

CBE 450/550
Systems Analysis Applied to Chemical Engineering
South Dakota School of Mines and Technology

Spring 2010
Room 310 Civil-Mechanical Engineering Bldg.
Mondays, Wednesdays, and Fridays, 9:00-9:50 am

- Instructor:** Professor Kenneth M. Benjamin
C218 Chemistry and Chemical Engineering Bldg.
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394-2636
- Office Hours:** Monday 12:30-1:30 pm
Tuesday 9:00-10:00 am
By appointment
- Text:** Plantwide Dynamic Simulators in Chemical Processing and Control, First Edition, W. L. Luyben, CRC Press, 2002
- References:** Process Modeling, Simulation, and Control for Chemical Engineers, Second Edition, W. L. Luyben, McGraw-Hill, Inc., 1990
- Systematic Methods of Chemical Process Design, L. T. Biegler, I. E. Grossmann, and A. W. Westerberg, Prentice Hall, 1997
- Chemical Engineering Dynamics, J. Ingham, I. J. Dunn, E. Heinzle, and J. E. Prenosil, VCH Publishers, 1994
- AspenPlus on-line manual
- “Perry’s” Chemical Engineering Handbook.
- Thermodynamics textbook (e.g. Smith and VanNess)
- Course Website:** <http://web.me.com/kmbenjamin/CBE-450-550/CBE-450-550.html>
- Catalog Description:** CBE/CHE 450/550 SYSTEMS ANALYSIS APPLIED TO CHEMICAL ENGINEERING
2 to 3 credits. Prerequisite: CHE 417, CHE 433 or permission of instructor. The development of mathematical models for dynamic and steady state chemical engineering systems; simulation of these complex systems using computers and software, such as AspenPlus; estimation of physical and equilibrium properties; and analysis of results. Students enrolled in CHE/CBE 550 will be held to a higher standard than those enrolled in CHE/CBE 450.

Rationale: Mathematical modeling and simulation is a key component of process/systems engineering. In this course, we focus on the use of mathematical models and process simulation software to predict the properties of matter and the behavior of unit operations belonging to various chemical engineering systems.

Course Outcomes:

1. Demonstrate how to setup and solve TGS property predictions using AspenPlus
2. Demonstrate how to setup and solve equations that model various systems and unit operations from the chemical process industry
3. Demonstrate how to setup and solve AspenPlus models of various systems and unit operations from the chemical process industry
4. Find the optimum of systems and unit operations from the chemical process industry using optimization techniques
5. Formulate and solve equations to model the dynamic behavior of specified chemical process systems
6. Demonstrate setup and solutions to dynamic models using Aspen Dynamics simulator
7. Demonstrate setup and solution of a heat exchanger network
8. Work in teams to solve both traditional (closed-ended) and open-ended problems

Homework: There will be approximately ten (10) homework assignments during the semester. You are encouraged to work in groups, where general approaches to problem solving can be discussed with peers. However, each student must work out and submit the problem solutions individually.

Exams: There will be one midterm exam during the semester and one final comprehensive exam at the end of the semester. The exact dates and times of the exams will be announced in class well in advance of the exams. All exams will be take-home, and as such will be open-book and open-note. As always, each individual should complete exams on their own, without assistance from others. Students are expected to abide by the SDSMT policies of academic integrity (with regard to cheating, plagiarism, etc.), as outlined in the Course Catalog. For those taking this course for 3 credits, please note that the final exam will be May 7 from 3:00-4:50 pm.

Group Design Projects: Students will work in groups of 2-3 to complete two small open-ended design projects. These projects will involve the application of process modeling principles to solve research or industrially relevant problems. The projects will require computer simulations (of the same type to be covered in class and on homeworks and exams), as well as a written report. Grades for the projects will be determined by the accuracy and quality of the engineering calculations, as well as by the quality and detail of the written discussion and analysis.

Late Assignment Policy: Assignments (homeworks and group projects) must be submitted at the start of class on the respective due dates. Late work will be accepted up to one day late, but 25% of the grade will be deducted. Once homework solutions are posted for a given assignment (typically 1-2 days after its due date), that homework assignment will no longer be accepted.

Grading: The various course assignments will be weighted as follows:

For 3 credit hours:

Homework	30%	
Design Projects (Group)	30%	(15% each for two projects)
Exams (Individual)	40%	(20% each for midterm and final)

For 2 credit hours:

Homework	40%	
Design Projects (Group)	40%	(20% each for two projects)
Exams (Individual)	20%	(midterm only)

Overall course grades will be determined from the following straight percentage scale:

A/B cutoff	90%
B/C cutoff	80%
C/D cutoff	70%

ADA Statement: *Students with special needs or requiring special accommodations should contact Professor Benjamin at 394-2636 and/or the campus ADA coordinator, Jolie McCoy, at 394-1924 at the earliest opportunity.*

Freedom in Learning Statement:

Under Board of Regents and University policy student academic performance may be evaluated solely on an academic basis, not on opinions or conduct in matters unrelated to academic standards. Students should be free to take reasoned exception to the data or views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled. Students who believe that an academic evaluation reflects prejudiced or capricious consideration of student opinions or conduct unrelated to academic standards should contact the dean of the college which offers the class to initiate a review of the evaluation.

Electronic Devices Policy: *Please turn off your cell phone before class starts. No text messaging in class. No headphones. If you wish to use a laptop in this class for purposes of note taking, that's great; however, you will be required to download DyKnow software and then join ENGL350 to activate. Any attempt to circumvent the DyKnow monitoring system will be considered a form of cheating and a breach of academic integrity. Note that according to "Policy Governing Academic Integrity" in the SDSM&T Undergraduate Catalog, the instructor of record for this course has discretion of how acts of academic dishonesty are penalized, subject to the appeal process, and that "Penalties may range from requiring the student to repeat the work in question to failure in the course" (72-73). No other use of any other electronic/computer media is allowed during class time.*

Academic Integrity: Students are expected to abide by the SDSMT policies of academic integrity (with regard to cheating, plagiarism, etc.), as outlined in the Course Catalog.

<i>Tentative list of topics (not necessarily covered in this order)</i>	<i>2 Cr Hr</i>	<i>3 Cr Hr</i>
1. Introduction to Class and AspenPlus Properties	**	**
TGS in AspenPlus		
Phase equilibrium review		
Fugacity and activity coefficient models		
UNIFAC on AspenPlus		
Electrolytes		
2. Steady State Simulations	**	**
Degree of Freedom Analysis		
Stream tearing and solution techniques		
Basic steady state models		
Complex models (AspenPlus)		
3. Dynamic Modeling	**	**
Model development		
material and energy balances		
unit operations, such as reactors, separators		
Simulator usage (Aspen Dynamics)		
Controls		
4. Optimization	**	**
Sensitivity analysis (AspenPlus)		
Design Specifications (AspenPlus)		
Theory and solution techniques (AspenPlus)		
5. Process Economic Modeling	TBD	TBD
6. Heat Exchanger Networks		**
7. Dynamics – Complex systems		**

Those enrolled for 2 credits will cover topics 1-4 (and possible topic 5) above, which will be presented over the first ten (10) weeks of class, which end March 26, 2010.