

MECH-320 Thermodynamics
(Required Core Course)

Catalog Data: Credit: (4-0-0-4) Four Lecture Hours
Prerequisite: PHYS-224, PHYS-225, Minimum Class Standing: SO
Corequisite: None

A study of the first and second laws of thermodynamics and their application to energy transformations during various processes. Property relations are studied for pure substances, ideal gases, mixture of ideal gases, and atmospheric air. Steam power cycles, refrigeration cycles, spark-ignition and compression-ignition engines, and turbine cycles are evaluated to determine performance parameters and energy efficiencies.

Textbook: Fundamentals of Classical Thermodynamics by: Van Wylen, Sonntag, and Borgnakke, 7th Edition

References: Fundamentals of Engineering Thermodynamics by: M. J. Moran and H. N. Shapiro, 5th ed., 2004.

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Course Learning Objectives:

Upon completion of this course, the student will be able to:

1. Identify the state and properties of a pure substance in a single or multiple phase (mixture). [ABET's A,B,L].
2. Develop in-depth understanding of mass and energy conservation laws [ABET's A,E,I].
3. Identify, formulate, and solve problems in classical thermodynamics [ABET's A,C,E].
4. Demonstrate a systematic and structured approach to problem solving [ABET's A,C,E,M]
5. Apply fundamental principles to analyze components of a thermodynamic cycle (turbines, compressors, etc.) [ABET's A,B,C,E,I]
6. Apply thermodynamic laws to design a cycle or a thermodynamic system [ABET's A,C,E,G,H,I,J,K,L]
7. Utilize thermodynamic tools to perform a preliminary design of a complex system (or cycle) [ABET's A,C,D,K,N]

Prerequisites by Topic:

1. Electricity and Magnetism
2. Electricity and Magnetism Lab

Topics Covered:

<i>Week</i>	<i>Topic</i>
1	Introduction, pressure, temperature, energy, work and heat definitions
2	1 st Law of thermodynamics, energy balance – process and cycles, closed systems
3	Properties: Phase diagrams, table look-up
4	Conservation of Energy - Processes and cycles in a closed system
5	Ideal gas law – Processes and cycles with ideal gases – Open systems - SSSF and USUF
6	Second Law: Thermal reservoir, Kelvin-Planck and Clausius statements, Reversible and irreversible processes, Temperature scales, Carnot Cycle, maximum efficiency
7	Entropy: for pure substances and ideal gases
8	2 nd Law for closed systems, isentropic processes
9	2 nd Law for open systems, Cycles: Refrigeration, Rankin
10	Otto, Diesel, and Brayton cycles
11	Review and final exam

Schedule:

Two sessions per week of 120 minutes each.

Computer Usage:

Basic computer skills (MS Word, Excel and MATLAB or equivalent)

Recommended Laboratory Project:

No required laboratory. Laboratory experience is attained in the Energy Systems Lab (MECH-422)

Recommended Team Project

A team project (10%) of the final grade is assigned to students during week 6.

Relationship to Professional Component:

This course is 90% engineering science and 10% engineering design

References: Fundamentals of Engineering Thermodynamics by: M. J. Moran and H. N. Shapiro, 5th ed., 2004.

Grading:	Test 1	20%	Quizzes	10%
	Test 2	25%	Final Project	10%
	Final Exam	30%	Subjective	5%

No prior notice for quizzes will be given.

Attendance: is mandatory. Any anticipated absence should be worked out with the instructor ahead of time. No make-up exam will be offered without the Department's head or the Provost's written statement. Missing classes will significantly affect the subjective part of your final grade.

Week	Chapter(s)	Homework Problems for Practice
1	1 2 3	----- 2.23, 2.26, 2.30, 2.37, 2.42, 2.46, 2.53, 2.71, 2.72, 2.75, 2.77, 2.86, 2.87, 2.88, 2.89 3.24, 3.29, 3.30, 3.32, 3.35, 3.37, 3.40, 3.43, 3.49, 3.52, 3.59, 3.62, 3.64, 3.66, 3.67, 3.75, 3.80, 3.82, 3.84, 3.89, 3.94
2	3	3.97, 3.99, 3.101, 3.107, 3.111, 3.113, 3.117, 3.122, 3.125, 3.138, 3.153, 3.166
3	4 5	4.25, 4.32, 4.34, 4.38, 4.48, 4.51, 4.61, 4.64, 4.67, 4.72, 4.88, 4.99, 4.106, 4.110, 4.117, 4.118, 4.129, 4.151 5.21, 5.25, 5.27, 5.28, 5.29, 5.30, 5.31, 5.32, 5.33, 5.38, 5.42, 5.50, 5.55, 5.57, 5.58, 5.61, 5.64, 5.67, 5.68, 5.70, 5.73, 5.75, 5.79, 5.87, 5.91, 5.95, 5.101, 5.107, 5.109
4	5 6 Test I	5.111, 5.124, 5.127, 5.131, 5.134, 5.138, 5.160, 5.161, 5.168, 5.164, 5.167, 5.171 6.23, 6.25, 6.28, 6.30, 6.38, 6.39, 6.40, 6.44, 6.46, 6.53, 6.54, 6.58, 6.60, 6.66, 6.71, Covers Chapters 1-5 (Including 5)
5	6	6.74, 6.76, 6.77, 6.78, 6.79, 6.80, 6.83, 6.85, 6.87, 6.93, 6.95, 6.97, 6.103, 6.106, 6.108, 6.109, 6.110, 6.119, 6.120, 6.123, 6.124, 6.127, 6.138, 6.140, 6.141
6	7	7.22, 7.25, 7.29, 7.48, 7.54, 7.62, 7.67, 7.73, 7.80, 7.88, 7.101
7	8 Test II	8.25, 8.26, 8.27, 8.30, 8.34, 8.45, 8.51, 8.59, 8.62, 8.68, 8.74, 8.79, 8.83, 8.85, 8.88, 8.90, 8.95, 8.104, 8.114, 8.123, 8.128, 8.131, 8.138, 8.146, 8.150, 8.171, 8.177 Covers Chapters 1-8 (Including 8)
8	9	9.22, 9.29, 9.37, 9.40, 9.43, 9.44, 9.45, 9.46, 9.47, 9.62, 9.83, 9.85, 9.89, 9.96, 9.99, 9.101, 9.126, 9.136, 9.137, 9.147, 9.149, 9.155, 9.157, 9.166, 9.168
9	11	11.27, 11.40, 11.42, 11.50, 11.64, 11.71, 11.73, 11.74, 11.82, 11.90, 11.95, 11.99
10	11	11.122, 11.126, 11.133
11	Final Exam	Deadline for turning in the final projects

Prepared by: Homayun Navaz, Professor of Mechanical Engineering