Spring 2024

ME 311-104: ThermodynamicsI

Abul Ali

ME 311 – Thermodynamics I

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Text book: Thermodynamics – An Engineering Approach, 9th edition,
by Cengel and Boles, McGraw-Hill publisher

Course Description

This is course deals with the introduction to the concept of energy and its transformation to work and heat. Property data and the laws of thermodynamics are applied to open and steady-flow systems to perform energy balance of various engineering devices. Concepts of reversibility, thermal efficiency are introduced, Carnot heat engine and refrigerator are discussed. Concept of entropy is developed and applied to perform entropy balance. 2nd law efficiency and exergy balance are applied to thermodynamic processes and cycles.

Course Objectives

After successful completion of the course, the students should be able to:

1. Understand SI measurement units used in engineering.
2. Understand system and control volume approach in thermodynamics.
3. Develop a concept of thermodynamic properties, states, processes, and cycle.
4. Identify forms of energy, mechanical energy and their applications.
5. Recognize work and heat.
6. Apply 1st law of thermodynamics, thermal efficiency.
7. Be familiar with property tables for fluids.
8. Understand ideal gas equation, compressibility and other equations of states.
9. Perform energy balance of closed system.
10. Perform energy balance of steady-flow system.
11. Apply energy balance equations to various engineering devices.
12. Understand the 2nd law of thermodynamics, reversible and irreversible processes, Carnot heat engine & refrigerator.
13. Develop a concept of entropy, isentropic processes.
14. Apply T-ds relationships in solving problems related to ideal gases for various engineering devices.
15. Understand isentropic efficiency related heat engines and refrigerators.
16. Perform entropy balance of thermodynamic systems.
17. Understand exergy transfer and destruction.
18. Apply exergy balance for closed and steady-flow systems.

COURSE ATTENDANCE AND PARTICIPATION:

- There will be one lecture per week following the academic calendar.
- Every single lecture is important.
- Students are strongly advised to be highly proactive throughout the semester to stay with the pace of the course.
- Follow each lecture attentively. Participate in discussions.
- There will be periodic quizzes throughout the semester, in addition to scheduled exams.
- Canvas will be used as part of the course presentation and communications.
- Make sure you have installed Canvas and WebEx in your computer and that you are fluent in using these software.
- Contact NJIT - IST Service Desk if you need help in using Canvas. The instructor cannot resolve IT issues for you.

COMMUNICATION PLATFORM:

Canvas will be used as our communication platform. I will be posting my lecture slides routinely for each chapter. The slides will be posted in Canvas/Files. Make sure you have installed Canvas and WebEx in your computer and that you are fluent in using the software.

POSTING AND REVIEWING LECTURE SLIDES:

All lecture slides will be routinely posted in Canvas throughout the semester. This will be done either through using “Files” in Canvas or through providing a link for the location of the file.

To review the slides:

- You must first download the files from Canvas.
- Open the Power Point file.
- Select “Slide Show”
- From selection menu, select “From Beginning”, or “From Current Slide” as you need.
- The slides will now be presented with full animations.
- Successful performance in the course requires that you thoroughly review these materials immediately after each lecture.
- This should be followed by any clarification/question that you may have.
- Such discussions preferably should be carried out by using the “Discussions” forum in Canvas or by discussing issues with the professor during the office hour.
- Using the “Discussions” forum will give exposure to other students as well who may have similar questions.

COURSE PRESENTATION

Week	Topic	Chapter	Activities
1	**Thermodynamic Basics:** Dimensions and Units, Unit Conversion, Heat and Work, System and Control Volume, Properties, States, Processes and Cycles, Zeroth Law.	1	**Lecture**
2	**Thermodynamic Basics:** Pressure due to external forces. Energy: Forms of Energy, Internal energy, Mechanical Energy, Energy of closed and steady flow system, Energy and work transfer, Forms of work, 1st law of thermodynamics for closed system.	2	**Quiz #1 (week 2)** **Lecture**
3, 4, 5	**Properties of Pure Substance:** Phase Change, Property Diagram, Thermodynamic Tables. Ideal Gas Equation of State, Compressibility Factor, Other Equations of State.	3	**Quiz #2 (week 4)** **Lecture**
Exam #1 on Week 6 covering chapters 1, 2, and 3			
6	**Energy Analysis of Closed Systems:** Moving Boundary of Work, Energy Balance of Closed System.	4	**Exam #1 (week 6)** **Lecture**
7	**Energy Analysis of Closed Systems:** Specific Heats, Internal Energy, Enthalpy, Specific Heat for Ideal Gases, Specific Heat of Solids and Liquids.	4	**Lecture**
8, 9	**Energy Analysis of Control Volume:** Conservation of Mass, Flow Work, Energy Balance of Steady Flow Systems, Nozzles & Diffusers, Turbines & Compressors, Throttle Valves, Mixing Chambers, Heat Exchangers.	5	**Quiz #3 (week 8)** **Lecture**
9, 10	**Introduction to 2nd Law:** Thermal Reservoir, Heat Engines, Refrigerators, Heat Pumps, Perpetual Machines, Reversible & Irreversible Processes, Carnot Cycle, Carnot Principle, Thermodynamic Temperature Scale.	6	**Exam #2 (week 10)** **Lecture**
Exam #2 on Week 10 covering chapters 4, and 5			
11	**Entropy:** Entropy, Increase of Entropy Principle, Entropy Change of Pure Substances, Isentropic Processes, Property Diagrams involving Entropy.	7	**Lecture**
12, 13	**Entropy:** Isentropic Efficiencies of Steady Flow Devices, T-ds Relationship, Entropy Changes of Liquids and Solids. Entropy Changes of Ideal Gases, Reversible Steady Flow Work, Compressor Work,	7	**Quiz #4 (week 12)** **Lecture**
14	**Exergy:** Reversible Work, Irreversibility, 2nd Law Efficiency, Exergy and exergy change of a System, Exergy and exergy change of control volume, 2nd law efficiency of mechanical devices, Decrease of exergy and exergy destruction.	8	**Exam #3 (week 14)** **Lecture**
COMPREHENSIVE FINAL EXAM			

COURSE TENTATIVE GRADING SCHEME:

The course evaluation will be based on the following scheme.

- Multiple Quizzes
- 3 Mid-Term Exams
- Comprehensive Final Exam
- Attendance and Participation

Your course grade will be determined as follows:

Quizzes	15%
Exam 1	20%
Exam 2	20%
Exam 3	20%
Final Exam	20%
Attendance & Participation	5%

NOTE: The above is a tentative grading scheme. It is subject to slight modification if felt necessary by the instructor.

To be properly prepared for exams, you should read the textbook, review the lecture slides and your class notes on a regular basis, and do the exercises problems suggested by the instructor.

Absolutely no make-up exams will be given. Do not ask for it.
If you miss an exam or quiz your marks for the exam or quiz will be zero.

TENTATIVE GRADING SCALE:

Letter Grade	Total Weighted Mark
A :	90 – 100
B+ :	80 – 89
B :	75 – 79
C+ :	70 – 74
C :	60 – 69
D :	50 – 59
F :	0 – 49

EXERCISE PROBLEMS:

- Exercise problems will be assigned throughout the semester at the end of each topic/chapter.
- This course has a heavy focus on conceptual understanding of the basics of thermodynamics. Doing the exercise problems is vital in clearly understanding the concepts.
- Students are strongly advised to discuss any conceptual issue that may arise while doing the problems.

OFF-LECTURE HELP / OFFICE HOURS:

- There is a scheduled office hour each week.

  Every Wednesday 3:00 PM – 5:00 PM

- In addition, we will communicate through Canvas / Discussions or emails to clarify issues.
- Students are advised to post their questions in Canvas / Discussions. This allows everybody to see the questions and obtain answers.

One to one WebEx session is impractical and will not be entertained at any anytime. Please do not ask for it. Resolve your issues using e-mails / Discussions forum / Office hours.