ME EN 321 THERMODYNAMICS

Fall 2025, Section 1: MWF 9:00 – 10:00 am, CB 254

Class	Date	Topic	Reading*	Homework**	Due
0	W Sep 3	Syllabus,	Syllabus	none	
1	F Sep 5	thermodynamics and energy, units	1.1 – 1.2	HW1: 1-11, 1-16E(P), 1-18, 1-87E	Tu Sep 9
2	M Sep 8	Systems, properties, states, *T* & *P*, problem solving	1.3 – 1.11	HW2: 1-30C, 1-37E(P), 1-43, 1-53E, 1-62, 1-90E(P), 1-91E	Tu Sep 9
3	W Sep 10	Energy, heat and work	2.1 – 2.5	HW3: 2-16, 2-17(P), 2-29E, 2-35(P)	Tu Sep 16
4	F Sep 12	1st Law (conservation of energy), efficiency, environment	2.6 – 2.8	HW4: 2-43, 2-48, 2-75(P), 2-117, 2-120(P)	Tu Sep 16
5	M Sep 15	Phases of a pure substance	3.1 – 3.3	HW5: 3-63	Tu Sep 16
6	W Sep 17	Phase diagram, property tables	3.4 – 3.5	HW6: 3-28, 3-29E(P), 3-39(P), 3-40, 3-56E(P), 3-59	Tu Sep 23
7	F Sep 19	Property tables practice	3.4 – 3.5	HW7: 3-25(P), 3-30, 3-46, 3-54(P)	Tu Sep 23
8	M Sep 22	Ideal gas and compressibility	3.6 – 3.7	HW8: 3-84, 3-86(P), 3-93(P), 3-98	Tu Sep 23
9	W Sep 24	Review			
10	F Sep 26	**Exam 1**			
11	M Sep 29	Boundary work	4.1	HW9: 4-5(P), 4-6, 4-24, 4-115(P)	Tu Oct 7
12	W Oct 1	Energy balance (1st Law): Closed systems	4.2	HW10: 4-30, 4-34(P), 4-43(P), 4-137E	Tu Oct 7
13	F Oct 3	Specific heat: ideal gases, solids, and liquids	4.3 – 4.5	HW11: 4-57E(P), 4-64(P), 4-91, 4-111	Tu Oct 7
14	M Oct 6	Specific heat: practice properties	4.3 – 4.5	HW12: 4-74(P), 4-81, 4-84E(P), 4-139	Tu Oct 7
15	W Oct 8	Energy balance (1st Law): Control volumes	5.1 – 5.3	HW13: 5-6, 5-11(P), 5-16(P), 5-25	Tu Oct 14
16	F Oct 10	Steady flow devices	5.4	HW14: 5-36(P), 5-51, 5-67, 5-79(P)	Tu Oct 14
17	M Oct 13	Steady flow devices	5.4	HW15: 5-37, 5-49(P), 5-68, 5-84(P)	Tu Oct 14
18	W Oct 15	Unsteady flow	5.5	HW16: 5-120(P), 5-125, 5-137, 5-182(P)	**M Oct 20**
19	F Oct 17	Practice problems	5.5	HW17: 5-119 (P), 5-171E, 5-189	**M Oct 20**
20	M Oct 20	Review			
21	W Oct 22	**Exam 2**			
22	F Oct 24	2nd Law, reservoirs, heat engines	6.1 – 6.3	HW18: 6-18, 6-19E(P), 6-24	Tu Oct 28
23	M Oct 27	Heat pumps, refrigerators, perpetual motion	6.4 – 6.5	HW19: 6-35C, 6-41(P), 6-45, 6-49(P), 6-57, 6-61C	Tu Oct 28
24	W Oct 29	Irreversibility, temperature, Carnot heat engine	6.6 – 6.10	HW20: 6-77C, 6-81E(P), 6-90, 6-131, 6-132(P)	Tu Nov 4
25	F Oct 31	Carnot refrigerator and heat pump	6.11	HW21: 6-98, 6-103E(P), 6-108, 6-109, 6-112(P)	Tu Nov 4
26	M Nov 3	Entropy, increase of entropy principle, *T* – *s* diagram	7.1 – 7.5	HW22: 7-29, 7-36, 7-58(P), 7-62(P)	Tu Nov 4
27	W Nov 5	Finding Δs	7.6 – 7.9	HW23: 7-53, 7-71(P), 7-88(P), 7-94	Tu Nov 11
28	F Nov 7	Reversible steady-flow work	8.1	HW24: 8-10(P), 8-12E	Tu Nov 11
29	M Nov 10	Isentropic efficiency, entropy balance	8.3 – 8.6	HW25: 8-23, 8-26(P), 8-36(P), 8-45(P), 8-56(P), 8-58	Tu Nov 11
30	W Nov 12	Entropy balance (2nd Law)	8.4 – 8.6		
31	F Nov 14	Entropy balance examples			
32	M Nov 17	Review			
33	W Nov 19	**Exam 3**			
34	F Nov 21	Intro to power cycles, air-standard assumptions	10.1 – 10.3	HW26: 10-24	Tu Nov 25
35	M Nov 24	Overview of reciprocating engines, Otto cycle	10.4 – 10.5	HW27: 10-34E(P), 10-35E	Tu Nov 25
36	W Nov 26	Otto cycle	10.5	HW28: 10-36, 10-42E(P)	Tu Dec 2
--	F Nov 28	Thanksgiving: No class			
--	M Dec 1	Thanksgiving: No class			
37	W Dec 3	Diesel cycle	10.6	HW29: 10-57(P), 10-60	Tu Dec 9
38	F Dec 5	Brayton cycle	10.8	HW30: 10-95(P), 10-97, 10-98(P)	Tu Dec 9
39	M Dec 8	Rankine cycle	11.1 – 11.2	HW31: 11-20, 11-24(P)	Tu Dec 9
40	W Dec 10	Vapor-compression refrigeration cycle	12.1 – 12.3	HW32: 12-15E(P), 12-16(P)	**F Dec 11**
41	F Dec 12	Review			
	M Dec 13	Final Exam (07:00 am – 10:00 pm)			

* This schedule and syllabus serve as an outline and guide for our course. I may modify it with reasonable notice to you; changes will be announced in class and posted on Learning Suite.

** Homework is from the 10th edition of the textbook. (P) indicates Practice Problems for which solutions are posted on Learning Suite.

Instructor: Hongjuan Ran
Email: hongjuan@byu.edu
Office: EB 360Q

Phone: 801-422-3650 (office)

Office hours:
Monday 11-12:00 am
Tuesday 2-3:00 pm
Wednesday 11-12:00 pm

About me

Favorite book: Old Testament of bible, by Bryce Courtenay
Favorite song: God will make a way.
Hobbies: Running, Hiking, Swimming, Skiing
reading with my kids
Mission: maybe senior someday
Weakness: Cookies

When

Office hours : Give me a chance to know you

My office hours are right after class! If you are unable to meet during office hours or would like to meet a different time, feel free to email or drop by my office. If my door is closed, don't hesitate to knock. If another student is already talking to me, and we're jabbering away, make your presence known.

Purpose

Office hours are for YOU! This is time that I have set aside each week to dedicate to helping students. Do not feel like you are taking advantage of my time by coming—that is what the time is for! Don't feel like you need to stop by exactly at the start time—any time during the entire window is fair game. And don't feel pressured into making it quick, especially if no one else is waiting: if you want to spend the whole block of time hashing out some things or getting help for whatever reason, that's okay!

What to discuss

Many think that office hours are only for homework help or if you didn't understand the lecture. That's just the start! You can come into office hours to talk about anything—other things related to the class, other engineering classes, some fun project idea you're thinking about, guidance on picking a research lab, talking about graduate programs or career plans, shooting the breeze about baking, etc. This is your chance to have dedicated one-on-one time with me, regardless of whether it has to do with thermodynamics. I love it when students come by and you should feel comfortable doing so, for whatever reason.

Bonus

Office hours are a good way for me to get to know you. If you end up applying to graduate/law/med school or jobs that require letters of recommendations, I can't really write a good one if you were "just" another student in my class. But if you've come to office hours and given me a chance to get to know you, I can write a better letter for you when it's needed.

Special point

Since I just came from China last October, I'm still not very familiar with American students, culture, and daily life. So, I really hope to learn more about you and also find ways we can help each other. Meeting and talking with you will also help me improve my English, which has gotten a bit rusty over the years. I truly appreciate your kindness and support!

TA hours

Gaining mastery of thermodynamics isn't easy. Along the way, it can be messy and frustrating and very demanding. Don't try to push through alone! TAs can help guide your path through the muck. That's why we have them! The TA office is also a fantastic place to find fellow students grappling with the material. Learn from and teach one another. Effective teamwork is essential for influential engineers.

TA office hours are held in room CB 350. They are posted on Learning Suite under the "Content" tab.

Brian Easthope
east03@byu.edu

Forrest Holbrook
fholbro@byu.edu

Neil Jarvis
ncsivraj@byu.edu

Matthew Fogleman
mdfogle@byu.edu

TA Office

CB 350

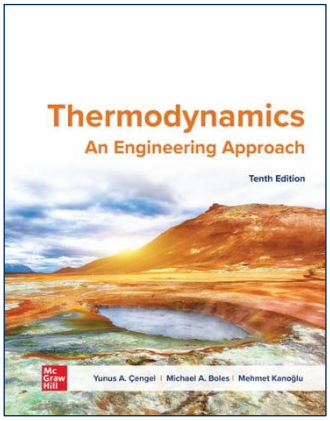
Prerequisites

PYSCS 123 and CHEM 105

Textbook

Thermodynamics: An Engineering Approach Tenth Edition, by Çengel, Boles, and Kanoglu.

- The digital textbook is available through Inclusive Access, and the cost ($48.75) will be automatically added to your tuition and fees. If you prefer a hard copy of the textbook, you may opt out of Inclusive Access on Learning Suite, tab VitalSource by 9/10/25.
- Thermodynamic properties of steam, Refrigerant-134a, air, and select ideal gases are found in the textbook appendices.
- Steam properties are also available from the smartphone app "International Steam Tables" by Hans-Joachim Kretzchmar (IAPWS-IF97 formulation), available on both iOS and Android. I highly recommend purchasing this app to save time!



ME EN 321 Course Learning Outcomes

Knowledge & skills you'll develop

1. *Problem Solving* – Each student can use structured techniques to develop engineering problem statements based on real-world applications and to solve engineering problems.
2. *Writing* – Each student can write a *technical theory section*, a *results and discussion of results* section and create a *figure* consistent with specified guidelines.
3. *Thermodynamic Systems, States, Properties and Processes* – Each student can characterize the material comprising a thermodynamic system, use the state postulate to fix the state of a system and obtain thermodynamic properties using appropriate methods. Each student can use properties and boundary interactions to describe processes and can sketch processes on thermodynamic diagrams.
4. *1st Law Analysis* – Each student can use conservation of mass and conservation of energy to model open and closed systems undergoing transient and steady processes.

Knowledge & skills you'll develop

5. *2nd Law Analysis* – Each student can identify irreversibilities and determine whether a process may be approximated as reversible, internally reversible or externally reversible. Each student can use the entropy balance equation to model open and closed systems undergoing transient and steady processes.
6. *Engineering Devices* – Each student can describe the operation of engineering devices and the models typically used to represent these devices.
7. *Cycles* – Each student can list the devices and describe the processes executed in power and refrigeration cycles. Each student can build thermodynamic models to analyze and evaluate cycles and to draw conclusions regarding their performance.
8. *Ethical and Professional Responsibility* – Each student recognizes the role of thermodynamics in addressing economic and environmental concerns related to energy and can make informed judgements consistent with ethical and professional responsibilities.

ME EN 321 Course Expectations

How to be successful

- Attend the lectures, ask questions, give answers! When we do mini reviews or practice problems during lectures, actively work with the people around you. The value of class time increases with the level of your engagement.
- This is a difficult course. To be successful, it will require your consistent and diligent effort. Each reading assignment will take about ½ hour. Homework problems take a significant amount of time to be mastered, so avoid procrastination.
- While this material is difficult, it can also be fun! There are incredible ways that thermodynamics affects and enriches our lives. I'm excited to share with you and learn about these things together.
- As you put forth your honest best effort, I will provide every opportunity I can for you to thrive. If you're struggling with an assignment, come talk to me. If you have questions about the reading, come talk to me. If you feel overwhelmed, come talk to me. If you have special circumstances or needs, come talk to me. I want to help you succeed in this course and in your engineering career.
- Finally, I expect personal integrity from my students and myself. I encourage group studying and hope you will collaborate on homework but copying from others or from AI without being intellectually engaged is cheating. I consider using an online or prior semester's solution manual (other than what I post for you on Learning Suite) for Homework Practice or Homework Mastery problems to be plagiarism. This will be considered a violation of the Honor Code. Cheating isn't worth it. Let's work together to learn the material and we can have a great semester.

The big picture

Course Purpose

Advance along the path of a BYU student to an engineer in the world that solves problems, gives your best, embraces the Holy Ghost, lives authentic discipleship, and finds joy and balance in career, family, social, and gospel living.

Homework

This class has two types of homework. 1. *Practice* and 2. *Mastery*.

Practice problems are intended to help you learn the material but not necessarily to assess your knowledge. To facilitate learning, solutions to Practice problems are posted on Learning Suite. You should attempt these problems on your own or with other students and check the posted solution as a last resort for clues or to confirm that you are doing the problems correctly. Please do not to copy/save the posted Practice solutions. They are only for review as you do the homework.

Mastery problems are intended to assess your ability to apply concepts to new problems. Solutions to the Mastery problems are not posted prior to the due date. You may confer with other students on

these problems and with the TA and the instructor if you have a conceptual question. The TA will not show you the key or give answers to these problems so please do not request that.

Homework Practice and Mastery problems are due at midnight on the date specified in the syllabus. Your solutions to homework should be orderly and follow a structured format. Scanned copies of both Practice and Mastery solutions should be uploaded digitally on Learning Suite. Immediately after the due date/time, all homework solutions will be posted on Learning Suite. You will have **48 hours to grade your own homework** following the ME EN 321 Homework Self-Grading Procedure below and to submit a grade under "Homework Report" in Learning Suite. Self-grading helps you learn where you went wrong while the homework is still fresh in your mind.

ME EN 321 HOMEWORK SELF-GRADING PROCEDURE

Homework solutions will be published on Learning Suite ("Content" tab) immediately after the homework submission deadline. Students should review the posted solutions and grade their own work. Each assigned homework problem (Practice and Mastery) should be graded using the following general grading rubric, with **10 points possible for each problem**:

Work	Points
Problem setup (Appropriate control volume, process diagram, etc.)	1
Fundamental laws (Correct use of mass, energy, and entropy balances)	4
Property relationships (State postulate, properties correctly determined)	4
Correct numerical answer and units	1

The total score for the assignment should be summed and scaled to 100 points as follows. If N problems were assigned, the scaled possible score for the assignment would be

$$(100 \times \text{sum of scores for all problems}) / (10\ N)$$

For example, if 8 problems are assigned and the total self-graded score for the assignment is 71 of a possible 80, the scaled score would be

$$(100 \times 71) / 80 = 88.75$$

Each student will submit this score in the "HW XX Report" in the "Exams" tab on Learning Suite. Scoring buttons are listed in 5-point increments (*e.g.*, 5, 10, 15, ..., 90, 95, 100). Enter the self-graded total homework score for the assignment using the buttons, rounded up the nearest 5-point option.

Late Policy

In general, late **Homework** will not be accepted. However, you are allowed **one exception** to submit a late assignment with no penalty. To do so, complete the work when you can and email the scanned copy of your solutions and self-graded score directly to our TA Brian Easthope (east03@byu.edu).

Late **Homework Reports** have their own policy. If you email Brian your self-graded score with 24 hours of the deadline, there is a 5-point penalty applied to your score. If the score is emailed to Brian greater than 24 hours from the deadline, a 15-point penalty will be applied.

Writing Assignment

To practice writing high quality technical reports that you will produce throughout your engineering career, you will write a technical theory section, results and discussion section for a thermodynamics problem of your choosing. More details regarding this assignment will be provided later in the semester.

Service Assignment

"I have tried to imagine [Jesus Christ] bustling between meetings or multitasking to get a list of urgent things accomplished," President Dieter F. Uchtdorf said. "I can't see it. Instead, I see the compassionate and caring Son of God purposefully living each day" (Of Regrets and Resolutions, October 2012 GC). While each of our semesters will unquestionably be busy, it is important to take time for the most

important things. I will reduce your Homework load this semester to free up time for service. Details of this assignment will be presented in class.

Education and service in your 20s leads to a happier, more regret-free life in your 30s

Service and BYU's 150th

Reading Quizzes

There will be a Learning Suite reading quiz on the assigned reading material prior to each class period. The quizzes are designed to encourage self-learning in the textbook prior to the lecture. Each quiz is open book and must be taken in Learning Suite by 9:00 am the day it is due. The quiz is found under the "Exams" tab in Learning Suite titled by the assigned reading section (*e.g.*, "Quiz 1.1-1.11"). A portion of the total credit for each quiz will be given just for completing the quiz, and the remaining credit will be given for answering quiz questions correctly. **These quizzes cannot be made up.** However, the five lowest scores on quizzes will be dropped. If there is a prolonged illness or other reason for missing more than five quizzes, I will work out an equitable score with you for missed quizzes.

Exams

There will be three midterm exams and a final exam. The format for each exam will be presented in class. The final exam will be comprehensive on the date shown in the syllabus.

Grades

The total score for each category is averaged and then weighted by the percentage given below. The grade scale can be found on Learning Suite. Importantly, note that the grade computed on Learning Suite throughout the semester is not predictive of your final grade.

Homework & Writing Assignment	18%
Service Assignment	2%
Reading Quizzes	10%
Midterm Exams (3)	45%
Final Exam	25%

Honor Code

In keeping with the principles of the BYU Honor Code, students are expected to be honest in all academic work. Academic honesty means, most fundamentally, that any work you present as your own must in fact be your own work and not that of another. Violations of this principle may result in a failing grade in the course and additional disciplinary action by the university. Students are also expected to adhere to the Dress and Grooming Standards. Adherence demonstrates respect for yourself and others and ensures an effective learning and working environment. It is the university's expectation, and every instructor's expectation in class, that each student will abide by all Honor Code standards. Please call the Honor Code Office at 801-422-2847 if you have questions about those standards.

Why do pandas have fur coats?

Because they'd look silly in denim jackets.

Use of AI

Elder Gerrit W. Gong recently taught, "As Church members, we will not grow spiritually if we let artificial intelligence write our sacrament meeting talks or do our seminary homework. AI cannot replace our individual effort and spiritual preparation as we prepare lessons, prayers, or blessings. However, AI may be helpful as we research, edit, translate, or do similar tasks… We are not afraid of artificial intelligence, nor do we think it is the answer to every problem. As we work hard and smart, AI can be a valuable tool to enhance but not replace our own efforts… Artificial intelligence cannot replace revelation or generate truth from God. We have the responsibility to ensure that the Holy Ghost can

attest to the truth and authenticity of all we say and share—in our form and in our content. As we seek the Lord's wisdom and understanding, He will continue to guide and bless us." (Devotional, 8/19/2025)

You will need to know how to use generative AI software, like ChatGPT, in your engineering career. I want you to learn to use such tools now, so you're not disadvantaged at graduation. At the same time, I want *you* to learn thermodynamics and how to solve problems. Leaning too much on AI, which can easily solve many of the problems we look at in this class, will impede your growth as an engineer. With that in mind, here are a few principles:

1. You may use generative AI to help you prepare for class, study for exams, and brainstorm for assignments. AI software should not be used to replace course materials such as assigned readings, nor should it be used for reading quizzes.
2. For homework, you may use generative AI sparingly to help you get unstuck. I discourage it though, and prefer you look to the textbook, fellow students, TAs, and my office hours first. Growth comes from overcoming difficult challenges. The work you submit should reflect your intellectual engagement with and understanding of the material. A copy or cut and paste approach from AI is no different than copying from another student. Please don't do it.
3. Generative AI software may not be used for any purpose in any exam situation.

What happens when you let a panda drink NH_4^+?

Pandamonium!

Preventing & Responding to Sexual Misconduct

The health and well-being of students is of paramount importance at Brigham Young University. If you or someone you know has experienced sexual harassment (including sexual violence), there are many resources available for assistance.

In accordance with Title IX of the Education Amendments of 1972, BYU prohibits unlawful sex discrimination, including sexual harassment, against any participant in its education programs or activities. The university also prohibits sexual harassment by its personnel and students. Sexual harassment occurs when

- a person is subjected to unwelcome sexual speech or conduct so severe, pervasive, and offensive that it effectively denies their ability to access any BYU education program or activity;
- any aid, benefit, or service of BYU is conditioned on a person's participation in unwelcome sexual conduct; or
- a person suffers sexual assault, dating violence, domestic violence, or stalking on the basis of sex.

University policy requires all faculty members to promptly report incidents of sexual harassment that come to their attention in any way, including through face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Incidents of sexual harassment should be reported to the Title IX Coordinator at t9coordinator@byu.edu or 801-422-8692 or 1085 WSC. Reports may also be submitted online at https://titleix.byu.edu/report or 1-888-238-1062 (24-hours a day).

BYU offers confidential resources for those affected by sexual harassment, including the university's Sexual Assault Survivor Advocate, as well as a number of non-confidential resources and services that may be helpful. Additional information about Title IX, the university's Sexual Harassment Policy, reporting requirements, and resources can be found at http://titleix.byu.edu or by contacting the university's Title IX Coordinator.

What did the woman say when she saw twin pandas?

"That bears repeating."

Student Disability

Brigham Young University is committed to providing a working and learning atmosphere that reasonably accommodates qualified persons with disabilities. A disability is a physical or mental impairment that substantially limits one or more major life activities. Whether an impairment is substantially limiting depends on its nature and severity, its duration or expected duration, and its permanent or expected permanent or long-term impact. Examples include vision or hearing impairments, physical disabilities, chronic illnesses, emotional disorders (e.g., depression, anxiety), learning disorders, and attention disorders (e.g., ADHD). If you have a disability which impairs your ability to complete this course successfully, please contact the University Accessibility Center (UAC), 2170 WSC or 801-422-2767 to request a reasonable accommodation. The UAC can also assess students for learning, attention, and emotional concerns. If you feel you have been unlawfully discriminated against on the basis of disability, please contact the Equal Opportunity Office at 801-422-5895, eo_manager@byu.edu, or visit https://hrs.byu.edu/equal-opportunity for help."

What do you call a bear that doesn't want to grow up?

Peter Panda.

Devotional Attendance

President C. Shane Reese recently said, "Our BYU devotionals are such an important part of our uniqueness at BYU. They provide us as students, faculty, and staff an opportunity to blend the sacred elements of the restored gospel of Jesus Christ with elements of academic disciplines. Devotionals help each of us to develop our full divine potential, which is central to all that we do at BYU. BYU strives to emit a unique light for the benefit of the world—a light that will enable BYU to be counted among the exceptional universities in the world and an essential example for the world. I love that each of you has made it a priority to participate in our devotional today." (Opening remarks, 5/23/23 Devotional). Your attendance at each devotional and forum is strongly encouraged. You are welcome to join the faculty each Tuesday (meet at 10:45 am in the Me En front offices) to walk to the Marriott Center and enjoy the devotional together.

Why is panda one of the easiest words to spell?

All you need is P and A.

An Apostle's Message

I have observed a common characteristic among the instructors who have had the greatest influence in my life. They have helped me to seek learning by faith. They refused to give me easy answers to hard questions. In fact, they did not give me any answers at all. Rather, they pointed the way and helped me take the steps to find my own answers. I certainly did not always appreciate this approach, but experience has enabled me to understand that an answer given by another person usually is not remembered for very long, if remembered at all. But an answer we discover or obtain through the exercise of faith, typically, is retained for a lifetime. The most important learnings of life are caught—not taught.

-Elder David A. Bednar, Seek Learning by Faith, Ensign 9/2007

What's the difference between a panda and a polar bear?

About one thousand miles.