday, December 9, 2026 (Student Handbook §6.4).

Academic Integrity

Alkimi University is an academic community devoted to rigorous scholarship, open intellectual inquiry, and uncompromising ethical conduct. All students are subject to the regulations of the Alkimi University Academic Integrity Policy. Academic dishonesty—including plagiarism, cheating on examinations, unauthorized collaboration, fabrication of empirical data, and unauthorized submission of academic work generated by artificial intelligence—undermines the integrity of the university and carries severe disciplinary sanctions. Sanctions range from a failing grade on an assignment or exam to an administrative course failure recorded as an 'XF' on the official transcript, academic suspension, or expulsion. Suspected violations are formally investigated and resolved through the Office of Academic Integrity in accordance with Faculty Handbook §6. For detailed information, consult the Office of Academic Integrity, Lovell Hall 315, (555) 555-0163, integrity@university.alkimi.ai.

Accessibility Services

Alkimi University is committed to providing equitable educational access and reasonable accommodations for all students with documented disabilities, including physical, sensory, psychological, learning, and chronic health conditions. Students requesting academic accommodations must formally register with the

Office of Accessibility Services, Harlan Hall 204, (555) 555-0155, access@university.alkimi.ai. Once approved, students will receive an official Faculty Accommodation Letter detailing approved accommodations. Students should present this letter to the instructor as early in the semester as possible, and at least one week prior to any exam or assignment requiring accommodation. Accommodations cannot be applied retroactively.

Student Wellness and Mental Health

Your physical health, psychological well-being, and mental health are essential to your academic success. If you experience heightened stress, anxiety, depressive symptoms, personal trauma, or academic burnout, free, confidential counseling and medical care are available through the Hollis Health & Counseling Center, located in the Hollis Center. Routine appointments are available Monday–Friday 8:00 a.m.–6:00 p.m. and Saturday 10:00 a.m.–2:00 p.m. during the semester by calling (555) 555-0190 or emailing health@university.alkimi.ai. Urgent, 24/7 crisis psychological counseling is accessible immediately at (555) 555-0199.

Campus Student Support Services

- **Academic Advising Center:** Lovell Hall 101 | (555) 555-0158 | advising@university.alkimi.ai
- **Writing Center:** Whitcombe Library 3rd Floor | Free consultations on papers, reports, and research projects at any stage.
- **Whitcombe Library:** Whitcombe Library, Main Floor | (555) 555-0170 | askalibrarian@university.alkimi.ai
- **Hollis Health & Counseling Center:** Hollis Center | (555) 555-0190 | 24/7 Counseling Line: (555) 555-0199 | health@university.alkimi.ai
- **Thermal-Fluids Peer Help:** Rowan Engineering Center 140 | Drop-in thermodynamics and fluids tutoring offered Tuesday and Thursday 6:00–8:30 p.m.