

**Standing Instructions for Students (SIS)****CH365 Chemical Engineering Thermodynamics, AY2025-2026 (AY26-1)**REDBOOK DESCRIPTION

This course covers the body of thermodynamic knowledge necessary for understanding modern chemical process simulation. The course includes calculus- and numerical-based methods for determining the thermodynamic properties of substances, solutions, and multiphase mixtures. Topics include equations of state, pure component properties, properties of mixtures, fugacity, excess properties, activity coefficients, and phase equilibria. The problems in the course emphasize engineering applications. Topics covered in class are related to real systems using chemical process simulators.

COURSE INTRODUCTION, PHILOSOPHY AND OVERVIEW - (Beyond the Redbook)

A great deal of the theory and operation of chemical process equipment is determined by the thermodynamic properties of the substances within the equipment. Differences in enthalpy, entropy, and Gibbs energy determine not only energy duty, but also how much performance we can ultimately expect from any given design. Furthermore, thermodynamics plays a role in the *optimization* of energy duty and performance.

For example, the design of a chemical reactor requires knowledge of how molecules react. This includes an understanding of the chemical kinetics of the reaction, or the rate at which molecules are converted. Since the holding time in the reactor must be large enough to obtain the desired conversion, the rate of reaction influences the reactor volume. However, there is more to the story. How do we know the desired conversion is feasible? The desired conversion *must* be thermodynamically consistent. That is, thermodynamics tells us how much chemical reaction is ultimately possible. Thus, the ability to predict the equilibrium constant and extent of reaction at equilibrium is critical for determining if the reactor design is plausible. Furthermore, since reactions require addition or removal of heat and the rate depends on temperature, thermodynamics tells us the amount of heat we need to add or remove from the system to sustain the reaction.

The same concepts apply to separation operations, but in a slightly different form. In your separations course, you learned that the design of separation equipment depends upon various equilibrium expressions, such as Raoult's Law K-values, Henry's Law constants, and partition coefficients in liquid-liquid extractors. Deriving these different forms of the equilibrium expression is entirely the domain of thermodynamics. As an example, distillation tray design depends on the equilibrium of the different substances between the vapor and liquid phases, which depends on the K-values of the substances, and

the K-values are calculated using thermodynamic methods. In this course, we will show that the driving force for mass transfer between phases is the difference in chemical potential between molecules in different phases, and the chemical potential is used to calculate the K-values. It is true that the design also depends on movement of molecules, momentum, and heat, as well as the contact area available for movement between phases. These other properties are covered in your transport courses, but many of the physical properties used in the calculations are determined directly from thermodynamic methods.

In summary, this course is concerned with the properties of substances and mixtures of substances. You have already been exposed to some of this in your mechanical engineering courses, where you were introduced to the thermodynamics of pure substances. CH365 is a continuation of this theme, and the course objectives are listed below.

#### COURSE OBJECTIVES

1. Be able to calculate thermodynamic properties.
2. Interpret the suggestions made by the CHEMCAD thermodynamics wizard.
3. Derive binary interaction parameters from experimental data and apply them to activity coefficient models.
4. Interpret and calculate fugacity and fugacity coefficients.
5. Select an appropriate thermodynamic method for an application
6. Use cubic and virial equations of state to calculate enthalpy and entropy.
7. Calculate the properties of mixtures and solutions.

As in all courses, the course objectives are achieved through reading and study assignments, classroom lectures and lessons, graded homework problems, written partial reviews (WPRs), and writing assignments.

#### CONTACT INFORMATION

Instructor:	Dr. Biaglow
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Classroom:	BH331, A1-hour (0740-0835), C1-hour (0950-1045)

#### TEXTBOOK

*Introduction to Chemical Engineering Thermodynamics, 9<sup>th</sup> Edition*, by J.M. Smith, H.C. Van Ness, M.M. Abbott, and M.T. Swihart. New York: McGraw-Hill, 2022. ISBN: 978-1-260-72147-8. Access to a printed or electronic textbook is required for the entire duration of this course.

#### GRADED EVENTS

1 Term End Examination (TEE) at 500 pts:	500	21.01%
1 Capstone Design Problem (CDP)	300	12.61%
1 CDP In-Progress Review (IPR) 0 pts (Pass/Fail)	0	0.00%
3 Written Partial Reviews (WPRs) at 200 pts each:	600	25.21%
66 Homework Problems at 10 pts. per problem:	660	27.73%
1 Writing Assignment at 200 pts:	200	8.40%
1 SIS Quiz at 60 pts:	60	2.52%
1 Mathematica Quiz at 60 pts:	60	2.52%
TOTAL	2380	100.00%

#### LETTER GRADES

Letter grades in CH365 are based approximately on the scale shown in the table below. Prior to the TEE, letter grade equivalents can be computed at any time by dividing your earned points by the course point total. Point cutoffs for final letter grades may vary somewhat from those shown here.

Letter Grade	Numerical Score	Letter Grade	Numerical Score	Letter Grade	Numerical Score	Letter Grade	Numerical Score
A+	97%	B+	87%	C+	77%	D	67%
A	93%	B	83%	C	73%	F	<67%
A-	90%	B-	80%	C-	70%		

#### GRADED EVENT POLICIES

*Written Partial Reviews (WPRs) and Term-end Exams (TEE).* Mastery of material is important and is assessed primarily through the WPRs and the TEE.

- WPRs are given during class and are allotted the full class period.
- Approved solutions will be made available after the last exam is taken. This could be several days if cadets schedule make-up exams.
- If you are absent on the day of an exam, you will be required to take either a make-up or make-ahead exam.
- Cadets who know that they will be absent from a WPR must notify me via email at least 48 hours in advance.
- In accordance with the Dean's policy in the buff card general information (paragraph 7), cadets may request relief from a WPR if you have more than two major graded event on the same day.
- Any requests for relief from an exam must be submitted via email. Include the reason for seeking relief in the request. You must also receive a written response from me to confirm the schedule change. Failure to follow this procedure will result in denial of your request.

- The TEE is scheduled during TEE week and is 3.5 hours. The date of the TEE will be posted as soon as it is available. The course director, program director, and department head are not authorized to change TEE schedules.

*WPR Resubmissions.* It is my philosophy that students should be offered a chance to learn from mistakes. When appropriate, you may be offered a chance to submit corrections of your errors to earn additional points on an exam. The amount of credit available will depend on the average score for the WPR, but the total points awarded in this manner typically amount to about 10-20% of your grade for the event.

*WPR References.* WPRs are normally open note, open computer, open book, and open internet, unless announced otherwise. Open exams sound great, but there is a catch. Open exams actually require increased organization. There is too much content and not enough time for impromptu searching, and when you find what you need, you still need to write a solution, so you will want to optimize your time during exams. The bottom line is you will not do as well as possible if you are disorganized. Students who are prepared always do better and sometime enjoy the exams. Even though references are available during the exam, work must be individual, and you may not collaborate by sharing electronic files or by any other means during the exams. Also, use of references from outside of this course on an exam must be documented.

*GRADED HOMEWORK.* Homework consists of problem assignments aligned with the daily reading assignments. Homework is an important part of any engineering course, and this course is no exception. The homework is intended to illustrate and reinforce key concepts covered in both the classroom and the reading assignments. Assigned problems will be submitted for a grade. Problem solutions will be posted to the course web site after problem sets have been received from all cadets.

You are highly encouraged to solve problems using your computer with Mathematica and/or Excel. This serves two purposes. First, computerized problem solutions are useful during exams and for emailing me when you need assistance. Second, using computer tech requires disciplined problem solving. You will develop an ability to organize your work in an "algorithmic approach," which is a fundamental skill in the engineering problem solving approach. Also, computers are quick but, in some ways, they are "dumb." That is, while they are getting better, computer hardware does not by itself understand the way humans think and communicate. In order to communicate with the computer, you must learn how to organize your thoughts and encode them in a manner that is understandable by the computer. This skill (programming) is a powerful learning

method, and it works, provided you invest individual effort in the process. Learning to interact with a computer is like learning a foreign language, and like languages, there are always nuances and subtleties that empower you the more you use them.

The purpose of graded homework is to encourage frequent lesson preparation. To that end, homework problems will be collected and graded on a weekly basis. Each problem is worth 10 points and the problem sets contain different numbers of problems, so each problem set will vary somewhat in terms of total point value. The problem sets will range in value from 30 to 100 points and will make a total contribution toward your grade of 660 out of 2380 points. The sum of all problem sets for the semester is weighted to more than the value of the TEE (660 points versus 500 points for the TEE). This means homework grades can significantly raise or lower your final course grade.

Computerized problem solutions are easy to share, and you are completely free and encouraged to share and discuss problems with your classmates. However, this can be good or bad for you. Over-reliance on sharing or internet solutions can reduce your learning and, correspondingly, waste your time and your instructor's time. Try not to go to the well too quickly! I strongly advise that you try the problems on your own first and seek AI from your instructor or classmates as needed. It is far better if your instructor knows you are struggling than to present a false front by over-reliance on someone else's work. This could really hurt your exam scores when it comes time to demonstrate your individual knowledge under time constraints.

Use of files from previous classes or from the internet is not discouraged. *However, the use of solutions from previous years or from internet sources must be documented.* Not surprisingly, it is easy for me to recognize and confirm a cadet's work from a previous year and I have all previous submissions in my archive. Failure to document may result in an approach for clarification. Please use extreme caution when using someone else's solution. You are ultimately responsible for knowing all aspects of the problems, and you will be expected to solve similar problems on exam. Copying solutions, even carefully, will not fully achieve this. Also, solutions change in subtle ways from year to year. An exact copy of a solution that received a specific grade in a previous year may result in a different score this year. This is because errors in the solutions are sometimes detected during reviews in subsequent years. Furthermore, the emphasis may change from year to year. Alternate better solution methods are sometimes discovered from one year to the next, sometimes resulting from unique cadet approaches. Also, be aware that problem solutions found online are often written by students (graduate or undergraduate) and frequently have errors or other issues.

All homework must be submitted in CANVAS in pdf format in a **single pdf document** containing a signed and initialed cover page. A fillable-form cover page is linked to the course web page. You may type your initials and signature. Mathematica or Excel files must be converted or printed to pdf format and bundled with the cover page to create **a single pdf document**. Failure to follow this policy will result in the problem being kicked back to you for resubmission but with a late cut applied.

**IMPORTANT NOTE:** Graded homework, as well as all other graded assignments, **MUST** be documented in a manner that is consistent with the *Documentation and Acknowledgement of Academic Work (DAAW)*. Accordingly, **a signed cover sheet must be attached to all submissions completed outside of class**. The DAAW is linked to the main course web page. Pages 30, 34, and 36-37 of the DAAW specifically describe cover sheet requirements. The fillable form cover sheet linked to the course web site meets all requirements for cover pages in the DAAW.

**LATE HOMEWORK POLICY.** Homework may be submitted late for a cut of 2 points per problem per day (including weekends and holidays). Date and time of late submissions must appear accurately on the cover page. After two days, the cut increases to 3 points per problem per day. Homework not submitted after four days will receive a zero grade. However, submission of all homework problems is required. You still need to submit the assignment even if the late cure results in a zero. Your course grade will be set to "F" until the assignment is submitted. Any assignment not submitted before the end of the course will result in an incomplete for the course.

**HOMEWORK GRADING POLICY.** The grading rubric and rubric procedure shown below will be used to grade all homework problems.

Grade	Attributes
10	Cadets present complete problem solution and answers are correct.
4	Adequate work shown but contains one or more errors.
1	Answer is shown but work is incomplete or inadequate.
0	Answer is shown with no work.

**Rubric Procedure:**

1. Detailed grading comments will not normally be provided by the instructor.
2. Cadets are responsible for reviewing the approved solutions and finding any mistakes. Approved solutions will be posted when all cadet work has been received.
3. Resubmissions are subject to the following constraints:
  - a. Corrections must be re-submitted under separate cover with a new title (e.g., PS10 Corrections).
  - b. Resubmissions must be submitted within 48 hours of initial grade posting (weekends and holidays included). Beyond that time, resubmissions will not be accepted.
  - c. Cadets must notify the instructor via email when the resubmission has been uploaded.
  - d. Resubmissions are worth 90% of the initial point value and late cut does not apply (maximum score is 9/10).
  - e. Late initial submissions and problems with scores less than 4/10 are not eligible for a re-grade.
  - f. You must identify in writing what you did wrong.
  - g. You must make corrections to your work and verify the correction.
  - h. Approved solutions can be used find your mistakes (see note 4).
4. Copying the approved solution for resubmission will not change your grade. You must make corrections to your work and identify in writing what you did wrong.

*Guidance for Use of Generative AI.* According to the DAAW (pages 40-42), “Faculty must provide guidance to cadets on how generative AI can be used in the course. Rather than course-wide policies banning use, a course must state explicitly at the assignment level if there are restrictions on the use of generative AI based on learning objectives of the assignment.” Accordingly, generative AI is allowed for any assignment in this course with the exception of WPRs and the TEE. While generative AI is welcome, assistance must be acknowledged according to the DAAW. Faculty allowance of generative AI usage does not waive your requirement to acknowledge the usage. Also, faculty allowance of AI usage does not excuse you for submitting false or erroneous information such as false citations. ChatGPT, for example, is notorious for fabricating references. Finally, while this course encourages you to use and enjoy the tool, use it properly. Use of generative AI does not excuse you from mastery of the material.

*WRITING ASSIGNMENTS.* You will have a writing assignment in this course. The writing assignment is designed to assist you with self-reflection on skills

learned in our program, as well as for you to take inventory of and assess your own intellectual growth. You will be asked to prepare a resume explaining your skills as a chemical engineer. Grades on this assignment depend on your ability to describe the material and projects in your academic courses and the skills you acquired as a result. The grade is iterative. That is, you will make a submission, receive feedback, and then make a resubmission. The resubmission allows you to make corrections and expand your professional skill set over the course of the semester, hopefully improving your grade. Important Note: The grading rubric requires addition of new content in the final version. Failure to do so can result in a lower grade

*CLASSROOM POLICY.* Classroom activity will include interactive discussions, execution of classroom problems, homework problems, or other pertinent topics. Review sessions are scheduled at appropriate times during the semester to re-enforce classroom concepts and to allow time for discussion of concepts. You may use the review sessions to ask questions and work on homework problems. Classroom activities are organized and facilitated by the instructor. Discussions between cadets on topics not related to class will result in a negative COR. Work on assignments for other courses is prohibited and will result in a negative COR.

*COMPUTER USAGE DURING CLASS TIME.* This class is conducted in the computer lab in Bartlett Hall Room 331. Desktop computers are provided to assist you with assignments in this class. You will also be bringing your laptops to class. **During class time, any personal laptop or desktop computer activity not related to CH365 is prohibited.** This includes but is not limited to emailing, texting, web surfing, and typing assignments for other classes. If you are observed using computers inappropriately, this will result in an immediate COR and possible deduction of points from your grade. While I encourage you to bring your personal laptops to class, I do not maintain laptop software or assist cadets with networking issues. Because of this, ***lab desktop computers are required for exams and laptops may be used for reference material only.*** This policy will be strictly enforced.

*CAPSTONE PROJECT.* There is a capstone design project for this course. This project will require you to use an advanced thermodynamic method to model experimental data using calculations in Mathematica and CHEMCAD. The assignment will be posted before lesson one and is due before midnight on the last day of class. You are cautioned that this project cannot be completed in one day. There will be parts that you can do early in the semester, and there are parts that require discussion in class. You are encouraged to read through the capstone assignment now, plan how you will achieve the objectives, and begin



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working as soon as possible. More information on the capstone project can be found on the course website.

*ADDITIONAL INSTRUCTION (AI).* AI in this course is encouraged. I maintain an open door for CH365 students provided I am not otherwise engaged. You may stop in without an appointment, and if I am available, I will meet with you. If I am not available, I will ask you to leave. I encourage you to make appointments for AI. Appointments work to your advantage since they guarantee my presence, one-on-one attention, and priority over walk-ins. However, I completely understand that sometimes you may have a question that you would like answered “in the moment.” In addition to walk-in AI, email is also an effective way to receive help without an appointment. I normally answer emails as quickly as possible. Just be aware that appointments work to your advantage since they will guarantee my presence, one-on-one attention, and priority over walk-ins.