



Course Information

- **Course number and title:** ME50000 Advanced Thermodynamics
- **CRN:** 15040
- **Meeting day(s) and time:** TTh 3:00 – 4:15 pm (Indiana Time)
- **Class Location:** FRNY B124
- **Instructional Modality:** Face-to-Face (On Campus); Async-Online (EPE/OL)
- **Course credit hours:** 3
- **Prerequisites (if any):** ME20000; suggested ME30000 or equivalent
- **Required textbook:** None (reference texts listed below)

Instructor(s) Contact Information

- **Name of the instructor(s):** Riley Barta
- **Office Location:** Ray W. Herrick Laboratories (177 S. Russell Street, behind LILY); HLAB 1018
- **Purdue Email Address:** bartar@purdue.edu
- **Office/Consultation hours, times, and location:** 3 x 1-h per week (Indiana Time) Online via Zoom or in person; Zoom (<https://purdue-edu.zoom.us/my/rbbarta>). *Office hours to be confirmed with students.*

- **Name of the TA:** TBD (PhD student)
- **Office Location:** Herrick Labs
- **Purdue Email Address:** TBD@purdue.edu
- **Office/Consultation hours, times, and location:** Zoom/Herrick Labs.

Course Description

ME 50000 covers the fundamentals and physical basis of the laws of thermodynamics, availability and exergy concepts and applications, properties, and relations between properties in homogeneous and heterogeneous systems, the criteria of equilibrium and the application to a variety of systems and problems, including phase and reaction equilibrium, vapor compression systems, combustion, and fuel cells, among others. Topics are investigated in depth, and students should leave ME 50000 with a good appreciation for the fundamentals and practical applications of classical thermodynamics.

Learning Outcomes

By the end of the course, you will be able to:

1. **Build an appreciation for the fundamentals and practical applications of classical thermodynamics.**
 - Methods of Evaluation: homework and responding to questions asked during lecture
2. **Enhance your understanding of thermodynamic principles and their relevance to the problems of mankind.**
 - Methods of Evaluation: homework and responding to questions asked during lecture
3. **Apply thermodynamic principles to predict physical phenomena and solve engineering problems.**
 - Methods of Evaluation: homework and exams

Teaching Philosophy

As a first graduate-level course in advanced thermodynamics, the student should also gain the ability to take on increasingly complex topics relevant to their academic, research, and/or career interests. It is my responsibility to clearly

present concepts and provide examples using different strategies to try to reach as many learners as possible. At the same time, student feedback is key, as every semester consists of different learners. I am willing to support you and give effort above and beyond what is required, as long as you show you've made an honest effort on your own and come with constructive question and discussion points. Teaching energizes me very much, and I look forward to each semester.

How to Succeed in this Course

If you want to be a successful student in this course, it is essential to:

- Keep up with the lectures
- Treat the homework as an opportunity to build upon what you have learned in lecture
- Develop a physical framework in your mind for the phenomena being discussed, and build upon that framework throughout the course so that problem solving approaches become more and more intuitive
- Commit to 4-6 hours per week outside of lecture for reviewing the material and homework, with more hours prior to an exam
- Be willing to ask questions and keep up with the questions from other students
- Reach out to the instructor if there are issues with lecturing content, lecturing style, or any other issue.

In contrast, here are some common behaviors that lead to doing poorly in the course.

- Fall behind in lecture
- Treat the homework as optional or only worth doing for possible points towards your grade
- Wait until the last day to begin working on the homework
- Not allocate enough time to work on review problems
- Ignore emails from the instructor and/or your peers regarding course activities.

Learning Resources, Technology & Texts

- **Required Textbook:** None
- **Reference Textbooks:** Any of the following textbooks are recommended for reviewing the fundamentals of thermodynamics and enhancing your understanding. However, all required materials will be made available in lectures and files posted on-line throughout the course.
 - *[Preferred] Fundamentals of Engineering Thermodynamics*, M.J. Moran, H.N. Shapiro, D.D. Boettner, and M.B. Bailey, 6th and above Edition, John Wiley and Sons.
 - *Thermodynamics – An Engineering Approach*, Y.A. Cengel and M.A. Boles, Any Edition, McGraw-Hill.
- **Communication:** E-mail and Brightspace will be used on a regular basis in this course for communication between the instructors and students, and each student is responsible for checking their account on a regular basis for the latest information regarding ME 50000.
- **Software/web resources:** A non-linear equation solver with built-in thermodynamic properties will be used in this course. This computer program, called Engineering Equation Solver (EES), was developed by F-Chart Software and is available to Purdue students in labs and remotely. Instructions for using the EES program will be given in class. A User's Manual for the program is also available for further reference on-line at www.fchartsoftware.com. **Documentation and examples will be made available on Brightspace.** You can access EES in two ways.
 - Students can access EES from itap's software remote: <https://goremote.itap.purdue.edu/>

- EES is installed on all ME lab machines and they can be accessed remotely by following the instructions listed here: <http://eng.purdue.edu/jump/2e86d30>

Anaconda/Python/MATLAB can also be used as an alternative.

- **Use of artificial intelligence (AI) or Large Language Models (LLM) in this course:** AI software like ChatGPT shall not be used in this course.
- **Hardware requirements (e.g., webcam for exam proctoring):** N/A
- **Tutoring support:** Please contact the professor if you feel you are not able to keep up with the material just based on lectures, homework, and the instructor and TA office hours. Study groups will be encouraged throughout the course.
- **Brightspace learning management system:** Access the course via Purdue's Brightspace learning management system. It is strongly suggested that you explore and become familiar not only with the site navigation but with content and resources available for this course. See the Student Services widget on the campus homepage for resources such as Technology Help, Academic Help, Campus Resources, and Protect Purdue. Lecturing material, examples, additional reading materials will be shared on Brightspace.

Course Logistics

- Lectures will be delivered with F2F (on-campus students) and Asynchronous (online/remote students) modes at the regularly scheduled time for the course. Lectures are live streamed through Kaltura Streaming and recordings are available right after class. The course is designed for live learning. Remote access to live lecturing will be discussed in class. You will be encouraged to ask questions verbally. There may also be short breakout sessions during the lectures.
- Self-study homework assignments will be provided at various intervals via Brightspace, and the solutions will be provided prior to the due date but after you have had some time to try them on your own. The responsibility to learn the material rests by you, and participation points for handing in the homework, which you must write up on your own, are awarded to help motivate everyone to keep up with the course.
- Study groups are encouraged but not enforced. You are encouraged to schedule a time to meet and discuss the homework outside of class. Study groups may not submit homework as a group, unless specified by the assignments.
- The instructor will make changes in the administration of the course as needed throughout the semester to optimize the learning process and include feedback from the students.
- Modifications to the instruction mode may become necessary depending on Protect Purdue guidelines.

Assignments

Homework assignments are indicated on the course syllabus. The homework problem statements are provided in a separate document at the beginning of the semester. Homework problems are illustrative of the general material and of problems found on exams. **Homework problems are assigned to prepare the students for the exams and integrate in-class examples.** Homework problems will not be graded, but **submission of minimum 50% of HW problem assigned per each mid-term exam period will contribute to 10% of the final grade.** Solutions to all assigned homework problems will be posted on Brightspace on a weekly basis.

Grading Scale and How your Grade will be Earned

In this class, grades reflect the sum of your achievement throughout the semester. You will accumulate points as described in table below. At the end of the semester, final grades will be calculated by adding the total points earned and translating those a letter Grade.

The instructor will use the +/- grading scheme in assigning the final grades. Each midterm is cumulative, as is the final exam. The grading scale will be curved with the mean score approximately earning a B+.

Any form of academic dishonesty will result in a failing grade for this course.

Grading Element	Due	Grade Points (%)
Midterm Exam 1	TBD	25%
Midterm Exam 2	TBD	30%
Midterm Exam 3	TBD	35%
Final Exam	TBD	(optional)
50% HW problems prior to each Midterm Exam	Throughout the semester	10%
		Total: 100%

If a student misses one of *three* midterm exams for university approved reasons, then the final exam will substitute the mid-term. This must be communicated with the instructor before the exam. Participation questions posed during lectures from time to time are most effective when completed on a regular basis and will be accepted for participation points within one week of each lecture period. Extensions for the self-study homework will only be granted with an explanation and plan for completion. These requests will be accepted at the instructor's discretion and may include deductions. Asking for an extension does not guarantee it will be granted.

The final date to withdraw from a course with a W for Fall 2024 is TBD.

Incomplete Grades

A grade of incomplete (I) will be given only in unusual circumstances. To receive an "I" grade, an e-mail request must be submitted and approved by the instructor. The request must describe the circumstances, along with a proposed timeline for completing the course work. Submitting a request does not ensure that an incomplete grade will be granted. If granted, you will be required to fill out and sign an "Incomplete Contract" form that will be turned in with the course grades. Requests to make up missed exams, for example, will not be allowed after solutions are posted

Attendance Policy

On-campus students are expected to attend all classes in-person unless they are ill or otherwise unable to attend class. If they feel ill, have any symptoms associated with COVID-19, or suspect they have been exposed to the virus, students should stay home and contact the Protect Purdue Health Center (496-INFO).

In the current context of COVID-19, in-person attendance cannot be a factor in the final grades. However, skipping classes may affect your ability to learn and perform during the exams. Students need to inform the instructor of any conflict that can be anticipated and will affect the timely submission of an assignment or the ability to take an exam.

Classroom engagement is extremely important and associated with your overall success in the course. The importance and value of course engagement and ways in which you can engage with the course content even if you are in quarantine or isolation, will be discussed at the beginning of the semester. Student survey data from Fall 2020 emphasized students' views of in-person course opportunities as critical to their learning, engagement with faculty/TAs, and ability to interact with peers.

Only the instructor can excuse a student from a course requirement or responsibility. When conflicts can be anticipated, such as for many University-sponsored activities and religious observations, the student should inform the instructor of the situation as far in advance as possible. For unanticipated or emergency conflicts, when advance notification to an instructor is not possible, the student should contact the instructor/instructional team as soon as possible by email, through Brightspace, or by phone. In cases of bereavement, quarantine, or isolation, the student or the student's representative should contact the Office of the Dean of Students via [email](#) or phone at 765-494-1747. Our course Brightspace includes a link to the Dean of Students under 'Campus Resources.'

Academic Guidance in the Event a Student is Quarantined/Isolated

If you must quarantine or isolate at any point in time during the semester, please reach out to me via email so that we can communicate about how you can continue to learn remotely. Work with the Protect Purdue Health Center (PPHC) to get documentation and support, including access to an Academic Case Manager who can provide you with general guidelines/resources around communicating with your instructors, be available for academic support, and offer suggestions for how to be successful when learning remotely. Your Academic Case Manager can be reached at acmg@purdue.edu. Importantly, if you find yourself too sick to progress in the course, notify your academic case manager and notify me via email or Brightspace. We will make arrangements based on your particular situation.

Course Schedule

Course Schedule will be provided on Brightspace. Student should refer to Brightspace to retrieve the most updated version of the Course Schedule. The instructor shall inform the students of any changes in a timely manner. A version tracker (with version/date) will be employed.

Tentative schedule (Fall 2024) [updated 05/08/2024]:

ME 500 - ADVANCED THERMODYNAMICS					
COURSE SCHEDULE - FALL 2024 (Updated May 8, 2024)					
Course Text: None (References Suggested in the Syllabus)					
Lecture	Day	Date	Topic (subject to change)	Notes	Homework
1	T	20-Aug	Introduction and Course Overview; First Law for Closed Systems		1-3, 1-6
2	Th	22-Aug	First Law for Closed and Open Systems		1-14, 1-18
3	T	27-Aug	Transient Analysis		1-24, 1-26
4	Th	29-Aug	EES Introduction/Examples		1-29, 1-35
5	T	3-Sep	Introduction to Second Law; The Future of Reliable Energy Supply		1-11, 1-28
6	Th	5-Sep	The Future of Reliable Energy Supply; Second Law Concepts		2-3, 2-4
7	T	10-Sep	Entropy Production in Closed and Open Systems		2-8, 2-10, 2-12; 2-20, 2-23
8	Th	12-Sep	Entropy Production in Open Systems and Cyclic Devices		2-25, 2-27
9	T	17-Sep	Applications of Second Law Analyses & Exam 1 Review		
10	Th	19-Sep	Exam 1 Review; Useful Work - Availability Analysis		3-2, 3-4, 3-5
11	T	24-Sep	Availability Analysis, Closed Systems		3-12, 3-15, 3-17
12	Th	26-Sep	Exam #1, Lectures 1 - 9		
13	T	1-Oct	Availability Analysis, Open Systems		3-24, 3-29; 3-40, 3-41
14	Th	3-Oct	Availability Analysis, Cycles		3-40, 3-41; 4-2, 4-4, 4-6
	T	8-Oct	No class due to Fall Break (Oct. 7 & 8)		
15	Th	10-Oct	Equation of State (Part I); Equation of State (Part II)		4-14, 4-20, 5-2; 5-3, 5-14, 5-18
16	T	15-Oct	Equation of State (Part II); General Thermodynamic Relations (Part I)		5-3, 5-14, 5-18; 6-6, 6-10
17	Th	17-Oct	General Thermodynamic Relations (Part II); Liquid-Vapor Phase Change		6-20, 6-21; 6-42, 6-43; 6-52
18	T	22-Oct	Liquid-Vapor Phase Change; Review of EoS & Therm. Relations, Exam 2 Review		6-42, 6-43; 6-52
19	Th	24-Oct	Partial Properties (Part I); Partial Properties (Part II)		8-1
20	T	29-Oct	Exam #2, Lectures 10 - 18		
21	Th	31-Oct	Fugacity (Part I); Fugacity (Part II)		8-14, 8-15; 8-21
22	T	5-Nov	Fugacity (Part II); Ideal Solutions		8-21; 8-25, 8-28
23	Th	7-Nov	Equilibrium of Multi-Component Systems; Vapor-Liquid Equilibrium		8-31; 9-3, 9-4, 9-5
24	T	12-Nov	Vapor-Liquid Equilibrium; Review Partial Prop. / Multi-Component Systems		9-3, 9-4, 9-5
25	Th	14-Nov	Thermochemistry; Second Law, Chemical Reactions		10-2, 10-4, 10-7; 10-13, 10-15
26	T	19-Nov	Second Law, Chemical Reactions; Fuel Cells		10-13, 10-15; 10-23, 10-27
27	Th	21-Nov	Exam #3, Lectures 19 - 26		
28	T	26-Nov	Equilibrium Reaction and Affinity; Equilibrium Constants, Ideal/Real Gas Mixtures		10-30, 10-33; 10-35; 10-43; 10-50
	Th	28-Nov	No class due to Thanksgiving Break (Nov. 27 - 30)		
29	T	3-Dec	Equilibrium Constants, Real Gas Mixtures; Equilibrium Constants; Chemical Availability	Quiet Period	[Optional] 11-1, 11-3; 12-2, 12-9
30	Th	5-Dec	Chemical Availability - Overview; Semester Review	Quiet Period	
Finals			Final Exam [Optional], Lectures 1-40		Release Date TBD

Classroom Guidance Regarding Protect Purdue

“The [Protect Purdue Plan](#), which includes the [Protect Purdue Pledge](#), is campus policy and as such all members of the Purdue community must comply with the required health and safety guidelines. Required behaviors in this class include: staying home and contacting the Protect Purdue Health Center (496-INFO) if you feel ill or know you have been exposed to the virus, properly wearing a mask [in classrooms and campus building](#), at all times (e.g., mask covers nose and mouth, no eating/drinking in the classroom), disinfecting desk/workspace before and after use, maintaining appropriate social

distancing with peers and instructors (including when entering/exiting classrooms), refraining from moving furniture, avoiding shared use of personal items, maintaining robust hygiene (e.g., handwashing, disposal of tissues) prior to, during and after class, and following all safety directions from the instructor.

Students who are not engaging in these behaviors (e.g., wearing a mask) will be offered the opportunity to comply. If non-compliance continues, possible results include instructors asking the student to leave class and instructors dismissing the whole class. Students who do not comply with the required health behaviors are violating the University Code of Conduct and will be reported to the Dean of Students Office with sanctions ranging from educational requirements to dismissal from the university.

Any student who has substantial reason to believe that another person in a campus room (e.g., classroom) is threatening the safety of others by not complying (e.g., not properly wearing a mask) may leave the room without consequence. The student is encouraged to report the behavior to and discuss the next steps with their instructor. Students also have the option of reporting the behavior to the [Office of the Student Rights and Responsibilities](#). See also [Purdue University Bill of Student Rights](#)."

Related Considerations:

1. A listing of recommended safe practices for the specific class or laboratory setting (other PPE or safety behavior) can be found at the links below.
 - [Overarching SOP for Classrooms, Instructional Laboratories, and Experiential Courses](#)
2. References Supporting Protect Purdue Compliance:
 - Office of the Dean of Students [Protect Purdue Compliance Plan: Ask, Offer, Leave, Report](#)
 - Office of the Dean of Students [Managing Classroom Behavior and Expectations](#)

Academic Integrity

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing (integrity@purdue.edu) or by calling 765-494-8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern.

All students are expected to abide by the use of [Purdue's Honor Pledge](#): *"As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue."*

You may also refer to Purdue's [Academic Integrity and You: Graduate Edition - Office of Student Rights and Responsibilities - Purdue University](#)

Nondiscrimination Statement

Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. A link to Purdue's Nondiscrimination Policy Statement can be found [here](#)

Accessibility

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247.

Mental Health/Wellness Statement

If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try [WellTrack](#). Sign in and find information and tools at your fingertips, available to you at any time.

If you need support and information about options and resources, please contact or see the [Office of the Dean of Students](#). Call 765-494-1747. Hours of operation are M-F, 8 am- 5 pm.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc. sign up for free one-on-one virtual or in-person sessions with a [Purdue Wellness Coach at RecWell](#). Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is completely free and can be done on BoilerConnect. If you have any questions, please contact Purdue Wellness at evans240@purdue.edu.

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact [Counseling and Psychological Services \(CAPS\)](#) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office on the second floor of the Purdue University Student Health Center (PUSH) during business hours.

Additional Resources:

- [ODOS services and information portal](#) and the [Critical Need Fund](#).
- [Student of concern reporting](#) (anyone on campus can submit a report if they are unsure where to go or in what way they can help a student - it does not need to be an emergency).
- The [ACE Campus Food Pantry](#) (open to the entire Purdue community)
- The [Center for Advocacy, Response & Education \(CARE\)](#) (open to all Purdue students) "provides support and advocacy for survivors of sexual violence, dating violence, and stalking.

Emergency Preparation

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.

Guidelines regarding ensuring access to emergency information:

1. If you experience any symptoms of COVID-19 or suspect you may have been exposed to someone with COVID-19 stay home and call the Protect Purdue Health Center at 765-496-INFO.
2. Keep your cell phone on to receive a Purdue ALERT text message.
3. Log into a Purdue computer connected to the network to receive any Desktop Popup Alerts.
4. If you feel threatened or need help on campus, use one of 300 Emergency Telephones outdoors across campus and in parking garages that connect directly to the PUPD. Push the button to be connected immediately.

Course Evaluation

During the last two weeks of the course, you will be provided with an opportunity to evaluate this course and your instructor. Purdue uses an online course evaluation system. You will receive an official email from evaluation administrators with a link to the online evaluation site. You will have up to two weeks to complete this evaluation. Your participation is an integral part of this course, and your feedback is vital to improving education at Purdue University. I strongly urge you to participate in the evaluation system.

Disclaimer

This syllabus is subject to change. Such changes will be announced and updated on Brightspace.