Fall 2020

ME 311-105: Thermodynamics I

Naruemon Suwattananont

MECHANICAL ENGINEERING
NEW JERSEY INSTITUTE OF TECHNOLOGY

ME311 Thermodynamics I
(FALL 2020)

Course Description:
Thermodynamic fundamentals. Topics are the first and second laws of thermodynamics, physical properties of pure substances, entropy, ideal and real gases, and gaseous mixtures.

Credits and Contact Hours: 3 credits, 3 contact hours (3-0-0).

Prerequisites: MATH 211, PHYS 111.

Class Time: Section 105 – THU. 06:00 PM - 08:50 PM (Synchronous Online via WebEx)

Instructor: Prof. Naruemon Suwattananont
MEC324; ns48@njit.edu

Required textbook:
Y. A. Çengel, M.A. Boles and M.Kanoglu. Thermodynamics: An Engineering Approach, 9th Ed., McGraw-Hill, NY, 2019.

Course Motivation: This course is an introduction to the concept of energy. It provides the basic tools necessary for the analysis of any engineering system in which energy transfer or energy transformations occur; thus, thermodynamics is an important part of the training of almost all engineering disciplines.

Course Objectives: The students will be asked to demonstrate their knowledge of the material covered in this first thermodynamics course through their mastery of the following course objectives. Through the study of this material the student will be able to:

1. Determine properties of real substances, such as steam and refrigerant 134-a, and ideal gases from either tabular data or equations of state.
- Use absolute, gage, and vacuum pressures correctly.
- Calculate gage and vacuum pressures using the manometer equation.
- Use absolute and Celsius temperatures correctly.
- Determine property data using the steam and R-134a tables.
- Sketch P-v, T-v, and P-T plots for steam, R-134a, and ideal gases.
- Locate data states on P-v, T-v, and P-T plots for steam, R-134a, and ideal gases.
- Determine the condition of a data state as a compressed, saturated, or superheated state and determine the thermodynamic properties at that state by using property tables
- Demonstrate the use of quality in finding properties of two-phase substances.
- Apply the concept of the generalized compressibility factor to demonstrate when the ideal gas equation may be used to determine the state of a gas.

- Apply the ideal gas equation to solve problems involving pressure, temperature, and volume of ideal gases.
- Determine changes in internal energy and enthalpy for ideal gases.

2. Analyze processes involving ideal gases and real substances as working fluids in both closed systems and open systems or control volumes to determine process diagrams, apply the first law of thermodynamics to perform energy balances, and determine heat and work transfers.

- Determine the pressure-volume relation for processes and plot the processes on P-v and diagrams.
- Calculate the boundary work for a variety of processes for closed systems.
- Apply the first law to closed systems containing ideal gases, steam, or R-134a to determine heat transfer, work, or property changes during processes.
- Apply the first law to steady-flow open systems containing ideal gases, steam, and refrigerant-134a to determine heat transfer, work, and property changes during processes.

3. Analyze systems and control volumes through the application of the second law.

- Determine the efficiency of heat engines and compare with the Carnot heat engine efficiency.
- Determine the coefficient of performance of refrigerators and heat pumps and compare with refrigerators and heat pumps operating on the reversed Carnot cycle.
- Determine entropy changes for both ideal gases and real substances.
- Determine the properties of a working fluid at the end of an isentropic process.
- Plot processes on both P-v and T-s diagrams.
- Apply both the first and second laws to determine heat transfer, work, and property changes during processes occurring in both closed and open systems.

4. Analyze systems through the application of the concepts of exergy.

HW assignments:

Homework is issued at every lecture and due at the beginning of the following lecture.

Homework format guidelines:

- Structure the solution into the following sections:

Known	– The problem is posed
Find	– The quantities to be found are stated
Sketch	– The physical situation and/or diagram
Assumptions	– The significant assumptions in solving the problem are stated
Properties	– The materials properties needed to solve the problem are listed
Analysis	– The problem is solved in a systematic manner, showing all steps, the fundamental equations from which the calculation begins are included, and all numerical values (including units) are shown
Discussion	– Comments are made on the results, as appropriate

Exam:

The Respondus Lockdown Browser and webcam are required for taking online exams in Canvas.

The exams will be held in the regular time following the syllabus weekly schedules.

The exams are closed book and notes. The *formula sheets and scratch papers* are allowable.

Only *non-programmable calculator* is allowed during the exams. Mobile phones, smart watches, programmable calculators, and similar electronic devices are prohibited.

No bathroom breaks are allowable during the exams.

Grading:

Exam1	17%	A	Superior
Exam2	17%	B+	Excellent
Exam3	17%	B	Very Good
Final Exam	34%	C+	Good
Quizzes	10%	C	Acceptable
HW& Class Participation	5%	D	Minimum
		F	Inadequate

Lecture Topics and Assignment:

Week	Date	Topics	Chapter	Problems
1	9/3/20	Introduction and Basic Concepts	1	1-4C, 1-6C, 1-13, 1-19C, 1-23C, 1-33C, 1-40C, 1-58, 1-72, 1-109E
2	9/10/20	Energy, Energy Transfer, and General Energy Analysis	2	2-2C, 2-16, 2-21C, 2-31, 2-44E, 2-52C, 2-69, 2-73
3	9/17/20	Properties of Pure Substances	3.1-3.5	3-3C, 3-4C, 3-22, 3-28, 3-30, 3-40, 3-46, 3-64
4	9/24/20	Properties of Pure Substances (cont.) Energy Analysis of Closed Systems	3.6-3.8 4.1-4.2	3-65C, 3-69, 3-79E, 3-88, 3-89
5	10/1/20	Energy Analysis of Closed Systems (cont.) **EXAM 1 (Chapter 1-3)**	4.3-4.5	4-3C, 4-6, 4-28, 4-41, 4-61, 4-72, 4-87
6	10/8/20	Mass and Energy Analysis of Control Volumes	5.1-5.3	5-2C, 5-4C, 5-6, 5-15, 5-22
7	10/15/20	Mass and Energy Analysis of Control Volumes (cont.)	5.4-5.5	5-38, 5-42C, 5-46, 5-65, 5-78E, 5-81, 5-97
8	10/22/20	The Second Law of Thermodynamics **EXAM 2 (Chapter 4-5)**	6.1-6.4	6-2C, 6-3C, 6-9C, 6-11C, 6-17, 6,26, 6-30C, 6-31C, 6-45, 6-57
9	10/29/20	The Second Law of Thermodynamics (cont.)	6.5-6.11	6-60C, 6-64C, 6-68C, 6-71C, 6-80E, 6-83, 6-88, 6-100, 6-109E
10	11/5/20	Entropy	7.1-7.8	7-8C, 7-21, 7-38, 7-51, 7-53, 7-67
11	11/12/20	Entropy (cont.)	7.9-7.13	7-70C, 7-86, 7-104, 7-134E, 7-137, 7-152
12	11/19/20	Exergy **EXAM 3 (Chapter 6-7)**	8.1-8.4	8-3C, 8-4C, 8-5C, 8-11C, 8-14E, 8-17, 8-22
13	11/26/20	Thanksgiving Day (No Class)		
13	12/3/20	Exergy (cont.)	8.5-8.8	8-39, 8-62, 8-75, 8-97
14	12/10/20	Review		
	12/17/20	**FINAL EXAM**	1-8	