



ABE 340: Thermodynamics for Agricultural and Biological Engineering

Fall 2026

Course Information

- Duration: Full Semester
- Contact Hours: Tuesday, Thursday, 2:00-3:20 pm (two 80-minute lecture periods each week)
- Format: In-person
- Location: 103 Bevier Hall
- Weekly Hours of Expected Student Work, apart from instruction time: 9 hours outside of class per week
- Credit Hours: 3

Instructor Information

Instructor Name: Dr. Mohammed Kamruzzaman

Instructor Title: Associate Professor, Department of Agricultural and Biological Engineering

- Contact information: mkamruz1@illinois.edu, 217-974-4040
- Office location: 376A ASEB
- Drop-in hours for students: Open door policy or by appointment
- Course Website: <https://canvas.illinois.edu/courses/50626>

Teaching Assistant (TA): Md Shahinur Alam

Ph.D. Student in the Department of Agricultural and Biological Engineering

- Contact information: msa28@illinois.edu
- Office location: 254 ASEB
- Drop-in hours for students: Monday, 9:00 am - 11:30 am, 1:00 pm - 3:30 pm.

Course Description

Fundamental concepts of thermodynamics will be introduced and applied to the discipline of Agricultural and Biological Engineering. Topics will include forms of energy and the first law of thermodynamics, energy balances on closed and open systems. Also included are the second law of thermodynamics, concepts of entropy, refrigeration and cooling. A laboratory/discussion section will explore application of thermodynamic principles applied to Agricultural and Biological Engineering systems: thermodynamics of flow processes, mass and energy balances for non-reacting systems, mechanical energy balances, thermodynamics of food drying, freezing and reaction kinetics of biological systems.

Course Goals

This course prepares students to use fundamental thermodynamics to solve agricultural and biological engineering problems. The overall goals of this course are:

- To describe basic concepts of thermodynamics
- To describe principles of thermodynamic laws
- To understand and use techniques to find and measure thermodynamic properties
- To think critically when solving thermodynamic problems
- To solve agricultural and biological engineering problems using thermodynamic principles

Learning Outcomes

Upon successful completion of this course, students should be able to

- Find and use data on thermodynamic properties of pure substances
- Draw thermodynamic processes and perform thermodynamic analyses
- Apply 1st law of thermodynamics for closed and open systems
- Apply 2nd law of thermodynamics for closed and open systems
- Apply thermodynamic laws to thermodynamic devices and determine efficiency using thermodynamic principles
- Apply entropy concepts to solve thermodynamic problems related to work and heat
- Determine properties of atmospheric air; and analyze air-conditioning processes
- Apply knowledge to solve thermodynamic problems in agricultural and biological systems
- Apply thermodynamic laws to reaction kinetics

Prerequisites

Math 241

Course Materials

Course Readings

Required Textbook:

Cengel, Yunus A., Michael A. Boles, and Mehmet Kanoglu. 2019. *Thermodynamics : An Engineering Approach*, 10th Edition, McGraw Hill (you can buy the electronic version through McGraw Hill Connect).

Optional Textbook:

Riley, Donna. 2012. *Engineering Thermodynamics and 21st Century Energy Problems: A textbook companion for student engagement*. Morgan & Claypool Publishers.

Note: These are general thermodynamics texts. For ABE-specific thermodynamics, the instructor will prepare notes.

Software

- Engineering Equation Solver, F-Chart Software, Middleton, WI (<https://www.fchartsoftware.com/ees/>)
- McGraw Hill CONNECT: A web-based assignment and assessment platform linked to the course textbook.

Course Requirements and Policies

Grading Breakdown

Instructional Activity	Occurrences	% Point Value
Attendance and in-class participation	1	5
Class quiz* (individual and group)	9	10
Homework (problem sets, PS)	9	10
Midterm Exam	4	60
Project (individual)	1	15
Total		100

(*The lowest score will be dropped to calculate the final weight at the end of the semester).

Grading Criteria

Grades are not awarded based on a class curve. Grades are based on demonstrated understanding and mastery of the topic and are not affected by others' performance in the class.

Course Components

The major course components include attendance and in-class participation, class quizzes, homework, a midterm examination, and an individual project. Attendance and active participation are expected throughout the semester to support engagement with course materials and in-class problem-solving activities. Class quizzes will include both

individual and group quizzes and will assess students' understanding and application of concepts covered in lectures. Homework will consist of problem sets (PS) and assigned readings (AR) designed to reinforce course concepts and develop problem-solving skills. The midterm examination will assess students' understanding and application of the major concepts covered in the course. The individual project will require students to apply course concepts to an engineering problem and demonstrate analytical, problem-solving, and communication skills. Detailed project requirements, deadlines, grading criteria, and submission instructions will be available on Canvas. Additional course materials, announcements, assignment updates, and other relevant information will also be posted on Canvas throughout the semester.

Homework (PS)

Homework will consist of **problem sets (PS) and assigned reading (AR)**. PS will be based on engineering problems related to each course topic, and the PS submission dates are provided in the course schedule. No late PS submissions will be accepted. However, if you need an extension due to severe illness or a family emergency, you must arrange it with the instructor before the due date and provide appropriate documentation. Solutions to the problem sets will be posted approximately one week after the submission deadline. Therefore, late PS submissions cannot be accepted once the solution key has been posted. **AR** will be completed through **McGraw Hill Connect**. Students will be assigned readings related to the course topics and will answer associated questions in Connect to assess their understanding of the material. Reading assignments and their due dates will be available through Connect and/or the course schedule. Students are expected to complete both the assigned reading and associated questions by the specified deadline. Late reading assignments will not be accepted unless an extension has been approved by the instructor under the circumstances described above.

Class Quizzes

As part of attendance and in-class participation, there will be one unannounced quiz for each unit. Each quiz may be administered at any time during the lecture period and will last approximately 10-15 minutes. There will be nine quizzes during the semester, seven individual quizzes and two group quizzes, together worth 10% of the final course grade. All quizzes will be closed-book and closed-note. No make-up quizzes will be given. If a quiz is missed because of a university-excused absence, it will be excluded from the calculation of the student's final quiz grade. The lowest quiz score will be dropped at the end of the semester. Engineering professionals often work in teams to solve problems efficiently. Therefore, two unannounced quizzes will require group participation. Groups will be created using Picker Wheel (<https://pickerwheel.com/>). Each group will ordinarily receive a single grade. However, students will be asked to indicate each team member's contribution. If all members contributed equally, they will receive the same grade; otherwise, individual grades will be adjusted based on each member's contribution.

Midterm Exams

There will be four midterm exams, including one EES-based exam, on the dates indicated in the course schedule. The exams may include multiple-choice questions, short-answer questions, and engineering problems and will assess knowledge gained from class lectures and discussions, assigned readings, and homework. All midterm exams will be open-book and open-note. The EES exam will be administered on a computer and will require students to use EES software to solve assigned engineering problems. For the other midterm exams, laptops, tablets, and mobile devices will not be permitted; however, students may use a calculator. Make-up exams will be offered only to students with a university-excused absence.

Project

For the individual project, you will design, execute, and report on an independent project related to a topic that has been or will be covered in class. The project will provide an opportunity to explore a selected topic in greater depth and learn from your classmates' projects. You will present your findings through both a written report and an oral presentation to the class.

Late Homework Policy

If you cannot meet a deadline, you are responsible for making prior arrangements with the instructor. Otherwise, work submitted within 24 hours after the deadline will receive a 2% deduction, and work submitted more than 5 days after the deadline will not be accepted for grading unless prior approval has been granted by the instructor.

Class Attendance

Students are expected to attend all scheduled class sessions, arrive on time, and remain engaged during lectures, discussions, quizzes, and other in-class activities. Attendance may be recorded during class and will contribute to the attendance and in-class participation component of the final grade. Students who miss class are responsible for reviewing the material covered and obtaining any announcements or information provided during the missed session.

Class Attendance & Participation Policy

Regular class attendance is expected of all students at the university. The authority to excuse absences rests with the course instructors, subject to the requirement to reasonably accommodate class absences (see 'Absence Policy' below). Enrollment in this course includes expectation of regular attendance, and this is reflected in the Participation Grade. If you find you must miss (or have missed) class, contact the instructor as soon as possible. Repeated tardiness or leaving sessions early may be considered an unexcused absence unless alternate arrangements have been made with the instructor. Absences due to university-approved activities, illness, emergencies, or other circumstances recognized under University policy will be handled in accordance with University guidelines. When possible, students should notify the instructor in advance of an anticipated absence and provide appropriate documentation when required.

Attendance and participation will be evaluated by taking attendance each class, asking questions, participating in discussion topics, and answering questions when called upon during class.

Absence Policy

Attending all scheduled classes is essential for success in the course. However, circumstances may arise that require you to miss a class. If you need to miss a class for a legitimate and foreseeable reason, you must notify the instructor and make arrangements for any missed work at least one week before the absence. If you are seriously ill or experience a family emergency and cannot attend a scheduled class, please email the instructor as soon as possible.

Final Letter Grades

Grades will be calculated based on the total number of points you earn.

Grading Scale

Approximate Grading Scale (+/-) are:

Percentage/Points	Letter Grade
=>96.00	A+
91.00-95.99	A
86.00-90.99	A-
83.00-85.99	B+
80.00-82.99	B
77.00-79.99	B-
74.00-76.99	C+
71.00-73.99	C
68.00-70.99	C-
65.00-67.99	D+
62.00-64.99	D
60.00-61.99	D-
<60	F

Campus Academic Policies & Statements

Academic Integrity

The University of Illinois Urbana-Champaign [Student Code](https://studentcode.illinois.edu/) (https://studentcode.illinois.edu/) should also be considered as a part of this syllabus. Students should pay particular attention to Article 1, Part 4: Academic Integrity.

Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the [Academic Integrity Policy](https://studentcode.illinois.edu/article1/part4) (https://studentcode.illinois.edu/article1/part4). Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

Generative AI use statement for ABE 340

Artificial Intelligence (AI) tools such as ChatGPT, Microsoft Copilot, Gemini, Claude, and similar technologies may be used to support learning, studying, and concept clarification in this course. You may use AI tools to help explain thermodynamic concepts, generate practice problems, review mathematical procedures, improve writing quality, and assist with coding or computational exercises when applicable. However, use AI as a learning aid, not a substitute for independent thinking and problem solving. You are expected to:

- Understand and verify all AI-generated content before using it.
- Be able to explain and reproduce any solution, calculation, analysis, or written work submitted for credit.
- Independently complete all quizzes, examinations, and other assessments where outside assistance is prohibited.
- Ensure that all submitted work accurately reflects their own understanding of the material.
- Disclose substantial use of AI tools when required by the instructor.

You remain fully responsible for the accuracy, integrity, and originality of all submitted work. Using AI to generate solutions without understanding the underlying concepts, or to circumvent learning objectives, may be considered a violation of the University of Illinois Academic Integrity Policy.

Students with Disabilities

The University of Illinois Champaign-Urbana, is committed to ensuring that all students, including students with disabilities, do not experience barriers to learning and participating fully in class. Students who have a letter of accommodation from Disability Resources and Educational Services (DRES) are advised to share that with instructors as soon as possible to ensure accommodation needs can be discussed and met.

To obtain disability-related academic accommodations, disabled students are encouraged to contact DRES as soon as possible. To contact DRES, please visit 1207 S. Oak Street, Champaign, call (217) 333-1970, email disability@illinois.edu, or visit the [DRES website](https://dres.illinois.edu/) (<https://dres.illinois.edu/>).

Family Educational Rights and Privacy Act (FERPA)

See [FERPA – Office of the Registrar](https://registrar.illinois.edu/academic-records/ferpa/) (<https://registrar.illinois.edu/academic-records/ferpa/>) for more information on the Family Educational Rights and Privacy Act (FERPA).

Mental Health

Significant stress, mood changes, excessive worry, substance/alcohol misuse or interferences in eating or sleep can have an impact on academic performance, social development, and emotional wellbeing. The University of Illinois offers a variety of confidential services including individual and group counseling, crisis intervention, psychiatric services, and specialized screenings which are covered through the Health Service Fee. If you or someone you know experiences any of the above mental health concerns, it is strongly encouraged to contact or visit any of the University's resources provided below. Getting help is a smart and courageous thing to do for yourself and for those who care about you.

- Counseling Center (217) 333-3704
- McKinley Health Center (217) 333-2700
- National Suicide Prevention Lifeline (800) 273-8255
- Rosecrance Crisis Line (815) 720-4953 (available 24/7, 365 days a year)

If you are in immediate danger, call 911.

This statement is approved by the University of Illinois Counseling Center.

Community of Care

As members of the Illinois community, we each have a responsibility to express care and concern for one another. If you come across a classmate whose behavior concerns you, whether regarding their well-being or yours, we encourage you to refer this behavior to the Connie Frank CARE Center (formerly the Student Assistance Center) in the Office of the Dean of Students. You may do so by calling (217) 333-0050 or by submitting an CARE [online referral](https://odos.illinois.edu/community-of-care/referral) (<https://odos.illinois.edu/community-of-care/referral>). Based on your report, staff in the Connie Frank CARE Center will reach out to offer support and assistance.

Further, as a Community of Care, we want to support you in your overall wellness. We know that students sometimes face challenges that can impact academic performance (examples include mental health concerns, food insecurity, homelessness, personal emergencies). Should you find that you are managing such a challenge and that it is interfering with your coursework, you are encouraged to contact the [Connie Frank CARE Center](https://odos.illinois.edu/community-of-care/CAREcenter) (<https://odos.illinois.edu/community-of-care/CAREcenter>) (formerly the

Student Assistance Center) in the Office of the Dean of Students for support and referrals to campus and/or community resources.

Ombuds Assistance & Resources for Students (OARS)

OARS is housed in the Office of the Dean of Students and serves as a confidential, impartial, informal, and independent resource for students seeking guidance, clarity, and resolution when facing challenges or conflicts with university faculty, staff, policies, procedures, or practices. The office exists to provide a space where students can feel heard, discuss their concerns, explore potential options and pathways for resolving disputes and, when appropriate, be referred to other campus resources. The Student Ombudsperson listens without judgment, helps clarify issues, identifies possible pathways forward, and supports students in making their own decisions. For more information, please visit [the Ombuds Assistance & Resources for Students \(OARS\)](https://oars.illinois.edu/) (<https://oars.illinois.edu/>).

Disruptive Behavior

Behavior that persistently or grossly interferes with classroom activities is considered disruptive behavior and may be subject to disciplinary action. Such behavior inhibits other students' ability to learn and an instructor's ability to teach. A student responsible for disruptive behavior may be required to leave class pending discussion and resolution of the problem and may be reported using the [Public Incident Report Form](https://go.illinois.edu/ReportMisconduct) (<https://go.illinois.edu/ReportMisconduct>), email (conflictresolution@illinois.edu), or phone (217) 333-3680 to the [Office for Student Conflict Resolution](https://conflictresolution.illinois.edu/) (<https://conflictresolution.illinois.edu/>) for disciplinary action.

Emergency Response Recommendations

For emergency response recommendations and building floor plans, review [Public Safety's Run, Hide, Fight information](https://police.illinois.edu/em/run-hide-fight/) (<https://police.illinois.edu/em/run-hide-fight/>), [Emergency Action Plans](https://eoc.illinois.edu/plans/eap/) (<https://eoc.illinois.edu/plans/eap/>), and [Facility Access Maps](https://facilityaccessmaps.fs.illinois.edu/archibus/schema/ab-products/essential/workplace/index.html) (<https://facilityaccessmaps.fs.illinois.edu/archibus/schema/ab-products/essential/workplace/index.html>). I encourage you to review these resources within the first 10 days of class.

Religious Observances

It is the policy of the University of Illinois Urbana-Champaign to reasonably accommodate its students' religious beliefs, observances, and practices that conflict with a student's class attendance or participation in a scheduled examination or work requirement, consistent with state and federal law. Students must make requests for accommodation in advance of the conflict to allow time for both consideration of the request and alternate procedures to be prepared. Requests should be directed to the instructor. An optional resource to assist students in making such requests can be found on the [Religious Observances website](https://odos.illinois.edu/resources/students/religious-observances) (<https://odos.illinois.edu/resources/students/religious-observances>) of the Office of the Dean of Students.

Sexual Misconduct Reporting Obligation

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX Office. In turn, an individual with the Title IX Office will provide information about rights and options, including supportive measures, resources, the campus disciplinary process, and law enforcement options.

A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found on [We Care Student Resources](https://wecare.illinois.edu/resources/students/#confidential) (<https://wecare.illinois.edu/resources/students/#confidential>) and on the [Illinois app](#). Other information about resources and reporting is available on [At Illinois We Care](https://wecare.illinois.edu/) (<https://wecare.illinois.edu/>) and on the [Illinois app](#).

Veterans and Military Students

As a military-friendly institution, and per federal regulations and Illinois statutes, the University of Illinois Urbana-Champaign has established policies and procedures to accommodate military-connected students. In addition to the support available at the [Chez Veterans Center](https://chezveteranscenter.ahs.illinois.edu/) (<https://chezveteranscenter.ahs.illinois.edu/>), members of the National Guard or Reserves and active-duty military personnel with military obligations (e.g., deployments, training, drills) are encouraged to communicate these, in advance whenever possible, to the instructor. For policy details, see the Student Code on [Excused Absences and Departure from the University for U.S. Military or other U.S. National Defense Services](https://studentcode.illinois.edu/article3/part3/3-313) (<https://studentcode.illinois.edu/article3/part3/3-313>).

Course Schedule/Outline

Date	Wk	Cl	Topic	Preparation/reading	Assn Given	Assn Due**
8.25 Tu	1	1	Course overview, philosophy, and introduction to thermodynamics			
8.27 Th		2	U1: Introduction to engineering calculations, units, systems, basic concept of dimensional analysis, thermodynamics, properties of a system, review concept of temperature, temperature scales & pressure	U1 notes/Ch 1	PS1, AR1	
9.01 Tu	2	3	U1 (cont)			
9.03 Th		4	U1 (cont), problem-based learning (PBL)	U1 notes/Ch 1	UIF	UIF
9.08 Tu	3	5	U2: First law of thermodynamics for closed systems, forms of energy, energy transfer by heat, general energy analysis, energy conversion efficiency			
9.10 Th		6	U2 (cont)	U2 notes/Ch 2	PS2, AR2	PS1, AR1
9.15 Tu	4	7	U2 (cont), PBL	U2 notes/Ch 2	UIF	UIF
9.17 Th		8	U3: Properties of pure substances, physics of phase change process, thermodynamics tables	U3 notes/Ch 3	PS3, AR3	PS2, AR2

9.22 Tu	5	9	U3 (cont),			
9.24 Th		10	U4: Energy analysis of closed system	U4 notes/Ch 4	PS4, AR4	PS3, AR3
9.29 Tu	6	11	Exam 1 (U 1, 2, 3)			
10.01 Th		12	U4 (cont): Mass and Energy analysis of open system,	U4 notes/Ch 5		
10.06 Tu	7	13	U4 (cont)			
10.08 Th		14	Solving problems using EES			
10.13 Tu	8	15	U5: Thermodynamic devices: nozzles, diffusers, valves, turbines, compressors, mixing chamber, pipe flow, heat exchanger		PS5, AR5	PS4, AR4
10.15 Th		16	U5 (cont)	U5 notes/Ch 5		
10.20 Tu	9	17	Solving problems using EES		UIF	UIF
10.22 Th		18	U6: The second law of thermodynamics; thermal efficiency, carnot cycle	U6 notes/Ch 6 &7	PS6, AR6	PS5, AR5
10.27 Tu	10	19	U6 (cont)			
10.29 Th		20	Solving problems using EES			
11.03 Tu	11	21	Exam 2 on EES			
11.05 Th		22	U7: Vapor and combined power cycle	U7 notes, Ch 10	PS7, AR7	PS6, AR6
11.10 Tu	12	23	U8: Thermodynamic principles applied to ABE: Psychrometric chart for drying of foods	U8 notes, Ch 15	PS8	PS7, AR7
11.12 Th		24	U9: Thermodynamic principles applied to ABE: mechanical energy balances for food handling/transportation	U9 notes	PS9	
11.17 Tu	13	25	Exam 3 (U 4, 5, 6, 7)			
11.19 Th		26	U 9(cont) and U10		PS10	PS8
11.24 Tu	14	27	Fall Break			
11.26 Th		28	Fall Break			
12.01 Tu	15	29	U10 Thermodynamic principles applied to ABE freezing and thermal process control, kinetics	U10 notes		PS9
12.03 Th		30	U10 (cont)			PS10
12.08 Tu	16	31	Exam 4(8,9,10)			
12.10 Th		32	Reading day			
12.15 Tu	17	33	No class			
12.17 Th		34	Project submission and presentation			

