



BE 284 Biosystems Thermal Engineering

Tuesday/Thursday, 11:00AM – 12:15PM

In-Person Modality

Lecture Hall: Architecture, Rm 103

Description of Course

This course provides an integrated introduction to basic thermal engineering topics. A structured problem-solving approach emphasizes the interrelated roles of Thermodynamics, Fluid Mechanics, and Heat and Mass Transfer relevant to real-world engineering analyses.

Course Prerequisites or Co-requisites

MATH 129, PHYS 141

Instructor and Contact Information

Course Instructor

Murat Kacira, PhD.

Professor, Biosystems Engineering Department

Office: Shantz Building Room 504, Controlled Environment Agriculture Center (CEAC located at 1951 E. Roger Rd.) Room 104.

Email: mkacira@arizona.edu

Teaching Assistant

Olaf Jose Valencia Islas, PhD Student

Biosystems Engineering Department

Email: jovalenciais@email.arizona.edu

Office Hours:

- With Instructor: Mondays 1-2pm.
 - Office hours will be via Zoom session (<https://arizona.zoom.us/j/88532828193> ; **Password:** BE284KA)
Other than regular office hours please email me to make an appointment for Zoom or in-person based meeting and discussion.
- With Teaching Assistant: Monday 10-11am, Wednesday 11am-12pm
 - Office hours will be via Zoom session
 - (<https://arizona.zoom.us/j/87439457134> ; **Password:** BE284VA)

Note: This syllabus is longer than any syllabus in the past due to all the language around all of the course modalities for Fall 2021.

Course Objectives and Expected Learning Outcomes

The Course Objectives are: 1) to outline for the students and expose them to basic thermal engineering topics and systems, 2) to teach students structured problem-solving approach emphasizing the interrelated roles of Thermodynamics, Fluid Mechanics, and Heat and Mass Transfer relevant to real-world engineering analyses

Expected Learning Outcomes

Upon completing the course, students will be able to:

- 1) **Apply** the concepts of conservation of mass, conservation of energy, and the second law of thermodynamics,
- 2) **Apply** mass, energy, and entropy balances to closed systems and control volume systems
- 3) **Identify, formulate and solve** engineering problems in classical thermodynamics involving closed and open systems for both steady state and transient processes,
- 4) **Practice and Apply** use thermodynamic property data, units, unit conversions, significant digits,
- 5) **Identify** work interactions and heat transfer,
- 6) **Demonstrate** the ability to determine accurately the thermodynamic properties of simple compressible substances including incompressible substances and ideal gases,
- 7) **Analyze and apply** the concepts of Second Law analysis and an ability to apply them to closed and open systems for both steady and transient processes,
- 8) **Analyze** the performance of vapor and gas power cycles and to identify methods for improving thermodynamic performance,
- 9) **Comprehend** engineering applications of Psychrometrics, **Retrieve** and **Apply** data from Psychrometric charts,
- 10) **Analyze** the behavior of fluids at rest or in motion for analysis and design of engineering systems and
- 11) **Analyze** the internal flow of a viscous fluid through pipe systems and the external flow around familiar geometric shapes,
- 12) **Practice** the fundamental principles underlining heat transfer processes, and **Apply** heat transfer processes (conduction, convection and radiation) in conjunction with the first law of thermodynamics to solve problems in thermal systems engineering.

In accordance with the Accreditation Board for Engineering and Technology (ABET) goals of preparing graduates to meet the quality standards of their profession and global workforce, the course also supports the following ABET **Program Educational Outcome**:

- **ABET Criterion 1:** An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

Course Format and Teaching Methods

The course will be taught in IN-PERSON modality. Homework sets will be given each week (not graded) for students to review course materials and better prepare for quizzes and exams. Students will complete the quizzes given weekly in D2L. Two midterm exams will be taken and proctored in real-time via Zoom. Lectures will include the use of power point presentations, discussions and problem solving, and using thermodynamic property tables.

Course Communications:

All lecture notes and administrative information, including course syllabus, will be posted on the D2L course webpage.

COVID-19-Related Considerations

- **Course modality:** This class is scheduled to be taught in the IN-PERSON modality.
 - The entire class will be meeting on Tuesday and Thursday during 11am-12:15pm. The lectures will give us the opportunity to discuss about the course content scheduled for the session, practice example problems and discuss about the questions you might

have for the lecture content and problems discussed. In addition, you will review and practice homework sets (not graded), and there will be weekly quizzes (taken in the course D2L site under Quizzes section) based on learning from lectures and your review on homework sets.

- **Classroom attendance:**
 - If you feel sick or may have been in contact with someone who is infectious, stay home. Except for seeking medical care, avoid contact with others and do not travel.
 - Notify your instructor(s) if you will be missing a course meeting or an assignment deadline.
 - Non-attendance for any reason does not guarantee an automatic extension of due date or rescheduling of examinations/assessments.
 - Please communicate and coordinate any request directly with your instructor.
 - If you must miss the equivalent of more than one week of class, you should contact the Dean of Students Office DOS-deanofstudents@email.arizona.edu to share documentation about the challenges you are facing.
 - Voluntary, free, and convenient [COVID-19 testing](#) is available for students on Main Campus.
 - If you test positive for COVID-19 and you are participating in on-campus activities, you must report your results to Campus Health. To learn more about the process for reporting a positive test, visit the [Case Notification Protocol](#).
 - COVID-19 vaccine is available for all students at [Campus Health](#).
 - Visit the [UArizona COVID-19 page](#) for regular updates.
- **Class Recordings:**
 - Class sessions will be recorded and the recordings will be posted to D2L. For lecture recordings, which are used at the discretion of the instructor, students must access content in D2L only. Students may not modify content or re-use content for any purpose other than personal educational reasons. All recordings are subject to government and university regulations. Therefore, students accessing unauthorized recordings or using them in a manner inconsistent with [UArizona values](#) and educational policies ([Code of Academic Integrity](#) and the [Student Code of Conduct](#)) are also subject to civil action.
 - University of Arizona has decided that class session recordings are a part of your academic record. Accordingly, if you would like to not to be recorded, you are welcome to turn off your video and change your name during our synchronous lecture sessions.
- **Equipment and software required:** For this class you will need daily access to the following hardware: (1) a computer to access to course D2L for course materials and for Zoom based office hours sessions. (2) Zoom (free). Note, please contact me ASAP if for any reason accessing this technology is a significant financial barrier for engaging in this course, so that I may connect you with the appropriate campus resources.
- **Academic advising:** If you have questions about your academic progress this semester, please reach out to your academic advisor (<https://advising.arizona.edu/advisors/major>). Contact the Advising Resource Center (<https://advising.arizona.edu/>) for all general advising questions and referral assistance. Call 520-626-8667 or email to advising@arizona.edu
- **Life challenges:** If you are experiencing unexpected barriers to your success in your courses, please note the Dean of Students Office is a central support resource for all students and may be helpful. The [Dean of Students Office](#) can be reached at (520) 621-2057 or DOS-deanofstudents@email.arizona.edu.
- **Physical and mental-health challenges:** If you are facing physical or mental health challenges this semester, please note that Campus Health provides quality medical and mental health care. For medical appointments, call (520) 621-9202. For After Hours care, call (520) 570-7898. For the Counseling & Psych Services (CAPS) 24/7 hotline, call (520) 621-3334.
- **Compliance with COVID-19 mitigation guidelines:** As we enter the Fall semester, your and my health and safety remain the university's highest priority. To protect the health of

everyone in this class, students are required to follow the university guidelines on COVID-19 mitigation. Please visit www.covid19.arizona.edu.

Assignments and Examinations: Schedule/Due Dates

Homework:

- Assigned once per week. Homework assignments (practice problem sets) and solutions will be posted on D2L. The worked homework assignments are not turned in for grading. Those students who do the assigned homework will have the distinct advantage in the quizzes and exams over those who do not! The quizzes and exams will be designed to give the edge to those students who consistently do their homework assignments.
- Cooperation: Students are encouraged to work together on homework (practice problem sets) assignments.

Quizzes:

There will be weekly quizzes taken on D2L. The quiz questions will be based on the materials covered in the previous weeks lectures and the homework set posted for the students to practice the concepts covered in the lectures.

Exams:

There will be two midterm exam and a final exam in this course and will be taken in the same classroom where the class meets for the lectures. The exams will be based on the material covered during lectures, homework assignments, quizzes and any other supplemental materials discussed and/or distributed. Students will have access to equation sheet (provided by the instructor) and the thermodynamic tables during exams. The midterm and final exams will be taken on the dates and time indicated in the course schedule table provided in this syllabus. No make-up exams will be given in this class. If you have a legitimate reason that causes you to miss class on the day of an examination, you must contact the instructor at least one week prior to the examination. If you have an unexpected and extreme emergency on the day of the exam, such as a serious illness or accident, then you must contact the instructor (not the TA) as soon as possible. If you miss an exam without a valid excuse, you will be assigned a score of zero for the exam.

We will re-grade exams up to one week after it is returned. Email the instructor (mkacira@arizona.edu) to discuss any regrade requests. You are expected to tell the instructor *specifically* what you believe was graded incorrectly. Points may be added for errors made in the prior grading, and points may be deducted if errors are found that were missed in the prior grading.

Final Examination

The final exam will be given on 12/14/2021 (Tuesday) at 10:30AM-12:30PM (Exam will be taken in the lecture hall where the class meets).

Please review the Final Exam Regulations, <https://www.registrar.arizona.edu/courses/final-examination-regulations-and-information>, and Final Exam Schedule, <http://www.registrar.arizona.edu/schedules/finals.htm>

Absence and Class Participation Policy

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at: <http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop>

The UA policy regarding absences for any sincerely held religious belief, observance or practice

will be accommodated where reasonable, <http://policy.arizona.edu/human-resources/religious-accommodation-policy>. Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See: <https://deanofstudents.arizona.edu/absences>

Participating in the course and attending lectures and other course events are vital to the learning process. Excessive or extended absence from class is sufficient reason for the instructor to recommend that the student be administratively dropped from the course. You are responsible for all the materials covered in lectures, reading assignments, and those introduced in the problem sets whether you attend lectures or not.

If you anticipate being absent, are unexpectedly absent, or are unable to participate in class activities, please contact me as soon as possible. To request a disability-related accommodation to this attendance policy, please contact the Disability Resource Center at (520) 621-3268 or drc-info@email.arizona.edu. If you are experiencing unexpected barriers to your success in your courses, the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office is located in the Robert L. Nugent Building, room 100, or call 520-621-7057.

Textbook or Readings (Recommended)

Moran, M. J., H. N. Shapiro, B. R. Munson and D. P. DeWitt. 2003. Introduction to Thermal Systems Engineering: Thermodynamics, Fluid Mechanics, and Heat Transfer. John Wiley & Sons Inc. ISBN: 978-0-471-20490-0.

Required or Special Materials

Student will need to use their own regular scientific calculator and writing/erasing instruments for exams, nothing else will be allowed during the exams (if not mentioned by the Instructor specifically).

Required Extracurricular Activities

Students are encouraged to study collaboratively outside the class hours and have discussions together as well. Additional reading from scientific manuscripts or journals will be provided to the students to stimulate discussions and learning.

Grading Scale and Policies

	% contribution to Final Grade
Quizzes	15
Exam 1	25
Exam 2	25
Final Exam	35

Final letter grades for the course are computed as: 90-100% A; 80-89.99% B; 70-79.99% C; 60-69.99% D; <60% E. The percentages to achieve the letter final grades indicated may be lowered based on the class performance. A make-up exam may be scheduled only when a student has a valid excuse. The valid excuses for missing an examination are serious personal illness, or serious illness or death in your family, and pre-approved leave of absence signed by the UA Dean of Students (or Dean Designee) to attend a professional event. If you determine that you will be unable to attend an examination, inform the instructor (not the course TA). If you miss any of the exams or quizzes without a valid excuse or documentation, you will be assigned a score of zero for the exam(s) or quiz missed.

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at <http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete> and <http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal> respectively.

Scheduled Topics/Activities

Week No.	Lecture Schedule	HW Set #
1 (08/23-27)	Introduction to Thermodynamics Units - Force, Energy, Work, Power, etc. Concepts - Control Volume, Control Mass, Systems, etc. Basic Laws - First and second Laws	1
2 (08/30-09/03)	Energy and the First Law -	2
3 (09/06-10)	Energy Balance, Cycles, and Efficiencies Properties and States - Equilibrium, Pressure, Temperature, etc.	3
4 (09/13-17)	States of Simple Substances and Properties Phase Transitions How to use thermodynamic property data The Perfect Gas	4
5 (09/20-24)	Quantitative Energy Analysis How to set up mass balance and energy balance equations for control mass/control volume.	5
6 (09/27-10/01)	Engines, turbines, heat pumps, boilers, refrigeration units, separators, nozzles, turbo expanders, etc.	
7 (10/04-08) (Exam 1, 10/07/2021)	Entropy and the Second Law Reversible and Irreversible Processes Entropy Transfer and Change Entropy as a Function of State Entropy, Temperature, Pressure - Thermodynamic Definition	6
8 (10/11-15)	Carnot Cycle Efficiencies - Heat Engine, Heat Pump, etc.	7
9 (10/18-22)	The Thermodynamics of State - Vapor Power and Refrigeration Systems	
10 (10/25-10/29)	Gas Power Cycles Air-Standard Otto and Diesel Cycles (Cont.) Gas Turbine Power Plants	8
11 (11/01-11/05)	Power Cycles and Applications Diesel Engine and Fuel Consumption	
12 (11/08-12) (Exam 2, 11/18/2021)	Psychrometrics - Fundamentals Wet-bulb and dry-bulb temperatures. Psychrometrics - Applications	9
13 (11/15-19)	Introduction to Fluid Mechanics - Fluid Statics/Fluid Dynamics/Internal and External Flow/Laminar and Turbulent Flow/Pipe flow and Head Losses/Boundary Layer Theory	10
14 (11/22-26) (Thanksgiving recess 11/25-28, No Class)	Introduction to Heat & Mass Transfer - Conduction	
15 (11/29-12/03)	Radiation - Blackbody radiation/Heat exchange between surfaces Convection/Applications with the First Law of Thermodynamics	11
16 (12/06-10) Last Day of Classes (12/08)	Review	
Final Exam (12/14/2021, Tuesday)	10:30am - 12:30pm (In the lecture hall where the class meets)	

Classroom Behavior Policy

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, interfering live lecture sessions, etc.).

Students are asked to refrain from disruptive conversations, chatting, and communications with other students during lectures, office hours and discussion sessions. Students observed engaging in disruptive activity will be asked to cease this behavior. Those who continue to disrupt the class will be asked to leave the lecture or discussion and may be reported to the Dean of Students.

Threatening Behavior Policy

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See <http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students>.

Accessibility and Accommodations

Our goal in this classroom is that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, please let me know immediately so that we can discuss options. You are also welcome to contact the Disability Resource Center (520-621-3268) to establish reasonable accommodations. For additional information on the Disability Resource Center and reasonable accommodations, please visit <http://drc.arizona.edu>.

If you have reasonable accommodations, please plan to meet with me by appointment or during office hours to discuss accommodations and how my course requirements and activities may impact your ability to fully participate.

Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

Code of Academic Integrity

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See: <http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity>.

The University Libraries have some excellent tips for avoiding plagiarism, available at <http://www.library.arizona.edu/help/tutorials/plagiarism/index.html>.

Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor's express written consent. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement. The minimum penalty for cheating on exams and quizzes is an E grade.

UA Nondiscrimination and Anti-harassment Policy

The University is committed to creating and maintaining an environment free of discrimination; see <http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy>

Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

Additional Resources for Students

UA Academic policies and procedures are available at <http://catalog.arizona.edu/policies>
Student Assistance and Advocacy information is available at
<http://deanofstudents.arizona.edu/student-assistance/students/student-assistance>

Confidentiality of Student Records

<http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa>

Subject to Change Statement

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.