ME 3322 Thermodynamics (Required)

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CAMPUS: GEORGIA TECH EUROPE
SEMESTER: FALL 2024 (SYLLABUS DATE: FEB 12, 2024)
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1. Catalog Description: ME 3322 Thermodynamics (3-0-3)
Prerequisites: PHYS 2211 Intro Physics I and MATH 2403 Differential Equations
Introduction to thermodynamics. Thermodynamic properties, energy and mass conservation, entropy and the second law, and second law analysis. Thermodynamic analysis of power, refrigeration, and heat pump systems; vapor cycles and gas cycles.

2. Textbook: Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, and Margaret B. Bailey, *Fundamentals of Engineering Thermodynamics*, 7th Edition, John Wiley & Sons, 2011.

3. Topics Covered:

1. Definitions: property, state, closed and open systems, temperature, pressure, work interactions, and heat transfer. State postulate.
2. Forms of energy: kinetic, potential, and internal.
3. Properties of pure substances, equilibrium diagrams, and quality. Ideal gas and incompressible substances.
4. Conservation of mass: closed and open systems, and steady and transient processes.
5. Conservation of energy: closed and open systems, and steady and transient processes.
6. Introduction to the second law: entropy, *T*d*s* equations, irreversibility, and isentropic efficiency.
7. Second law analysis: closed and open systems, and steady and transient processes.
8. Power, refrigeration, and heat pump systems: vapor cycles (e.g., ideal, Rankine, and vapor-compression); and air standard analysis of gas cycles (e.g., ideal, Brayton, Otto, and diesel).
9. Optional topics at the discretion of the instructor: additional second law topics, including the Kelvin-Planck and Clausius statements, the Clausius inequality, and exergy (availability); and methods to improve cycle performance, including reheat, regeneration, and intercooling.

4. Course Outcomes:

Outcome 1: To teach students the basic principles of classical thermodynamics.

1.1 Students will demonstrate an understanding of the concepts of conservation of mass, conservation of energy, and the second law of thermodynamics.
1.2 Students will demonstrate an understanding of the concepts of work interaction and heat transfer.
1.3 Students will demonstrate an understanding of methods for determining thermodynamic properties of simple compressible substances, incompressible substances, and ideal gases.

Outcome 2: To train students to identify, formulate, and solve engineering problems in classical thermodynamics involving closed and open systems for both steady state and transient processes.

2.1 Students will demonstrate the ability to identify closed and open systems.
2.2 Students will demonstrate the ability to identify work interactions and heat transfer.
2.3 Students will demonstrate the ability to determine accurately the thermodynamic properties of simple compressible substances, incompressible substances, and ideal gases.

2.4 Students will demonstrate that they can apply the principles of conservation of mass and energy to the solution of problems.

Outcome 3: To train students in the application of a second law analysis to a thermodynamic system.

3.1 Students will demonstrate an understanding of the concepts of the second law including entropy, irreversibility, and the isentropic efficiency.

3.2 Students will demonstrate that they can apply a second law analysis to the solution of problems involving closed and open systems for both steady and transient processes.

Outcome 4: To train students to analyze the performance of power, refrigeration, and heat pump cycles.

4.1 Students will demonstrate that they can apply the principles of conservation of mass, conservation of energy, and the second law of thermodynamics to thermodynamic cycles.

4.2 Students will demonstrate the ability to analyze the performance of vapor and gas power cycles.

4.3 Students will demonstrate the ability to analyze the performance of vapor and gas refrigeration and heat pump cycles.

5. Correlation between Course Outcomes and Student Outcomes:

ME 3322											
	Mechanical Engineering Student Outcomes										
Course Outcomes	a	b	c	d	e	f	g	h	i	j	k
Course Outcome 1.1	X				X						X
Course Outcome 1.2	X				X						X
Course Outcome 1.3	X				X						X
Course Outcome 2.1	X				X						X
Course Outcome 2.2	X				X						X
Course Outcome 2.3	X				X						X
Course Outcome 2.4	X				X						X
Course Outcome 3.1	X				X						X
Course Outcome 3.2	X				X						X
Course Outcome 4.1	X				X						X
Course Outcome 4.2	X				X						X
Course Outcome 4.3	X				X						X

6. GWW School of Mechanical Engineering Student Outcomes:

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning

(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

7. MATTERS OF GRADING

WEIGHT:

Quiz 1 : 20% (closed book, closed notes, more info below)
Quiz 2 : 20% (closed book, closed notes, more info below)
Quiz 3 : 20% (closed book, closed notes, more info below)
Final Exam: 25% (open book, open notes, do not bring solved problems or homeworks etc, more info below)
Homework: 15% (each hw has the same weight, although some may take more time to solve than others)

For each item or assignment, you will receive a numerical grade on canvas. These numbers must be interpreted as:

A 90-100%
B 80-89.99%
C 70-79.99%
D 60-69.99%
F below 60%

Should canvas make any calculation for you, ignore it, because it does not count the above-mentioned weights for each task.

GRADING OF HOMEWORK:

Homework is graded as follows: For each homework problem, you receive full marks when solved 100% correctly, 50% when solved incorrectly and 0% when not solved. You can expect around 10 homeworks. They will all be graded on 100% and will therefore have an equal weight. HOWEVER: you will be excused one homework. Practically it means that I will ignore, for each student separately, his/her homework with the lowest marks. It means that for example if you cannot turn in your homework because due to circumstances you had no time to make it, you will receive a 0% and consequently will be excused one time. If it happens n-times, then I will ignore 1 zero and I will take into account (n-1) zeros.

8. About Homeworks, Quizzes

All tasks will be submitted through CANVAS. The standard procedure is to upload pictures of your HW. A QUIZ can be turned in on paper when the exam is done.

For homeworks you are allowed to work together and discuss with your colleagues, but you must turn in your own homework and not copy that of your colleagues or a solutions manual. Homeworks are submitted via Canvas. A HW can be short or extensive, however each HW will have the same weight.

For quizzes and the final exam, you are supposed to study everything covered before the quiz, unless otherwise announced before the quiz or in this syllabus.

The first quiz will mainly focus on theory (concepts, definitions, …) and slightly on solving problems (I will ask one or maximum two problems to solve).

The second quiz will slightly focus on theory (concepts, definitions, …) and mostly on solving problems (I will ask one or maximum two theory questions).

The third quiz and the final exam cover ‘problems’, I will not ask pure theory questions in the

sense of ‘concepts’ and ‘definitions’, but only problems to solve.

Quiz 1, Quiz 2 and Quiz 3 are closed notes and closed book. You are however allowed to bring a calculator, a unit conversion sheet and also a cheat sheet (maximum 2 sides of one A4-size sheet of paper, normal size letter type, i.e. readable at 30cm distance without using magnifying equipment other than what you normally wear in class, if any).

The final exam covers everything we have covered during the semester, except chapter 1. Note however that chapter 1 is not totally isolated from the rest of the course, therefore certain items re-appear in later chapters and in that case are of course not ignored, so they may appear as part of a larger problem… The final exam is an **open book and open notes exam**. Solved problems cannot be used during the exam (so **NO homeworks, NO solutions manuals etc**). In addition to your notes and book you are allowed to bring your calculator and a cheat sheet with the same restrictions as for the quizzes. In case you use a digital handbook, you may bring your laptop. However, you are responsible for having enough battery power and you are not allowed to check anything else but the handbook or your own notes on your laptop.

Duration of quizzes: Each quiz takes 1 hour, the final exam maximum 3 hours or the full time-slot given by GT Europe (maximum).

9. Calendar (provisionary – any changes will be posted on canvas as message to you)

Homework will be assigned as needed, there will be around 8-10 assignments including practice sets. The below dates are tentative and will be updated based on the class schedule.

Quiz 1: Sept 10, 2024
Quiz 2: Oct 15 , 2024
Quiz 3: Nov 12, 2024
Final exam: date to be decided later by GT Europe (period December)

10. Office hours

I’m always available for short questions or concerns just after class. If required, you may also send an email to make an appointment.

Email: pooja.dubey@gatech.edu

11. GT Academic Honor Code

As usual the GT Academic Honor Code is followed for this class. Please check this link for clear information: http://www.honor.gatech.edu/plugins/content/index.php?id=9

12. Canvas

Your instructor uses CANVAS to send you messages and your results of homeworks and quizzes. You are supposed the check your ME3322 messages and announcements every day to make sure you don’t miss anything. It is not guaranteed that the system will email you messages after I posted them.

Acknowledgements (for making the core of this syllabus):
This syllabus is largely based on that of Nico F. Declercq