

Process Thermodynamics

ECH 3101

Class Periods: MWF, period 8 (3:00 pm – 3:50 pm)

Location: Bartram Hall, 211

Academic Term: Spring 2022

Instructor:

Dmitry Kopelevich

Email: dkopelevich@che.ufl.edu

Office Phone Number: (352) 392-4422

Office Location: CHE 315

Office hours:

- Tuesdays: 1:00 pm – 2:00 pm
- Thursdays: 10:30 am – 11:30 am

Unless stated otherwise, the office hours will be held virtually via Zoom. Relevant Zoom links are provided in E-learning (Canvas).

If you would like to meet with the instructor outside of the regular office hours, please email to make an appointment.

Supervised Teaching Student:

Long Nguyen

Email: lnguyen2@ufl.edu

Please contact through the Canvas website

Office hours: Thursdays, 1:00-3:00 pm

Unless stated otherwise, the office hours will be held virtually via Zoom. Relevant Zoom links are provided in Canvas.

Course Description

3 credit hours. Introduces fundamental principles of classical thermodynamics. Applications to modeling and analysis of physical and chemical processes undergoing change.

Course Pre-Requisites

COT 3502 (Computer Model Formulation) and ECH 3264 (Elementary Transport Phenomena)

Course Objectives

Upon completion of this course, a student should be able to:

1. Formulate the first, second, and third laws of thermodynamics.
2. Develop and solve mathematical models of closed and open systems using mass, energy, and entropy balances.
3. Analyze power cycles.
4. Estimate thermodynamic properties of pure gases and liquids using equations of state and thermodynamic graphs and tables.
5. Estimate thermodynamic properties of multicomponent mixtures.

Materials and Supply Fees

N/A

Required Textbook

S. I. Sandler, "Chemical, Biochemical, and Engineering Thermodynamics", 5th edition (2017), ISBN 978-0-470-50479-6.

Relation to Program Outcomes (ABET):

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	High
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	Medium
3. An ability to communicate effectively with a range of audiences	
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	Low
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Low
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	High

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Tentative Course Schedule

Exact dates and homework assignments will be posted on Canvas

Week 1: Introduction (Chapter 1)

- Thermodynamic variables and their units
- Equilibrium State
- Pressure and Temperature
- Heat, Work, and Conservation of Energy
- Intensive and Extensive Variables

Weeks 2-3: Conservation of Mass and Energy

- Mass Balance Equation (Sections 2.1-2.2)
- Energy Balance Equation. First Law of Thermodynamics (Sections 3.1-3.2)
- Thermodynamic Properties of Matter (Section 3.3)
- Applications of the Mass and Energy Balances (Section 3.4)

Weeks 4-6: Entropy: An Additional Balance Equation

- Definition of Entropy (Section 4.1)
- Entropy Balance and Reversibility. Second Law of Thermodynamics (Section 4.2)
- Heat, Work, Engines, and Entropy (Section 4.3)
- Entropy Changes of Matter (Section 4.4)
- Applications of the Entropy Balance (Sections 4.5-4.6)

Midterm #1

Week 7: Liquefaction (Section 5.1)

Week 8: Power Generation and Refrigeration Cycles (Sections 5.2-5.3)

Week 9: Thermodynamics of Mechanical Explosions (Section 5.4)

Weeks 10-12: Thermodynamic Properties of Real Substances

- Thermodynamic Partial Derivatives. Maxwell Relationships (Sections 6.1-6.2)
- Ideal Gas and Absolute Temperature Scale (Section 6.3)
- Equations of State (Section 6.4)
- Evaluation of Changes in Thermodynamic Properties (Section 6.4)
- Departure Functions (Section 6.4)
- Principle of Corresponding States (Section 6.5)
- Generalized Equations of State (Section 6.6)
- Third Law of Thermodynamics (Section 6.7)
- Estimation Methods for Critical and Other Properties (Section 6.8)

Midterm #2

Weeks 13-15: Thermodynamics of Multi-component Mixtures

- Thermodynamic Description of Mixtures (Section 8.1)
- Partial Molar Gibbs Free Energy and Gibbs-Duhem Equation (Section 8.2)
- Equations of Change for a Multi-component System (Sections 8.3-8.4)
- Standard Heat of Reaction (Section 8.5)
- Experimental Determination of Partial Molar Volume and Enthalpy (Section 8.6)

Final Exam

Course Website (Canvas)

- To access the class E-learning (Canvas) website, go to elearning.ufl.edu
- After logging in using your UF credentials, you should be able to identify our class website and navigate to it.
- The homepage of the course website will contain topics and dates of completed lectures, as well as links to supplementary materials.
- Homework assignments will be posted in the "Assignments" tab of the website.
- The course website also contains a **discussion forum** on which the students are welcome to post questions related to the course material. These questions will be answered by the instructor or the Supervised Teaching Student on daily basis. In addition, the students are encouraged to provide answers to their classmates' questions on the forum.

Attendance Policy, Class Expectations, and Make-Up Policy

- Students are strongly encouraged to attend all lectures, although attendance is not required. It is student's responsibility to obtain the information (e.g. notes, assignments, and announcements) that they have missed due to their absence.
- Exams and quizzes will be rescheduled only for those students who missed them due to an acceptable reason, such as illness, serious family emergencies, military obligation, religious holidays, and participation in official university activities. Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies. Click here to read the university attendance policies: <https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>
- Students arriving late for a quiz/exam will be given only the balance of time remaining to complete their work unless an acceptable reason (see above) is provided.

Exam and Quiz Policy

- The final exam is scheduled to take place on Thursday, April 28, 7:30 am - 9:30 am.
- Dates of midterm exams and quizzes will be announced in class and posted on the course Canvas page.
- Students may not leave the room during a quiz/exam except in emergencies.
- Students may use their course notes and the textbook during quizzes, but not during the exams.
- Students are allowed to bring 1 letter-size sheet with notes to the exams. Use of other materials is not allowed on the exams.
- It is recommended that students bring a scientific calculator to all exams. However, the use of cell phones, laptops, tablets, or other electronic devices is not allowed, unless stated otherwise.
- Only one solution per problem should be turned in. If a student turns in two or more different solutions for the same problem, all of them will be graded but only the lowest of these grades will be counted towards the exam or quiz grade. The motivation for this policy is that the students should learn to identify correct solutions without outside help.

Homework Policy

- Homework will be assigned on 1-2 week basis.
- Homework solutions can be submitted either as a hard copy in class or scanned and uploaded to Canvas on the due date.
- Homework solutions will be posted on the Canvas website after the due date.
- A penalty of 10% per day will be imposed for a late homework submission. No credit will be given for homework submitted after the solution was posted on Canvas.
- A randomly selected subset of problems will be graded on each homework assignment. Please note that you are responsible for checking your own work against the solutions, as not every homework may be graded.
- Grade for some of the homework problems may be based on having completed the assignment, not on whether the results are correct or incorrect.
- **A failing grade will be assigned to students whose cumulative homework grade is less than 50%.**

Format for Assignments (Exams and Homework)

- Write name, date, course number or title, and exam/homework number on top of the front page.
- Write page number on each page.
- Clearly indicate the problem number.
- Clearly identify solutions by boxing all final and intermediate answers.
- Present solutions that are neat and well thought-out to maximize your grade.
- **Include enough details to justify your solutions.**

Evaluation of Grades

Assignment	Percentage of Final Grade
Homework	10%
Quizzes	10%
Midterm Exam #1	25%
Midterm Exam #2	25%
Final Exam	30%
Total	100%

Grading Scale:

- These percentages will earn you a letter grade of *at least*

Percent	Grade	Grade Points
90.0 - 100	A	4.00
85.0 - 89.9	A-	3.67
80.0 - 84.9	B+	3.33
75.0 - 79.9	B	3.00
70.0 - 74.9	B-	2.67
65.0 - 69.9	C+	2.33
60.0 - 64.9	C	2.00
55.0 - 59.9	C-	1.67
50.0 - 54.9	D+	1.33
45.0 - 49.9	D	1.00
40.0 - 44.9	D-	0.67
0 - 39.9	E	0.00

- The instructor guarantees these grades if you earn the posted percentages.
- The instructor may decide to *lower* the thresholds for the grades listed, based upon a curve. The instructor may employ a curve only to lower these thresholds.
- More information on UF grading policy may be found at:
<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Cooperation Policy

- Students are free to consult among themselves on the approach taken to solve any **homework** problem. However, *copying* homework solutions is a violation of the Honor Code. In particular, showing other students a copy of the actual manuscript to be submitted as homework *is not allowed*. Acceptable consultation includes discussing which equations should be used for solving a problem, writing down relevant relationships, etc.
- No consultation among students is allowed during **exams and quizzes**.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Conduct Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. If you have any questions or concerns, please consult with the instructor or the Supervised Teaching Student in this class.

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

Online Course Recording

Our class sessions may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate via Zoom with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the “chat” feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <https://counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

COVID-19

- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email covid@shcc.ufl.edu) to be evaluated for testing and to receive further instructions about returning to campus.

- If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.
- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the [UF Health Screen, Test & Protect website](#) for more information.
- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling; <https://career.ufl.edu>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.