

CAE 208: Thermal-Fluids Engineering I
MMAE 320: Thermodynamics

Illinois Institute of Technology

Department of Civil, Architectural and Environmental Engineering

Fall 2022
3 credit hours

Course Unique Number(s)

CAE 208 Section 01: 10116 – In Person

CAE 208 Section 02: 15456 – Online (Only for remote graduate students with a permit)

MMAE 320: Section 02: 11208 – In Person

Classroom and Meeting Time

Robert A. Pritzker Science Center (PS) 152, Tuesdays and Thursdays, 10 AM – 11:15 AM

Course Website

All content will be provided on Blackboard

Prerequisites

PREREQUISITE(S): ((CHEM 122 and CHEM 123) or CHEM 124) and (PHYS 123 and CS104-105 and MATH 251*), An asterisk (*) designates a course which may be taken concurrently.

Instructor

Mohammad Heidarinejad, Ph.D., P.E. Assistant Professor, Architectural Engineering

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Teaching Assistant

Jongki Lee

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ARC SI

Rachel Naomi Tjakra

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Office Hours

Instructor: Office hours are by appointment only. Please email me to schedule an appointment. Or stop by when you see my office door open to see if I'm free. I have an open door policy.

Teaching Assistant: Wednesdays 1-3 pm and Tuesdays 12-3 pm

SI: Tuesdays and Fridays from 7 to 8 pm held via zoom

Course Catalog Description

Basic principles of thermodynamics applied to engineering systems using pure substances and mixtures as working fluids. Direct application of the laws of thermodynamics to analysis of closed and open systems, mass and energy flow. Extensive analysis of isentropic processes in cycles, analysis of gas mixtures and psychometrics in heating and cooling systems. Introduction to fluid mechanics and analysis of fluid statics problems.

Instructor's Course Objectives and Learning Outcomes

To introduce students to fundamentals and theory of thermodynamics. By taking this course students will be able to:

1. Learn properties of pure substances and their implications for building science
2. Understand fundamentals of fluid and energy flows both for open and closed systems
3. Acquire a knowledge of first and second laws of thermodynamics
4. Become proficient in understanding and applications of power cycles and vapor compression cycles

Textbook

Cengel, Y.A., Cimbala, J.M., Ghajar, A.J., *Fundamentals of Thermal-Fluid Sciences*, 6th Edition, 2022. 126059758X 9781260597585

The 5th and 4th edition or older editions are also accepted. Assignments will be posted on Blackboard.

References (optional; will be given handouts when necessary)

In addition to the textbook, I may also rely on several other materials in this course. These materials are entirely optional for the student; handouts will be given when necessary, so that no one is required to purchase these items.

Borgnakke, C. and Sonntag, R.E., *Fundamentals of Thermodynamics*, 10th Edition, Wiley, 20

Sonntag, R.E., Borgnakke, C., Van Wylen, G.J., *Fundamentals of Thermodynamics*, 6th Edition, Wiley, 2002, ISBN 0471152323, 9780471152323

Homework Assignments

There will be a total of 11 homework assignments. Out of 11 assignments, the best of 10 will be used in the final grade. Homework sets will be assigned based on lecture coverage. The homework will involve hand calculations, development of spreadsheets, modeling, and/or learning the fundamentals and data analysis. Each homework will be assigned at least a week before the homework due date. Each assignment accounts for 1.5% of the total grade. You must work on the homework assignments individually.

Exams

There will be three exams focused on the fundamental concepts learned in the course. Two exams will be during the semester and the third exam will be the final exam. The first exam will cover materials till the last week before the exam. The second exam will only cover materials that are not covered in Exam 1. Exam 3 will cover all the materials in the course. Out of the three exams, the best of two exams will be used for the grade. Missing the exam will lead to zero grade for the exam.

Quizzes

Students will take random in-class pop quizzes. The quizzes are short and usually they can be solved within 10 minutes. The instructor will randomly assign quizzes in class. There might be two quizzes in a given week. Online student should take the exam on Blackboard.

Attendance

All students are expected to attend classes regularly. Excessive absences may be grounds for a failing grade. Quizzes will serve as the only means to assess the student attendance. Students who

attend all the quizzes will receive 5% bonus point. Students who attend 90% of the quizzes will receive 2.5% bonus points. Students should familiar themselves with the attendance Illinois Tech's attendance policy here:

<http://bulletin.iit.edu/undergraduate/academic-policies-procedures/registration/>

Late Homework Assignment and Report Policy

Homework assignments and the course project are due at the midnight on the day that it is due. Homework assignments and the course project will receive a 5-point deduction for every day that it is late before the solution is posted on Blackboard. After the solution is posted or the assignments are graded, the blackboard submission page is closed for that particular homework.

Grading

For all students, course grades will be determined by the total number of points accumulated through assignments, exams, and course project. The percentage of total points required for various letter grades is also given. There is a 5% bonus points for those who attend all the classes.

Grading	Quantity	% of Total for Each	% of Total
Homework	9	1.875	15 (Best of eight)
Exams	3	35	70 (Best of two)*
Quizzes	Vary	Depends on the number of quizzes	15
Attendance	-	-	Max 5

Grading Scale	A	B	C	D	F
UG and G	90% and up	80.0 – 89.9%	70.0 – 79.9%	60.0 – 69.9%	< 60.0%

** If the final exam grade is greater than the best of two exams, the entire final exam grade will be counted as 70.*

Personal Problems

If you have illness or personal problems that will affect your performance during the course of the semester, please let me know as soon as possible. “**After the fact**” provides little protection unless there are extreme circumstances. Contact the instructors by phone or e-mail at any time.

Students with Disabilities

Reasonable accommodations will be made for students with documented disabilities. In order to receive accommodations, students must obtain a letter of accommodation from the Center for Disability Resources. The Center for Disability Resources (CDR) is located in Life Sciences Room 218, telephone (312) 567-5744 or email: disabilities@iit.edu.

Academic Honesty

It is your responsibility to be familiar with IIT's Code of Academic Honesty. The Code of Academic Honesty can be found online: <https://www.iit.edu/student-affairs/student-handbook/fine-print/code-academic-honesty>

You must submit your own work for homework. You are encouraged to discuss and even work with other students on homework (unless explicitly told otherwise), but material that is submitted must be your own work. For group project assignments, each group is to submit their own work. For a first violation of the IIT Code of Academic Honesty for a homework or project, the

homework will receive a grade of zero for all involved students and the students will be reported to the Designated Dean for Academic Discipline (DDAD). For a first violation of the Code of Academic Honesty for a major project or an examination, the student will receive a failing grade for the course and the student will be reported to the DDAD. For a second violation, the student will receive also failing grade for the course and be reported to the DDAD.

COVID-19 Update, April 04, 2022: Information for the university's COVID related policy is accessible here: <https://www.iit.edu/reopening>. Please make sure to review the policy.

Illinois Tech's Sexual Harassment and Discrimination Information

Illinois Tech prohibits all sexual harassment, sexual misconduct, and gender discrimination by any member of our community. This includes harassment among students, staff, or faculty. Sexual harassment of a student by a faculty member or sexual harassment of an employee by a supervisor is particularly serious. Such conduct may easily create an intimidating, hostile, or offensive environment.

Illinois Tech encourages anyone experiencing sexual harassment or sexual misconduct to speak with the Office of Title IX Compliance for information on support options and the resolution process.

You can report sexual harassment electronically at [iit.edu/incidentreport](https://www.iit.edu/incidentreport), which may be completed anonymously. You may additionally report by contacting the Title IX Coordinator, Virginia Foster at foster@iit.edu or the Deputy Title IX Coordinator at eespeland@iit.edu.

For confidential support, you may reach Illinois Tech's Confidential Advisor at (773) 907-1062. You can also contact a licensed practitioner in Illinois Tech's Student Health and Wellness Center at student.health@iit.edu or (312)567-7550.

For a comprehensive list of resources regarding counseling services, medical assistance, legal assistance and visa and immigration services, you can visit the Office of Title IX Compliance website at <https://www.iit.edu/title-ix/resources>.

FE Exam

This is an important course for your Fundamental of Engineering (FE) exam. For students in Architectural Engineering, there are 9 to 14 questions in Section "14. Thermodynamics and Heat Transfer":

- A. Thermodynamic laws (e.g., first law, second law)
- B. Thermodynamic equilibrium
- C. Thermodynamic properties (e.g., entropy, enthalpy, heat capacity)
- D. Thermodynamic processes (e.g., isothermal, adiabatic, reversible, irreversible)
- E. Heat transfer (e.g., conduction, convection, radiation)
- F. Mass and energy balances
- G. Property and phase diagrams (e.g., T-s, P-h, P-v)
- H. Combustion and combustion products (e.g., CO, CO₂, NO_x, ash, particulates)
- I. Psychrometrics (e.g., relative humidity, wet bulb)

Most of the topics will be covered in this course and the heat transfer topics will be covered in CAE 209 and CAE 331. Architectural engineering students are encouraged to visit this page: <https://ncees.org/wp-content/uploads/FE-Other-Disciplines-CBT-specs.pdf>

Similarly, FE exam for mechanical engineering students includes 10 to 15 questions. Mechanical engineering students are encouraged to visit the Mechanical Engineering Exam requirements here: <https://nces.org/wp-content/uploads/FE-Mechanical-CBT-specs.pdf>

Course Topics and Tentative Schedule

Week	Date	Topics	Reading	Assignment Due
1	08/23/22	Introduction and Overview (I)	Ch. 1	
	08/25/22	Basic Concepts of Thermodynamics (I)	Ch. 2	
2	08/30/22	Basic Concepts of Thermodynamics (II)	Ch. 2	
	09/01/22	Basic Concepts of Thermodynamics (III)	Ch. 2	
3	09/06/22	Energy, Energy Transfer, and General Energy Analysis (I)	Ch. 3	Assignment 1
	09/08/22	Energy, Energy Transfer, and General Energy Analysis (II)	Ch. 3	
4	09/13/22	Energy, Energy Transfer, and General Energy Analysis (III)	Ch. 3	Assignment 2
	09/15/22	No Class – Recording	Ch. 4	
5	09/20/22	Properties of Pure Substances (I)	Ch. 4	Assignment 3
	09/22/22	Properties of Pure Substances (II)	Ch. 4	
6	09/27/22	Properties of Pure Substances (III)	Ch. 4	
	09/29/22	Properties of Pure Substances (IV)	Ch. 4	Assignment 4
7	10/04/22	Energy Analysis of Closed Systems (I)	Ch. 5	
	10/06/22	Energy Analysis of Closed Systems (II)	Ch. 5	
8	10/11/22	Energy Analysis of Closed Systems (III)	Ch. 5	Assignment 5
	10/13/22	Exam 1		
9	10/18/22	Mass and Energy Analysis of Control Volumes (I)	Ch. 6	
	10/20/22	Exam Solutions		
10	10/25/22	Mass and Energy Analysis of Control Volumes (II)	Ch. 6	
	10/27/22	Mass and Energy Analysis of Control Volumes (III)	Ch. 6	
11	11/01/22	Mass and Energy Analysis of Control Volumes (IV)	Ch. 6	Assignment 6
	11/03/22	The Second Law of Thermodynamics (I)	Ch. 7	
12	11/08/22	The Second Law of Thermodynamics (II)	Ch. 7	Assignment 7
	11/10/22	Exam 2		
13	11/15/22	The Second Law of Thermodynamics (III)	Ch. 7	
	11/17/22	Entropy (I)	Ch. 8	
14	11/22/22	Entropy (II)	Ch. 8	Assignment 8
	11/24/22	Entropy (III)	Ch. 8	
15	11/29/22	Power and Refrigeration Cycles (I)	Ch. 9	Assignment 9
	12/01/22	Power and Refrigeration Cycles (II)	Ch. 9	
16	12/06/22	Exam 3 (Final Exam - 12/06/22 from 10:30-12:30)		