

## MAE 501 – Advanced Engineering Thermodynamics

### Spring 2024 - Sections 001, 601

**Instructor:** Prof. Alexei V. Saveliev  
**Class time:** MoWe 11:45am – 1pm, 1230 EB II  
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**Grader:** TBD  
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**1.1. Course Prerequisites:** Undergraduate thermodynamics (MAE 201, 302 or equivalent) and advanced calculus (MA 341, 501, 511 or equivalent)

**1.2. Optional Textbook:** Advanced Engineering Thermodynamics, 4th ed., A. Bejan, Wiley, 2016

**1.3. Reference Material:** Advanced Thermodynamics for Engineers, Kenneth Wark, Jr., McGraw-Hill, 1995

Thermodynamics and an Introduction to Thermostatistics, 2nd ed., by H. Callen, Wiley, NY, 1991

Y.A. Çengel, M. A. Boles, M. Kanoglu, Thermodynamics: An Engineering Approach (Packet including Property Table Booklet), 9th Ed, The McGraw Hill Companies, New York, 2018.

**1.4. Course Support:** <http://engineeringonline.ncsu.edu>  
Moodle site - <https://wolfware.ncsu.edu/>

### 1.5. Course Objectives:

The students will be asked to demonstrate their knowledge of the material covered in MAE 501 through their mastery of the following course objectives. Through the study of MAE 501 the student will be able to:

1. Apply first and second law analysis to opened and closed systems.
2. Understand the key postulates to thermodynamics and their relationship to equilibrium and properties.
3. Understand and apply the fundamental relation, the Euler equation and the Gibb-Duhem relation.
4. Apply equations of state to make property calculations of real gases.
5. Apply relations between thermodynamic properties (Maxwell relations).
6. Analyze multicomponent & multiphase systems, phase equilibrium, and chemical reactions.

### 1.6. Projected schedule of homeworks, tests, and exams

Homeworks will be assigned on Wednesday of the current week of class and will be due on Wednesday of the following week. The homeworks will be posted as Moodle Assignments set up for electronic submission and grading.

There will be three 75-minute exams and a final examination. All exams will be closed-book, closed- notes. Thermodynamics tables and a formula/summary sheet will be provided. A scientific calculator may be used. The preliminary exam schedule is provided in the class syllabus. Exam dates and times for Distance Education students will be arranged by the student with their proctor at a mutually convenient time in the period starting 8 AM EST on the date listed in the syllabus to the following day by 2 PM EST.

### 1.7. Grading

Homeworks	10%
Exam 1	20%
Exam 2	20%
Exam 3	20%
Final Exam	30%

The final grade will be based on the final average and determined as follows:

Letter	A+	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
Highest,%	100.0	96.9	92.9	89.9	86.9	82.9	79.9	76.9	72.9	69.9	66.9	62.9	59.9
Lowest,%	97.0	93.0	90.0	87.0	83.0	80.0	77.0	73.0	70.0	67.0	63.0	60.0	0

Plus/minus grades will be used for the border line cases based on attendance, homework grades, and improvement in test and exam grades.

## 1.8. Tentative Course Outline

Introduction, Basic Concepts and Definitions (1 week)

Thermodynamic Properties, State Postulate, Pure Substances, Property Tables, Ideal Gas Equation of State (1 week)

Work, Heat, and 1<sup>st</sup> Law for Closed Systems (1 week)

Conservation of Mass and 1<sup>st</sup> Law for Open Systems (1 week)

### **Exam I**                      *February 5*

Introduction to 2<sup>nd</sup> Law, Heat Engines and Refrigeration Cycles, Carnot Principles (1 week)

Clausius Inequality, Reversible Work, Entropy (1 week)

Actual Work, Exergy Analysis – Closed and Open Systems (1 week)

Statistical Definition of Entropy (1 week)

### **Exam II**                      *March 4*

Fundamental Relations, Gibbs-Duhem, Euler (1 week)

Thermodynamic Potentials, Property Relations, Maxwell relations, Bridgman's Table (1 week)

Nonreactive Ideal Gas Mixtures, Real Gases and Real Gas Mixtures (1 week)

Multiphase Systems, Energy Minimum Principle, Phase Diagrams (1 week)

### **Exam III**                      *April 8*

Chemically Reactive Systems, Stoichiometry, Enthalpy of Formation (1 week)

Chemical Equilibrium (1 week)

Steady-Flow and Constant Volume Combustion (1 week)

**Final Exam**                      *on-campus section, Friday, April 26<sup>th</sup>, 12pm – 2:30pm*

## 1.9. Course Policies

### 1.9.1 Exams

There will be three 75-minute exams and a final examination. All exams will be closed-book, closed-notes. Thermodynamics tables and a formula/summary sheet will be provided. A scientific calculator may be used. The preliminary exam schedule is provided in the class syllabus. Exam dates and times for Distance Education students will be arranged by the student with their proctor at a mutually convenient time in the period starting 8 AM EST on the date listed in the syllabus to the following day by 2 PM EST. Credit will not be given for answers without supporting analyses, or for tests turned in late. There must be no collaboration on the exams. Arrangements for missed exams will be made on an individual basis provided you have an acceptable, certifiable excuse.

### 1.9.2 Homeworks

Homeworks are posted using Moodle Assignments and should be submitted electronically. Please submit your files as PDF (preferred) or web image files. There is a limit of 10 files/10 MB total for each submission. The homeworks will be graded electronically. The maximum for each homework will be 100 points. The homework solutions will be posted as pdf files.

Homework forums will be open to discuss homeworks and post questions. All students are encouraged to participate.

### 1.9.3 Office hours

I will conduct my office hours in the office and on Zoom. The times will be selected based on the poll posted on Moodle. Another option for irregular office hours: you can always set up a Zoom meeting and send me an invite. I will accept if I am available.

### 1.9.4 Instructor's policies on incomplete grades and late assignments

Incompletes are accepted only for medical reasons. Makeup work, if any, must be arranged within two weeks of due date at the option of the instructor, prior to two weeks before the end of classes. Arrangements for missed tests will be made on an individual basis provided you have an acceptable, certifiable excuse.

### 1.9.5 Instructor's policies on attendance for on campus students

Attendance is expected and necessary for success. I will excuse a small number of absences under certain special conditions. *NCSU policy on attendance, including what constitutes an 'Excused absence,' is at <http://policies.ncsu.edu/regulation/reg-02-20-03>.*

Work that is late due to an excused absence will either be 'excused' from your grade, or it may be turned in late. It is the students' responsibility to contact the instructor as well as NC State Absence Verification as soon as possible to discuss the most appropriate action.

### *1.9.6 Academic Integrity statement*

The faculty acknowledges the existence of the University policy on academic integrity found in <http://studentconduct.ncsu.edu/> and expects students to adhere to it. It is the expectation of faculty that students neither give nor receive unauthorized aid on any exam, or special assignment. The faculty recognizes the value of discussions by students regarding weekly homework assignments in student groups, with teaching assistants, and the faculty. However, homework assignments submitted for grading must be the product of the student submitting the work.

### *1.9.7 Student Wellness*

As a student, you may experience a range of personal issues that can impede learning, such as strained relationships, increased anxiety, alcohol/drug concerns, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance and may impact your ability to participate in daily activities. It is very important that you have a support system and that you ask for help when you are struggling. The Counseling Center at NC State offers confidential mental health services for full time NC State students, including same-day emergency services. Please visit <https://counseling.dasa.ncsu.edu/> to get connected.

### *1.9.8 Statement for students with disabilities*

Reasonable accommodation will be made for students with verifiable disabilities. To take advantage of available accommodations, students must register with Disability Services for Students at 1900 Student Health Center, Campus Box 7509, 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities at <http://policies.ncsu.edu/regulation/reg-02-20-01>.

### *1.9.9 Statement on personal communication devices*

All personal communication devices must be turned off during the exams. The use of silent mode during regular class is allowed.

### *1.9.10 Class evaluation*

Online class evaluations will be available for students to complete during the last week of class. Students will receive an email message directing them to a website where they can login using their Unity ID and complete evaluations. All evaluations are confidential; instructors will never know how any particular student responded to any question, and students will never know the ratings for any particular instructor. More information about ClassEval is available at <https://isa.ncsu.edu/for-the-pack/classeval/for-students/>

*Note: this syllabus is not a contract and can be altered at any point with advanced notice to accommodate the educational goals of the course.*