ABE 340: Thermodynamics for Agricultural and Biological Engineering

Course Syllabus

Instructor:	Mohammed Kamruzzaman, 376A AESB, mkamruz1@illinois.edu
Lecture :	Tuesdays and Thursdays 02:00 pm – 03:20 pm, room AESB 242
Office hours:	Open door policy or by appointment
Credit:	3 hours
Mode of delivery:	In-person
Course website:	https://canvas.illinois.edu/courses/50626

Required Textbook:

Cengel, Yunus A., Michael A. Boles, and Mehmet Kanoglu. 2019. *Thermodynamics : An Engineering Approach*, 9th Edition, McGraw Hill (you can buy 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 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. Two lectures and one laboratory/discussion session per week. Prerequisite: Math 241. Credit is not given for ABE 340 if credit for ME 200 or ChBE 321 has been given.

Course goals:

This course is designed to prepare students for using 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

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

Course assessment and criteria

Assessment	Quantity	% weight
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).

Attendance policy:

Your attendance at all scheduled classes is essential for success in the course. However, circumstances may occur where you may need to miss a class. If you need to miss class for any legitimate reason, you must make arrangements to make up the missed work a minimum of one week before the absence occurs. If you are seriously ill or experiencing a family emergency and cannot attend the scheduled class, inform the instructor via email. Attendance and participation will be evaluated by taking attendance each class, asking questions, participation in discussion topics and answering questions when called upon during class.

Homework:

Homework (Problem set, PS) will be based on engineering problems related to each course topic. Dates for PS submission are in the course schedule. No late PS submissions will be accepted. However, if you need an extension for PS due to severe illness or a family emergency, an arrangement must be made with the instructor before the due date and documentation obtained. Solutions of PS will be posted approximately after one week of your submission. Therefore, late PS submission cannot be accepted once the answer key is posted.

Class Quizzes:

As part of attendance and in-class participation, there will be one unannounced quiz for each unit. All quizzes will be taken any time during the lecture period (10-15 min long). No make-up quizzes will be given. For any quiz missed due to a university excused absence, that quiz will not be included in calculating the final quiz grade. The lowest quiz score will be dropped at the end

of the semester. There will be 9 class quizzes (7 individual and 2 group) during the semester worth 10%. Class quizzes will be closed book and notes. Engineering professionals often have to work in a team environment to solve problems quickly. There will be one group activity that requires a group effort. For group activity, the team/group will be created using Picker Wheel (https://pickerwheel.com/). There will be two group quizzes and they will not be announced. Group quizzes will receive a single group grade. However, the instructor will ask the students to write the contribution of each student on their team during the exam. If equal contribution then a single grade will be given for all students in the group as mentioned, otherwise, it will be distributed based on contribution.

Exams:

There will be four mid-term exams (one exam on EES) on the dates indicated in the course schedule. The exams may include multiple-choice questions, short questions, and engineering problems. The exams will test knowledge acquired from class lectures/discussions, reading assignments, and homework. All midterm exams will be open book (open laptop computer, tablet, or mobile device), and open notes. Dates for all exams are in the course schedule. Make-up exams will be given only for those having a university excused absence.

Project:

For individual project, you need to design, execute, and report on an independent project related to topics that have been or will be covered in class. You will explore topics in detail and learn about your classmates' topics. You need to present your findings in written papers and in oral presentations to the class.

Grading policy:

Grades will be calculated based on the total number of points you earn.
Approximate Grading Scale (+/-) are:

Overall Grade %	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

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.

ABE 340 ***Tentative*** **Course Schedule** as of **Aug 21,** 2024**

Date	Wk	Cl	Topic	Preparation/reading	Assn Given	Assn Due**
8.27 Tu	1	1	Course overview, philosophy, and introduction to thermodynamics			
8.29 Th		2	U1: Introduction of 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	
9.03 Tu	2	3	U1 (cont)			
9.05 Th		4	U1 (cont)	U1 notes/Ch 1		
9.10 Tu	3	5	Review U1, problem based learning (PBL)	U1 notes/Ch 1	UIF	UIF
9.12 Th		6	U2: First law of thermodynamics for closed systems, forms of energy, energy transfer by heat, general energy analysis, energy conversion efficiency			
9.17 Tu	4	7	U2 (cont)	U2 notes/Ch 2	PS2	PS1
9.19 Th		8	U2 (cont)	U2 notes/Ch 2		
9.24 Tu	5	9	Review U2, PBL	U2 notes/Ch 2	UIF	UIF
9.26 Th		10	U3: Properties of pure substances, physics of phase change process, thermodynamics tables	U3 notes/Ch 3	PS3	PS2
9.26 Tu	6	11	U3 (cont),			
10.01 Th		12	U4: Energy analysis of closed system	U4 notes/Ch 4	PS4	PS3
10.03 Tu	7	13	U4 (cont): Mass and Energy analysis of open system,	U4 notes/Ch 5		
10.08 Th		14	**Exam 1 (U 1, 2, 3)**			
10.10 Tu	8	15	U4 (cont)			
10.15 Th		16	U5: Thermodynamic devices: nozzles, diffusers, valves, turbines, compressors, mixing chamber, pipe flow, heat exchanger		PS5,	PS4
10.17 Tu	9	17	U5 (cont)	U5 notes/Ch 5		
10.22 Th		18	Solving problem using EES		UIF	UIF
10.24 Tu	10	19	U6: The second law of thermodynamics; thermal efficiency, carnot cycle	U6 notes/Ch 6 &7	PS6	PS5
10.29 Th		20	U6 (cont)			
10.31 Tu	11	21	U7: Vapor and combined power cycle	U7 notes, Ch 10	PS7	PS6,
11.05 Th		22	Solving problem using EES			
11.07 Tu	12	23	U8: Thermodynamic principles applied to ABE: Psychrometric chart for drying of foods	U8 notes, Ch 15	PS8	PS7
11.12 Th		24	**Exam 2 (U 4, 5, 6, 7)**			
11.14 Tu	13	25	Solving problem using EES		UIF	UIF
11.19 Th		26	U9: Thermodynamic principles applied to ABE: mechanical energy balances for food handling/transportation	**U9 notes**	PS9, UIF	PS8, UIF
11.21 Tu	14	27	**Exam 3 on EES**			
11.26 Th		28	**U 9(cont) and U10** Thermodynamic principles applied to ABE freezing and thermal process control, kinetics	U10 notes	PS 10	PS9
11.28 Tu	15	29	Thanksgiving break			
12.03 Th		30	**U10 (cont)**			PS10
12.05 Tu	16	31	**Exam 4((8,9,10)**			
12.10 Th		32	Reading day			
12.12 Tu	17	33	No class			
12.14 Th		34	Project submission and presentation			

***continuously** subject to change; check class schedule regularly

**assignments are due at 2 pm on due date

UIF: unit informal feedback

Academic Integrity

The University of Illinois at Urbana-Champaign Student Code should also be considered as a part of this syllabus. Students should pay particular attention to Article 1, Part 4: Academic Integrity. Read the Code at the following URL: http://studentcode.illinois.edu/.
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/part4/1-401/. 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.

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 Student Health 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 (217) 359-4141 (available 24/7, 365 days a year)

If you are in immediate danger, call 911.

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 in regards to their well-being or yours, we encourage you to refer this behavior to the Student Assistance Center (217-333-0050 or http://odos.illinois.edu/community-of-care/referral/). Based on your report, the staff in the Student Assistance Center reaches out to students to make sure they have the support they need to be healthy and safe. Further, we understand the impact that struggles with mental health can have on your experience at Illinois. Significant stress, strained relationships, anxiety, excessive worry, alcohol/drug problems, a loss of motivation, or problems with eating and/or sleeping can all interfere with optimal academic performance. We encourage all students to reach out to talk with someone, and we want to make sure you are aware that you can access mental health support at McKinley Health Center (https://mckinley.illinois.edu/). Or the Counseling Center (https://counselingcenter.illinois.edu/). For urgent matters during business hours, no appointment is needed to contact the Counseling Center. For mental health emergencies, you can call 911.

Students with Disabilities

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the as soon as possible. To ensure that disability-related concerns are properly addressed from the beginning, students with disabilities who require assistance to participate in this class should contact Disability Resources and Educational Services (DRES) and see the instructor as soon as possible. If you need accommodations for any sort of disability, please speak to me after class, or make an appointment to see me or see me during my office hours. DRES provides students with academic accommodations, access, and support services. To contact DRES you may visit 1207 S. Oak St., Champaign, call 333-4603 (V/TDD), or e-mail disability@illinois.edu. http://www.disability.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 to the Office for Student Conflict Resolution (https://conflictresolution.illinois.edu; conflictresolution@illinois.edu; 333-3680) for disciplinary action.

Emergency Response Recommendations

Emergency response recommendations can be found at the following website: http://police.illinois.edu/emergency-preparedness/. I encourage you to review this website and the campus building floor plans website within the first 10 days of class. http://police.illinois.edu/emergency-preparedness/building-emergency-action-plans/.

Religious Observances

Students should complete the Request for Accommodation for Religious Observances form should any instructors require an absence letter in order to manage the absence. In order to best facilitate planning and communication between students and faculty, we request that students make requests for absence letters as early as possible in the semester in which the request applies.

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 and Disability Office. In turn, an individual with the Title IX and Disability Office will provide information about rights and options, including accommodations, support services, 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 here: wecare.illinois.edu/resources/students/#confidential.

Other information about resources and reporting is available here: wecare.illinois.edu.