

ME 504: Advanced Engineering Thermodynamics
The Pennsylvania State University
Department of Mechanical Engineering
Dr. Catherine Berdanier

Class Location: Leonhard 316
Time: MWF 12:20-1:10 pm
Learning Management System: canvas.psu.edu

Office: 206 Reber Building
Contact information: cgb9@psu.edu

Office Hours:

On-campus office hours: Fridays 9:30-11 am in Reber 206
World Campus Office Hours: 8:30-10 PM on Sundays via Canvas “Chat” (find the tab in the Canvas menu on the left-hand side of the page.)

If these times do not work for you, please email me to set up a time for a meeting.

Required Resources:

Winterbone & Turan: Advanced Thermodynamics for Engineers (2nd ed)—available as an e-book through the Penn State Libraries system for free

Optional Resources:

Bejan: Advanced Engineering Thermodynamics (any edition)

COURSE OBJECTIVES:

The objective of this course is to prepare graduate level engineering students to effectively solve theoretical and applied thermodynamics problems. Significant emphasis is placed on the integration of recent thermodynamics-related research into the traditional resources in order to foster critical analysis of current work as it relates to fundamental principles. Multiple forms of assessment will be used throughout the course in order to evaluate student learning. As this is a graduate-level course, many of the competency-based assessments can be tailored to be useful to your long-term learning goals. In addition, multiple professional skills will be practiced and demonstrated throughout the course, such as engineering communication and teamwork, since these skills are important in all engineering professions.

By the end of this course, students will be able to:

1. Describe and calculate thermodynamic properties of single-phase and multi-phase systems
2. Apply the laws of thermodynamics to chemically reactive systems, kinetics, and combustion
3. Relate course principles to solve problems in authentic engineering settings, and able to access and critique recent literature employing thermodynamic principles
4. Communicate engineering knowledge of thermodynamics through written and verbal means

There are also learning objectives for each specific week, as outlined within the Canvas modules. These learning objectives are intended to help students “benchmark” their progress and evaluate their mastery of the course material.

COURSE REQUIREMENTS:

This is a 15-week course on engineering thermodynamics meeting three times per week. The course will require active participation throughout the course, engaging with both resident and online students. A variety of assessment mechanisms will be used to encourage students to fully engage in the class, including those that may not be considered traditional for engineering courses. I expect all learners in the experience to invest the time in the course required to complete deliverables at a level expected by graduate-level scholars. I have explicitly placed deliverables throughout the semester in order to facilitate the “deliberate and distributed practice” of the concepts in this course, which has been proven to increase transfer and memory of learning.

Study groups are strongly encouraged, and while most of the assessments will be personal, a collegial environment is most representative of the working situations in which modern engineers will find themselves. Online students will be integrated into the course: Although asynchronous, the students taking this course may have applied knowledge of what the principles of thermodynamics look like in industry careers.

ATTENDANCE and IN-CLASS PARTICIPATION POLICIES:

Attendance in class will be required for resident students, and online students will be required to engage with the online content and exercises within the week the material is introduced. Class content will be posted as soon as possible after class, pending the schedule of the MSME online program’s multimedia personnel. All students are responsible for the material given during class. If you need to miss class for a legitimate reason, please let me know ahead of class, preferably by the day before. For extenuating circumstances such as extended illness, bereavement, or other formally-excused absence validated by university regulations, please be in contact with me so I can work with you to achieve your curricular goals. Resident students are allowed to access the online course content, though any participation points awarded will come from class attendance. Attendance exceptions that are made for religious purposes must be submitted to me in writing by the end of the second week of class. If you have health issues (visible or invisible) and may need special accommodations, I am best able to work with you if I am aware of these issues in advance. In addition, if you have a family emergency, please inform me as soon as possible.

I **do not** post “filled in” notes, as it tempts students to not pay as much attention. Cognitive science also tells us that “multimodal learning” (e.g. writing something in addition to listening to it) is stored in different parts of the brain, and the more times and ways our brain accesses material, the more likely we are to remember it and be able to apply it. The lecture video links are posted online for the online students, and you are more than welcome to go back to fill in any gaps in the notes that you may have missed.

Online students: Watch for participation activities that correlate with class meetings in Canvas; they'll look like quizzes but will be labeled "Participation Activity for class [Date]" and they'll only be available to the online students.

Resident students: Attendance will be taken starting the second week of class, after the add/drop period. Attendance points will be measured through a variety of methods, including but not limited to sign-in sheets, Concept Checks and "Flipped Friday" participation. These points will factor into your attendance/participation score. Attendance/Participation points will be awarded during class. If you are not in the classroom at the time the points are awarded, then you will not have the opportunity to make them up. This means you'll likely want to be in class and ready to go when class starts! In the extent of a long-term extenuating absence (bereavement, etc.) we will work out a suitable alternative for attendance. If you have an excused absence (travel to a conference, legitimate illness, etc.) please let me know at least a day in advance that you won't be in class. You will not receive attendance points, but if a concept check would happen to be taking place when you're out, we will schedule a time to make it up via oral exam.

OFFICE HOURS:

Because of the mixed resident and online format of this course, I will have two sets of office hours. For resident students, walk-in office hours are available on a first-come, first-served basis in my office at the time indicated on page 1. For online students, I will be available on the Canvas "Chat" function, and if need be we can move to Zoom. In addition, I am easily accessed via email; however, I reserve the right to not check my email on nights, weekends, and holidays.

The "Chat" history is preserved through the entire semester. Resident students and online students who can't make office hours have the ability to check the chat history to see if a question was asked by a peer that could be helpful.

COMMUNICATION POLICIES:

Because part of becoming a professional in engineering is learning to effectively communicate, I expect that all elements of communication between students and with me as an instructor be conducted with respect. All emails sent to me must subscribe to professional expectations for communication, including a salutation, clear emails in full sentences that are grammatically correct and have been spell-checked, communicate clearly how you would like me to assist you, and end with a respectful closing followed by your name. I request that you call me Dr. Berdanier or Dr. B, and address me as such in emails and in person. If your emails with me do not subscribe to these requirements, I will kindly request that you revise your emails and re-send it to me before I will respond to your email.

You are welcome to email me at any time, however, I will be most responsive to emails during business hours. Although you may receive emails from me on weekends/holidays/evenings, I reserve the right to not be "on call" outside of working hours. All emails should include ME 504 in the subject line, as well as the subject of the email in order so I can quickly scan my emails. I will respond within one full business day to emails. You can also send "emails" through the messages feature in Canvas—this comes both to my Canvas account and also to my Penn State email address.

DELIVERABLES and WEEKLY ASSIGNMENTS:

The following list is an overview of the types of assessments that will be used in the course. For **all** students, these assignments will be submitted via Canvas. Scan homework and upload as a .pdf—there are apps that turn pictures into PDFs from your smartphone. I will not accept blurry photographs of your practice problem sets. All practice problems must be legible. If I can't read it or follow your line of thought, I will not award you points.

Each assessment that is not a traditional problem-solving set through the course has affiliated rubrics in order to help you self-assess your progress and whether or not you have met the objectives of the assessments. **All deliverables will be due on Mondays at 11:59 pm to Canvas unless noted otherwise.**

REQUIREMENTS OF MAJOR DELIVERABLES:

Introduction Video: Create a two-minute video introducing yourself to the instructor and the other members of the class and post it on Canvas, including

1. your research interests,
2. (Resident students) who you work with as a research advisor or (online students) where you work and a little about what you do there
3. why you decided to enroll in this course, and
4. something interesting about you.

Signing the Academic Integrity Contract and Understanding of the Code of Conduct: Print, sign, scan, (or sign it with a virtual signature) and upload this contract to the Canvas assignment.

Practice problems: Copying of any solutions from a solutions manual, from other (current or past) students, or from the internet is explicitly cheating, and will not be tolerated. **If you choose to work on problem sets with other students, please note who you worked with at the top of your sheet.** Note, your answers should still represent your individual work (e.g. be in your own hand, showing your own problem solving path). All practice problems must be legible. If I can't read it or follow your line of thought, I can't award you points.

Journal Club and Review-Critiques of Recent Thermodynamics Research: There are five assignments that require you to go to the libraries website or Google Scholar, and find an article that uses thermodynamics to study the application of interest. You will be responsible for writing a summary of the article, discussing the motivation for the work, the methods used, the outcomes/results, and implications of the work for the field. You should also note any questions that were raised for you as you were reading the article. You should also explicitly note how thermodynamic theory was used in studying the particular application. Please remember to provide the citation for the paper. A template is provided for your use.

You will be assigned to a team of your colleagues at the beginning of the semester (after the add-drop period), and it is your job to meet with them and “teach” each other your article. These groups will be a mix of online and resident students. You will need to find times to meet with each other to discuss your review critiques. Use Zoom to record your conference (available free for PSU students through <https://psu.zoom.us/>), and record your group meeting so I can award you points

for that portion of the assignment. Each group must upload their recording to the appropriate folder in the class Box folder. You must complete your journal club “meeting” and upload the recording within a week of the due date for that particular Review-Critique assignment. Your documents will be distributed to the class to build a class portfolio of knowledge, so be sure to do a good job! I am willing to look at drafts and help with any revisions or editing, and you are encouraged to use your peers for help as well.

Concept Checks: Periodically, I will assign concept check quizzes. Some of these are pre-scheduled on the syllabus, but some others will be “Pop Up” Concept Checks style during class (to which I’ll enable an online version of the quiz on Canvas for online students). These will be timed quizzes and function as concept checks for key principles, basic problem-solving, and definitions (Hint: review class notes before class). I reserve the right to vary the format of these concept checks. Online students: All of your quizzes will be available through Canvas in the appropriate module.

Final Project: This project will be a 6-8 page paper (double spaced, including figures; references do not contribute to page limit) that should investigate a topic of interest to you using scholarly literature to guide your paper. It is your job to explain why the topic is important, explain the thermodynamic theories and principles that govern the major work on the topic, and conduct a small literature review of advances relating to the topic. You should be citing references from scholarly journals (not popular culture venues) in the work: Make sure all references you cite are reflected in the References section. You are responsible for making the document clear and easy for readers to understand. This can look like more of a “project” or a literature synthesis, depending on your goals. For a literature review-type paper, you should include at least 30 scholarly citations.

Presentation of Final Project: This will be a short, scholarly presentation on the final paper you undertake for the project. We’ll take class time on week 15 to watch and critique these presentations, so be sure to practice ahead of time to make sure you stay on time and to help you feel prepared. (Time limits will depend on the number of students enrolled in the class). Use best practices in creating scientific presentations, and make sure to keep your slides clear, un-cluttered, and easy to follow (e.g. not too much text on the page, keep your fonts big enough to read, etc.) Online students will present via Zoom at a common time TBD during the final week of classes or during finals week.

Week (Dates)	Deliverables Due by Mondays at 11:59 pm	Module Title; Topics covered	Reference Chapters
1 (1/7-1/11)		Module 1: Thermodynamic Principles and First Law of Thermodynamics	Syllabus; W & T Chapter 1 Bejan Ch 1
2 (1/14-1/18) *Note, no class 1/14 due to MLK Day	Introduction Video Uploaded to Box Integrity/Code of Conduct Contract Signed		

3 (1/21-1/25)	Practice Problems #1 (covering Weeks 1-2 content)	Module 2: The Second Law of Thermodynamics	W&T Ch 2; Bejan Ch 2
4 (1/28-2/1) Monday: Concept Check (resident students in class; online students via Canvas by Monday 11:59 pm) No Class Wed 1/30	Review-Critique #1 (First and Second Law Concepts)		
5 (2/4-2/8)	Practice Problems #2 (covering week 3 and 4 content)	Module 3: Thermodynamic Cycles	W&T Ch 3,5-6; Bejan Ch 3
6 (2/11-2/15) Monday: Concept Check (resident students in class; online students via Canvas by Monday 11:59 pm)	Review-Critique #2 (Covering topics related to engine cycles)		
7 (2/18-2/22)	Practice Problems #3 (covering weeks 5 & 6) Submit 3 ideas for what topics your final project might cover	Module 4: Single Phase Systems and Equations of State	W&T Ch 7; Bejan Ch 4
8 (2/25- 3/1) Monday: Concept Check (resident students in class; online students via Canvas by Monday 11:59 pm)	Review-Critique #3 (Covering one additional topic area that we didn't spend time on related to first law, second law, cycles)		W&T Ch 8-9
PSU Spring Break March 3-10—No classes!			
9 (3/11-3/15)			
10 (3/18-3/22)	Practice Problems #4 (covering weeks 7-9)	Module 5: Multiphase systems	Bejan Ch 6

11 (3/25-3/29) Monday: Concept Check (resident students in class; online students via Canvas by Monday 11:59 pm)	Review-Critique #4 (Covering single or multiphase systems)	Module 6: Chemistry of Combustion	W &T Ch 11, 12, 14
12 (4/1-4/5)	Practice Problems #5 (Covering Weeks 10- 11) Submit your choice of topic for the final project		
13 (4/8-4/12) Monday: Concept Check (resident students in class; online students via Canvas by Monday 11:59 pm) No Class Friday 4/12: Dr. B at UC Irvine	Review-Critique #5 (Covering Combustion topics) Outline for final project due	Module 7: Chemically Reactive Systems and Kinetics	W&T CH 15- 17; Bejan Ch 7-8
14 (4/15-4/19) <i>*Dr. B traveling end of this week, Friday 4/19 might be canceled pending travel arrangements</i>	Practice problems #6 (Covering weeks 12- 13) Draft of final literature review or project (worth 10%)	Module 8: Statistical Thermodynamics	
15 (4/22-4/26) No Class Monday 4/22: Dr. B in Yokohama, Japan	Final Presentations in Class		
16	PSU Finals Week: No final exam Monday April 30: Final Papers Due on Canvas		

GRADING:

All grading will be done on a flat scale, with no grading curve. Final grades will subscribe to the cutoff percentages in the table below

Quality of Performance	Grade	Percentage Cutoff
Excellent	A	93.0
	A-	90.0
Good	B+	87.0
	B	83.0
	B-	80.0
Satisfactory	C+	77.0
	C	70.0
Poor	*D	60.0
Failure	**F	< 60

The total weights of each of the assignments across the semester are distributed as such:

Introduction Video, Signed Integrity Contract, and Attendance/Participation through semester (5%)

Concept Checks (25%)

- Scheduled Monday Concept Checks (15%)
- Pop-Up Concept Checks (10%)

Practice Problems (6 Assignments) (30%)

Journal Club Review-Critique Assignments and Group Meetings (5) (30%)

Final Research Paper and Presentation (10%)

TOTAL.....(100%)

Late assignment policy: No late assignments will be accepted. If you need an extension on a deadline (particularly for World Campus students due to work travel) or travel to conferences, etc., let me know in advance and we can negotiate a new deadline. All re-scheduled concept checks (for excused absences) will be in the form of an oral exam.

TEACHING PHILOSOPHY:

I am invested in teaching engineering using what is known about optimal learning at the graduate level. I believe that engagement during class is the most efficient way to learn material, so I will expect learners to participate in class in the activities I scope for learning. Literature tells us that writing is an embedded value in engineering and that writing is an effective way to learn new content, but most engineers rarely spend time practicing writing or communicating engineering principles in words. Ultimately, no matter how well a course is designed, it is ultimately up to the learners to make connections between course content and application. The more engaged students are, the greater their learning outcomes (above and beyond course grade). My role as an instructor is to be a facilitator of knowledge.

PLAGIARISM AND ACADEMIC DISHONESTY:

Plagiarism and academic dishonesty is not tolerated in this class, because it violates the ethical responsibilities of scholars, engineers, and de-values the efforts of your fellow students. As such, academic dishonesty of any form, including plagiarism, will not be tolerated. In order to avoid unintentional plagiarism, it is important to cite all your sources when you use an article, website, or use thoughts that are the result of someone else's intellectual work, and use direct quotes and appropriate citation mechanisms (e.g., page numbers) when necessary. The academic integrity/Code of Conduct Contract you signed will be your word that you understand what cheating is, and that you will not engage in dishonest behaviors. Students caught cheating or guilty of plagiarism (whether intentional or unintentional) will receive a zero for the assignment and will be reported to the institutional governing bodies.

OTHER UNIVERISTY POLICIES:

This syllabus is subject to change. Any changes to the syllabus shall be distributed in writing, which may include electronic communication.

ADA Compliance: Penn State welcomes students with disabilities into the University's educational programs. If you have a disability-related need for reasonable academic adjustments, contact the Office for Disability Services (ODS) at 814-863-1807 (V/TTY). For further information regarding ODS, please visit the Office for Disability Services website at <http://equity.psu.edu/ods/>. In order to receive consideration for course accommodations, you must contact ODS and provide documentation (see the documentation guidelines at <http://equity.psu.edu/ods/guidelines>). If the documentation supports the need for academic adjustments, ODS will provide a letter identifying appropriate academic adjustments. Please share this letter and discuss the adjustments with your instructor as early in the course as possible. You must contact ODS and request academic adjustment letters at the beginning of each semester.

Anti-Discrimination Statement: As an institution of higher education, The Pennsylvania State University is committed to making post-high school education available to all who possess a high school diploma or its equivalent without regard to personal characteristics not related to ability, performance, or qualifications. The Pennsylvania State University does not discriminate against any person because of age, ancestry, color, disability or handicap, national origin, race, religious creed, sex, sexual orientation, or veteran status.

Availability of Counseling Services to Penn State Students (including World Campus): Confidential counseling and psychological services are available through Student Health. More information can be found at <http://studentaffairs.psu.edu/counseling/>.