Thermodynamics 1

EML 3100, Fall 2023

MWF 5th Period – 2:00 PM to 3:15 PM

Since this class will be asynchronously delivered (except for exams), communication through Announcements will be heavily used.

Instructor:

Dr. Andrés Rubiano

For all grades-related communications, and help with homework and quiz work, please contact Nicholas Sardinia (TA) directly through a Canvas message. Please type "*Thermodynamics Student:"* before your subject in the subject line.

For all other class communications with me, please attend office hours. Overall class progress will only be discussed towards the end of the semester (when there's progress to discuss).

Office Hours: Monday and Wednesday 5:30 PM – 6:30 PM

Zoom Link: https://ufl.zoom.us/j/95057474192

Please sign up for an appointment, at least 3 hours in advance, using this link: https://calendly.com/dr-rubiano/office-hours

You can sign up for more than one 5-minute slot if you foresee a longer meeting.

Additional Office hours: as many as you want. Send me a Canvas message with a "Thermodynamics - Office Hours" subject line and a *when2meet* link with your own availability, and one concise sentence of what you want to discuss, and I'll reply to you with a time that works for both.

Teaching Assistant:

Nicholas Sardinia - nicholassardinia@ufl.edu - Zoom Link: https://ufl.zoom.us/j/2152276571

Office Hours: *Monday and Wednesday, 6 - 9pm.*

Course Description

Application of the first and second laws of thermodynamics to closed and open systems and to cyclic heat engines. Includes the development of procedures for calculating the properties of multiphase and single phase pure substances. Credits: 3

The Southern Association of Colleges and Schools Commission on Colleges provides the federal definition of the credit hour as the equivalent to one hour of in-person instruction and at least two to three hours of out-of-class work per week in a 16-week semester. Source: citt.ufl.edu

Since this is a summer course and all topics are covered in 12 weeks (3/4ths of the time of a regular semester), you will need to dedicate roughly 12 hours of work a week (4/3rds of 9 hours) for this 3 credit course.

Prerequisites

Reading Comprehension, Physics, Calculus, and Chemistry.

IMPORTANT:

Microsoft Excel will be widely used to solve problems. You can use Python or MATLAB, alternatively.

Civil Engineering significant figures rules (slide rule) will be used for answer values.

Class Structure:

At least a day before the date listed on the schedule (below), you are to:

- study the one 8-12-minute lecture main video. Set aside at least an hour to watch it, understand it, and take notes.
- study the 1-4-minute additional example videos for each lecture topic.
    - attempt to solve these problems **before** watching the solution. You need to have a file with your own work for each example video.
- solve the assigned textbook-style problems corresponding to the day's topic.

Class meeting times will be used to:

- Take exams (check Exams section below).

Course Assignments:

Homework:

- At least a day before every lecture day (not the day of, in case of a quiz), you must **study** the linked lecture and example videos for that day.
    - For the example of the main lecture video, create your own solution using Excel/MATLAB/Python and include your written work*. Your solution's numbers might not fully match with those in the video. This is intentional.
    - For the example videos, try solving them using Excel/MATLAB/Python and include your written work*, before watching the solution portion of the video. Be as organized as possible. If there are any questions about the solution, contact Nicholas or attend his office hours. Your solutions' numbers might not fully match with those in the videos. This is intentional.
    - Complete all textbook-style problems assigned for the topic using Excel/MATLAB/Python, and include your written work*. Your solution's numbers should match exactly those offered as answer values.

**The written work can be a picture of your notebook, added into your digital file.*

Organize and label your work neatly. There is no required labelling scheme, but use consistent names that help you find your work. Example if using Excel: for any given lecture, have an Excel spreadsheet labeled with the lecture number and topic (e.g. *Lecture 07 - Quality and Interpolation)*, that has multiple tabs, one for each problem. Each problem should have clear calculations and equations. Go as far as color-coding your cells.

Only answer values will be offered for the assigned problems. If you have questions about the solution, you can ask them during Nicholas' office hours. The solution to those problems will not be uploaded at any point during the semester.

Any of your problem solutions can be a) randomly requested during a quiz or exam, or b) asked to be opened and modified during a quiz or exam, and are therefore **mandatory** and essential to perform well in the class.

Quizzes:

Pop quizzes will be published during class time and will remain open for 24 hours. Why not scheduled quizzes? Studying and memorizing information right before a scheduled quiz does not result in overall retention of engineering knowledge or successful development of critical thinking skills.

Quiz time will appear limited and quiz problems challenging, if homework assignments are not completed.

Quizzes are a collection of numerical inputs (fill in numerical values of variables) and are graded automatically on Canvas. Use "Slide-Rule Accuracy" (civil engineering) significant rules. More information in your files folder: Significant Figures file.

Exams:

There will be 4 cumulative, 75-minute exams. These will be given at 2 PM (during the assigned class time).

The exams will be taken online, and they will begin and end with the class time period. You will record yourself and your on-screen work, while working on the exam, and submit your recording to the *Recording* assignment. You will need a working webcam and OBS set up (installation and set up instructions found in the Files tab).

Only one exam question will show at a time, and each question will lock after you submit your answers.

Written work submissions: you will need to upload your written work and software calculations (Excel, MATLAB, Python) for exams.

Exams Schedule: June 10th, July 1st, July 24th, and August 7th.

If you have conflicts with other classes, please let me know before May 17th, 2024. No dates will be moved if the conflicts are not reported before May 17th.

Grading: Homework (0%, but they are necessary to perform well during quizzes), Quizzes (0%, but they are necessary to develop critical thinking skills for exams), Exam 1 (30%), Exam 2 (20%), Exam 3 (25%), Exam 4 (25%).

Grade Changes: Corrections of grades should be submitted to the TA as a Canvas message within 5 business days of the grade posting in writing with a concise statement of why you believe there has been an error. Otherwise, the grade will remain unchanged. Use a proper subject line and include supporting documentation.

Make-up Policy: Missed exams will result in a zero grade, except in cases of personal or family emergencies, and will be handled on a case by case basis. In cases of emergency, the missed grade will be replaced by the grade of the following exam due to the cumulative nature of the course. If you know you'll be missing a class, let Dr. Rubiano know in advance. Send Dr. Rubiano a Canvas message after you receive the grade that will replace the zero you initially obtained.

Calculations: The video examples don't always use the most accurate unit conversions (273 K instead of 273.15 K). For your homework, quizzes, and exams, always use the most accurate version of unit conversions.

Course Content and Schedule:

Date	Day	Lecture(s)	Content	Lecture Links
May 13	M		Syllabus	
May 15	W	1 & 2	Units and Base Concepts Zeroth Law	https://youtu.be/3OyKUPur-eI https://youtu.be/wquovmwWhi4 https://youtu.be/FCZjgM8iHlE https://youtu.be/Ygm9Gr21Ib8 https://youtu.be/_me_AhPQ_dA
May 17	F	3 & 4	Open vs. Closed Systems First Law	https://youtu.be/b_FcNpZmpuM https://youtu.be/PKk3N32XKmU https://youtu.be/7TzDUt4j27w https://youtu.be/LjCTylK-RPQ https://youtu.be/WlS_ESOxnCE
May 20	M	5 & 6	Efficiency Tv Diagrams and Tables	https://youtu.be/eHhQ3VkQHeU https://youtu.be/D9UEMGsJXxU https://youtu.be/iZbnY0QWHe8 https://youtu.be/VJkyhHQjcuY https://youtu.be/fRJUwyxGXQw https://youtu.be/OQD9IAqo9xM
May 22	W	7	Quality and Interpolation	https://youtu.be/uISkuT6Mcxw https://youtu.be/q7a8doOFt-k https://youtu.be/jdLkEndf0GI https://youtu.be/uX_Nk2hSxuU
May 24	F	8	Enthalpy and Internal Energy	https://youtu.be/6Y_xjxUBd6Y https://youtu.be/OVmR-fVIIok

					https://youtu.be/38yfgPfIXPg https://youtu.be/MRzVZ6e9v5k
May	27	M	-	Holiday	-
May	29	W	9	Compressed Liquids	https://youtu.be/okVLi--oAp0
May	31	F	10	Ideal Gas and Compressibility	https://youtu.be/_L1Zhv3Os2o https://youtu.be/rAlwqLo2Y1k https://youtu.be/bCwlFqQgdKc https://youtu.be/ErJyvW9LAF4
June	3	M	11	Specific Heats	https://youtu.be/uGYAXsRmpRI https://youtu.be/OUbEHKNYFwg https://youtu.be/1QYJsDzAJDs https://youtu.be/IwRl3G5sl_Q
June	5	W	12	Incompressible Fluids	https://youtu.be/uOn9yWIajfQ https://youtu.be/iA2nZ3_4dsE
June	7	F	13	Polytropic Processes	https://youtu.be/xkFsBKf_Mbg https://youtu.be/NQdqiEHNs1Q https://youtu.be/gYpDxuEYbns
June	10	M	-	Exam 1	-
June	12	W	14 & 15	Volumetric and Mass Flow Rates & Flow Work & Open Systems	https://youtu.be/eXQfKThM7KM https://youtu.be/4oWgVuoa3do https://youtu.be/ysXzR6SpBV8 https://youtu.be/1pp4y9cwyK4 https://youtu.be/HleudqDDd9w https://youtu.be/37okuizUDJI https://youtu.be/-NeZn3xQUKA https://youtu.be/THWqP9EehCQ
June	14	F	16	Pipe Flow, Nozzles, Diffusers, and Throttling Devices	https://youtu.be/k0FaAI65vNE https://youtu.be/Y1VQBR-Q_AE https://youtu.be/Akdn7ZXzZ_A https://youtu.be/36uBMFevqRw
June	17	M	17	Turbines, Compressors, Pumps,	https://youtu.be/AHVvKzXYIcY https://youtu.be/6O2jcF74ZaE https://youtu.be/vxRCxWZP2Qk https://youtu.be/O_-eHl1wJ_M
June	19	W	-	Holiday	-
June	21	F	18	Heat Exchangers and Mixing Chambers	https://youtu.be/9szCFpV_yII https://youtu.be/30yb-a21LVs https://youtu.be/CrKhMzyQ6PU https://youtu.be/9AIh1twwaVw
June	24	M	-	Summer Break	
June	26	W	-	Summer Break	
June	28	F	-	Summer Break	
July	1	M	-	Exam 2	

July	3	W	19	Transient Systems (Unsteady Flow)	https://youtu.be/zW3I7IDyosE https://youtu.be/3JU_PyXSMOE https://youtu.be/0Osf_peMbg0 https://youtu.be/0JAbIbEra0o
July	5	F	20	2nd Law Intro and Power Cycles	https://youtu.be/SOpSbCxmaAc https://youtu.be/-EQ5cVq-tWU https://youtu.be/YRPFM1S4YJ8 https://youtu.be/wzF3N9c7wRA
July	8	M	21	Refrigeration and Heat Pumps	https://youtu.be/uF4UGM6xMp8 https://youtu.be/nhmDGil-_Vc https://youtu.be/zav4R7DIwJE https://youtu.be/U2zgbQ5k0Oo
July	10	W	22	Reversibility and Carnot Cycles	https://youtu.be/8EcvFxJmFI4 https://youtu.be/0NuMdKuiA84 https://youtu.be/M_qz9i2Rr6s
July	12	F	23	Entropy as a Property	https://youtu.be/49Nbpcv4sVg https://youtu.be/99y2Q-EvMbE https://youtu.be/hoRXBkE3XcY
July	15	M	-	Optional Exam (Basic Thermodynamics Concepts Check)	-
July	17	W	24	Reference Entropy and Specific Heats	https://youtu.be/kinE5eTVgQw https://youtu.be/0gUUejcsJ1Q https://youtu.be/cPLWt5TRJ2s https://youtu.be/nI73JIGWQE0
July	19	F	25	Isentropic Efficiency	https://youtu.be/K2A5gdROVZE https://youtu.be/pPkGtXqov6E https://youtu.be/qyuRukneC5I https://youtu.be/EqOS9aFl3Ao
July	22	M	-	Independent Review	-
July	24	W	-	Exam 3	-
July	26	F	26	Brayton Cycle	https://youtu.be/fZ80tkxWa-4 https://youtu.be/3MqkSjXZse8 https://youtu.be/nMJoLmV1dlo https://youtu.be/Odefd6YPRnI
July	29	M	27	Intercooling, Reheating, and Regenerators	https://youtu.be/EBQJv8pry2k https://youtu.be/p6A-w9Pt5IM https://youtu.be/wPjLapXwk_w
July	31	W	28	Otto Cycle	https://youtu.be/q5vgBPb8gSc

					https://youtu.be/dv91U1O_tv8 https://youtu.be/9gGsjg63AWQ https://youtu.be/Xv3Oiijjy_w
August	2	F	29	Standard Diesel Cycle	
August	5	M	30	Rankine Cycle	
August	7	W	-	Exam 4	-
August	9	F	-	Grades Finalized	-

Other Course Information

Textbook:

Thermodynamics, An Engineering Approach"; Yunus Cengel and Michael Boles; McGraw Hill;

Ninth Edition, ISBN: 978-1260048667. You can opt-in through UF all-access to obtain at a lower price.

Other Useful Course Related Resources:

Thermochemical Tables - https://janaf.nist.gov/Links to an external site.

Thermophysical Properties - https://webbook.nist.gov/chemistry/fluid/Links to an external site.

NIST Chemistry WebBook - https://webbook.nist.gov/chemistry/Links to an external site.

Python and Jupyter - https://www.anaconda.com/Links to an external site.

Cantera - https://cantera.org/Links to an external site.

Grading Scale: The final grade will be calculated by the following table.

Table 1. Grading Table. *%GE = Percent Grade Earned.*

Percentage Range	Grade Point
93.33 %GE 100.00 A	4.00

90.00	%GE	93.33	A-	3.67
86.67	%GE	90.00	B+	3.33
83.33	%GE	86.67	B	3.00
80.00	%GE	83.33	B-	2.67
76.67	%GE	80.00	C+	2.33
73.33	%GE	76.67	C	2.00
70.00	%GE	73.33	C-	1.67
66.67	%GE	70.00	D+	1.33
63.33	%GE	66.67	D	1.00
60.00	%GE	63.33	D-	0.67
00.00	%GE	60.00	E	0.00

Course Objectives:

The objective of this course is for students to learn about energy conversion to

describe physical systems relevant to today's world. Such systems include, but are not limited to, fossil

fuel powered fired power plants, renewable power plants, combustion engines, Stirling engines,

refrigeration, heat pumps and chemical reactors. Systems will be described applying the laws of energy

and mass conservation and their application to of the Second Law of Thermodynamics. This class will

provide a framework to understand the fundamentals of energy conversion from a somewhat broad and

macroscopic perspective, going into fine mechanistic details of specific systems only sporadically. With

the skillset obtained in this class, students will have the necessary tools to understanding and analyze a

broad range energy conversion processes, a necessary prerequisite for the ultimate design and

engineering of more cost effective and efficient systems in the future.

Relevance:

All (or almost all) energy ultimately is derived from the sun. The suns photons are converted

in nature to heat, wind, biomass and rain, all of which can be further transformed into heat, work or

electricity via a number of processes and thermodynamic cycles. As such, energy and energy conversion

surround and sustain our daily lives, from the sunlight used to grow food, to its transportation via rail,

ship or truck, to its storage in our refrigerators, to electricity provided from fossil or renewable sources.

Our metabolic cycles convert the energy stored in our food to do work, analogously to the way a

combustion engine converts the energy stored in gasoline to drive a car. Understanding the concept of

energy and mass conservation will allow one to approach, analyze and appreciate these systems from a

simplified energetic point of view to the more complex underlying mechanisms driving them.

General Course Schedule:

Week 1 – Introductory Concepts

Week 2 – Energy Transfer and the First Law of Thermodynamics

Week 3 – Properties of Pure Substances

Weeks 4 and 5– Closed System Analysis

Weeks 6 and 7 – Open System Analysis

Week 8 – Second Law of Thermodynamics

Week 9 – Spring Break

Week 10 – Entropy

Week 11 – Gas Power Cycles

Week 12 – Vapor and Combined Power Cycles

Week 12 – Refrigeration Cycles

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	Low
3) an ability to communicate effectively with a range of audiences	Low
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	High
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	Low
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	Medium

Academic honesty

All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a student at the University of Florida and to be honest in all work submitted and exams taken in this class and all others.

Accommodation for Students with Disabilities

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, https://www.dso.ufl.edu/drc) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at https://evaluations.ufl.edu/evalsLinks to an external site.. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at https://evaluations.ufl.edu/results/Links to an external site..

Health and Wellness

- U Matter, We Care: If you or a friend is in distress, please contact umatter@ufl.eduor 352 392-1575 so that a team member can reach out to the student.
- Counseling and Wellness Center: http://www.counseling.ufl.edu/cwcLinks to an external site., and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.
- 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/Links to an external site..

Software Use

All faculty, staff and student 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 regarding grades earned in courses and on individual assignments. For more information, please see: http://registrar.ufl.edu/catalog0910/policies/regulationferpa.htmlLinks to an external site.

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
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.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