



## **ABE 284 Biosystems Thermal Engineering**

Tuesday/Thursday, 11:00AM – 12:15PM, R A Harvill Bldg., Rm 302

### **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**

Murat Kacira, Ph.D.

Professor, Agricultural and Biosystems Engineering

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

Phone: 520-626-4254, [mkacira@email.arizona.edu](mailto:mkacira@email.arizona.edu), <http://ag.arizona.edu/research/kacira/>

Office Hours: - Monday 10:30am-12noon, Shantz Building Room 504 (with Instructor)  
- Open door policy at CEAC, Room 104 (with appointment)

### **Course Format and Teaching Methods**

The course will be provided in lecture format. The lectures, quizzes and exams will be given in R A Harvill Bldg., Rm 302. Lectures will include the use of power point presentations, discussions and problem solving on the board, and using thermodynamic property tables.

### **Course Objectives and Expected Learning Outcomes**

Upon completing the course students should be able to: 1) Understand the concepts of conservation of mass, conservation of energy, and the second law of thermodynamics, 2) Understand the methods for determining thermodynamic properties of simple compressible substances, 3) Identify, formulate and solve engineering problems in classical thermodynamics involving closed and open systems for both steady state and transient processes, 4) Have ability to use thermodynamic property data, units, unit conversions and significant digits, 5) Have ability to set up mass balance and energy balance equations for closed and control volume systems, 6) Identify work interactions and heat transfer, 7) Demonstrate the ability to determine accurately the thermodynamic properties of simple compressible substances including incompressible substances and ideal gases, 8) Apply the principles of conservation of mass and conservation of energy to the solution of problems, 9) Understanding of the concepts of Second Law analysis and an ability to apply them to closed and open systems for both steady and transient processes, 10) Analyze the performance of vapor and gas power cycles and to identify methods for improving thermodynamic performance, 11) Understand engineering applications of Psychrometrics, 12) Understand fluid mechanics, dealing with the behavior of fluids at rest or in motion for analysis and design of systems engineering systems, 13) Analyze the internal flow of a viscous fluid through pipe systems and the external flow around familiar geometric shapes, 14) Develop appreciation for the fundamental concepts/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.

**Relationship to Program Educational Learning Outcomes:**

**Outcome (a)** an ability to apply knowledge of mathematics, science, and engineering: **1-14**

**Outcome (e)** an ability to identify, formulate, and solve engineering problems: **3-14**

## **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. As such, attendance is required at all lectures and discussion section meetings. Students who miss class due to illness or emergency are required to bring documentation from their health-care provider or other relevant, professional third parties. Failure to submit third-party documentation will result in unexcused absences.

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. You will also risk losing credit for quizzes if you miss a class session.

## **Required Textbook or Readings**

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.

Availability: purchased, library reserve.

## **Required or Special Materials**

Student will need to bring their own calculator, and writing/erasing instruments into the exam room for exams and quizzes, 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.

## **Assignments and Examinations: Schedule/Due Dates**

**Exams:** There will be two regular examinations and one final exam. Exams will be closely related to the assigned homework problem sets, in-class quizzes and example problems reviewed in the class. Quizzes and exams will only be re-graded when there is evidence of grading error.

1<sup>st</sup> and 2<sup>nd</sup> Exams are scheduled on 10/13/2016 (Thursday) and 11/10/2016 (Thursday), respectively.

**In-Class Quizzes:** In-class quizzes (~ 8-10) will be given and is used as a way of checking on students' progress and encouraging class attendance. The quizzes will be closely related to the assigned homework and in-class example problems sets.

**Practice Problems/Homework:** Practice problems and their answers (*NOT solutions*) will be posted in class D2L site. You are encouraged to consult with course instructor and course teaching assistant when you encounter difficulties with solving the practice problems and also course materials.

## Final Examination or Project

The final exam will be given on 12/12/2016 (Monday) at 10:30AM-12:30PM.

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>

## Grading Scale and Policies

Contributions of the quizzes and exams to the final grade is provided below.

	<b>% contribution to Final Grade</b>
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% B; 79-70% C; 60-69% 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.

## Honors Credit

Students wishing to contract this course for Honors Credit should email me to set up an appointment to discuss the terms of the contact. Information on Honors Contracts can be found at <http://www.honors.arizona.edu/faculty-and-advisors/contracts>.

## Scheduled Topics/Activities

Week No.	Lecture Schedule
1 (08/22-26)	<b>Introduction to Thermodynamics</b> Units - Force, Energy, Work, Power, etc. Concepts - Control Volume, Control Mass, Systems, etc. Basic Laws - First and second Laws
2 (08/29-09/02)	<b>Energy and the First Law -            Energy Balance, Cycles, and Efficiencies            Properties and States</b> - Equilibrium, Pressure, Temperature, etc.
3 (09/05-09)	
4 (09/12-16)	<b>States of Simple Substances and Properties</b> Phase Transitions How to use thermodynamic property data <b>The Perfect Gas</b>
5 (09/19-23)	<b>Quantitative Energy Analysis</b> How to set up mass balance and energy balance equations for control mass/control volume. Engines, turbines, heat pumps, boilers, refrigeration units, separators, nozzles, turbo expanders, etc.
6 (09/26-09/30)	
7 (10/03-07)	<b>Entropy and the Second Law</b> Reversible and Irreversible Processes Entropy Transfer and Change Entropy as a Function of State Entropy, Temperature, Pressure - Thermodynamic Definition
8 (10/10-14) (Exam 1, 10/13/2016)	<b>Carnot Cycle</b> <b>Efficiencies</b> - Heat Engine, Heat Pump, etc.
9 (10/17-21)	<b>The Thermodynamics of State -</b> Vapor Power and Refrigeration Systems
10 (10/24-28)	<b>Gas Power Cycles</b> Air-Standard Otto and Diesel Cycles (Cont.) Gas Turbine Power Plants
11 (10/31-11/04)	<b>Power Cycles and Applications</b> Diesel Engine and Fuel Consumption
12 (11/07-11) (Exam 2, 11/10/2016)	<b>Psychrometrics</b> - Fundamentals Wet-bulb and dry-bulb temperatures. Psychrometrics - Applications
13 (11/14-28)	<b>Introduction to Fluid Mechanics</b> - Fluid Statics/Fluid Dynamics/Internal and External Flow/Laminar and Turbulent Flow/Pipe flow and Head Losses/Boundary Layer Theory
14 (11/21-25)	<b>Introduction to Heat &amp; Mass Transfer</b> - Conduction
15 (11/28-12/02)	<b>Radiation</b> - Blackbody radiation/Heat exchange between surfaces
16 (12/05-07) Last Day of Classes (12/07)	<b>Convection/Applications</b> with the First Law of Thermodynamics
Final Exam (12/12/2016, Monday)	<b>10:30am-12:30pm</b>

## **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, reading a newspaper, making phone calls, web surfing, etc.).

Students are asked to refrain from disruptive conversations with people sitting around them during lecture. 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 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.

## **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.