AY21-1 Chemical Engineering Course and Program Brief

LTC Matthew Armstrong
COL Geoff Bull
Dr. Andy Biaglow
MAJ Trevor Corrigan

LTC Corey James
Dr. Enoch Nagelli
LTC April Miller

10APR20

CH485: Heat and Mass Transfer
Course Director: LTC Sam Cowart

Credit Hours: 3.5 (BS=0, ET=3.5, MA=0)
Prerequisites: MA364 and MC312
Co-requisite: None
Lessons: 30 @ 75 min, 7 @ 120 min
Special Requirements: None

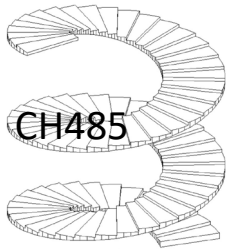
This course includes the study of the mechanisms of energy and mass transport, with special emphasis on applications in engineering systems. Coverage includes Fourier's Law of Heat Conduction, and Fick's Law of Diffusion, the development of shell energy and species balances, and the use of these equations to solve for temperature and concentration profiles in chemical engineering systems. An important emphasis in the course is the use of transport equations to understand species diffusion, convection, and chemical reaction in equipment design.

Topics

Mass and Heat Transfer, T.W. Fraser Russell, A.S. Robinson, and N.J. Wagner, Cambridge University Press, Copyright 2008

- Introduction (1 Lesson)
- Macroscopic mass, energy, and species balances
  - Chemical reactors (2 lessons)
  - Heat exchangers (5 lessons)
  - Mass contactors (4 lessons)
- Microscopic mass, energy, and species balances
  - Conduction and diffusion (9 lessons)
  - Convective heat and mass transfer (7 lessons)
  - Heat Exchanger Design - CHEMCAD (2 lessons)

Course Assessment – Items from Section III



Sustain:

Maintain Nondimensionalization Lab

Improve:

- Revamp Problem Sets – Create a library of problems
- Replace problem solving with in-class Problem Sets (open book / closed notes)
- Reconsider instruction of first half of course (do we need to follow textbook completely)

Assessment – Graded Events

8 Problem Sets @ 50 pts each:	400	18.96%
2 *In-Class Prob. Sets @ 100 pts each:	200	9.50%
3 *WPRs @ 200 pts each:	600	28.43%
1 *Writing Assignment @ 200 pts:	200	9.50%
7 Labs @ 30 pts each:	210	10.00%
1 *Term End Exam @ 500 pts:	500	23.70%
Total:	2110	
*Individual Points :	1500	71.10%

CH363: Separations Processes

Course Director: LTC Corey James

Credit Hours: 3.5 (BS=0, ET=3.5, MA=0)
Prerequisites: CH362
Co-requisite: None
Lessons: 30 @ 75 min, 7 @ 120 min
Special Requirements: None

This course covers methods for the physical separation of chemicals. Topics include dew point and bubble point calculations, adiabatic flash, distillation, chromatography, liquid-liquid and gas-liquid absorption/stripping. Students are taught the significance of staging of unit operations. Heavy emphasis is placed on theory of operations, numerical methods of solution, and simulation.

Topics – by Chapter

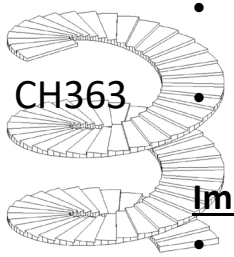
Separation Process Principles, 4th Ed., by J.D. Seader, E.J. Henley and D.K. Roper

- Introduction to Separations/DOF Analysis (Ch. 1)
- Vapor-liquid, gas-liquid, solid-liquid, flash(Ch. 4)
- Cascading configurations (Ch. 5)
- Designing trayed towers and packed columns (Ch. 6)
- Optimizing towers and columns (Ch. 7)
- Liquid-liquid extraction (Ch. 8)
- Multi-component distillation (Ch. 9)
- Capstone Project

Course Assessment – Items from Section III

Sustain:

- Technical Writing: Written Research Paper
- Capstone project – Ties all key concepts together. Assesses communication outcome.
- ChemCAD use in concert with theory



Improve:

- Need extra distillation lesson in block 3; topic needs more treatment and fits better in block 3
- Change labs to individual work to improve ChemCAD acumen
- Improve cadets reliance on the text as a resource

Assessment – Graded Events

8 Problem Sets @ 40 pts each:	320	13.3%	
4 *In-Class Prob. Sets @ 75 pts each:		300	12.5%
3 *WPRs @ 200 pts each:		600	25.0%
1 *Research Paper @ 100 pts:	100	4.2%	
7 *Labs @ 40 pts each:		280	11.6%
1 *Term End Exam @ 500 pts:	500	20.8%	
1 *Capstone		300	12.5%
Total:		2400	
*Individual Points :		1820	75.8%

CH365: Chemical Engineering Thermodynamics
Course Director: Dr. Andy Biaglow

Credit Hours: 3.0 (BS=0, ET=3.0, MA=0)
Prerequisites: CH363, CH364, MA366, MC312
Co-requisite: None
Lessons: 40 @ 55 min
Special Requirements: None

This course covers the body of thermodynamic knowledge necessary for understanding modern chemical process simulation. Students learn the theory behind the thermodynamic methods used in the software. The course includes calculus- and numerical-based thermodynamics approaches for determining the properties of substances, solutions, and multiphase mixtures. Topics include equations of state, pure component properties, transport 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 through the use of chemical process simulators.

Topics – by Chapter

Chemical Engineering Thermodynamics, Smith, van Ness, Abbott, and Swihart, 8th Edition (2018)

- Introduction (Ch. 1)
- First Law (Ch. 2)
- Equations of State (Ch. 3)
- Heat (Ch. 4)
- Entropy and Second Law (Ch. 5)
- Fluid Properties (Ch. 6)
- Equilibrium (Ch. 10)
- Solution Thermodynamics (Ch. 11)

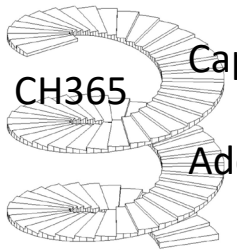
Course Assessment – Items from Section III

Sustain:

Writing project - resume exercise involved intense use of instructor time but positive changes were observed; many teachable moments

Capstone project – calculation of properties and comparison with CAD

Addition of writing to capstone



Improve:

More emphasis on Ch 11, specifically excess properties

More practice on calculating fugacity and activity.

Use of writing rubric to assess capstone.

Assessment – Graded Events

1 *Term End Exam @ 500 pts:	500	22.42%
1 *Capstone Design Project @ 300 pts	300	13.45%
3 *Capstone IPRs @ 30 pts each:	90	4.04%
3 *WPRs @ 200 pts each:	600	26.91%
64 *Problems @ 10 pts each:	640	28.70%
1 *Writing Assignment @ 100 pts:	100	4.48%
Total:	2230	100.00%
*Individual Points :	2230	100%

CH459: Chemical Engineering Lab
Course Director: Dr. Enoch Nagelli

Credit Hours: 3.5 (BS=0, ET=3.5, MA=0)
Prerequisites: CH362/CH363/CH364
Co-requisite: None
Lessons: 40 @ 120 min, 7 @ 120 min
Special Requirements: None

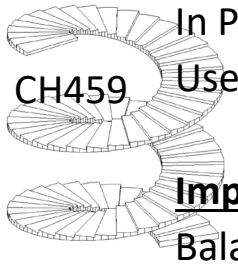
This course provides laboratory experience in selected chemical engineering unit operations, such as gas absorption, evaporation, distillation, liquid-liquid extraction, cooling tower, heat exchanger, and chemical reactors. Process control and process safety are emphasized in laboratory and classroom instruction. Written and oral reports required.

1. Unit Operations of Chemical Engineering, 7th Edition, by Warren L. McCabe, Julian C. Smith and Peter Harriott; McGraw-Hill, 2005.
2. Plant Design and Economics for Chemical Engineers 5th ed., Peters, Max S. and Klaus D. Timmerhause, McGraw-Hill, New York 2003, ISBN-10: 0071240446

1. Batch and CSTR — EC: Short HtExchgnr
2. Cooling Tower
3. Hydrogen Fuel Cell
4. Single/Double Effect Evaporator
5. Distillation
6. Carbon Dioxide Absorber

Course Assessment – Items from Section III

Sustain:
Technical Writing: Written Lab Reports/ Posters/ Executive Sum.
SACHE Modules
In Progress Reviews (IPRs)
Use of CHEMCAD to model all lab data



Improve:
Balance of work on teams
Individual CHEMCAD

Assessment – Graded Events

6 Lab HWs@ 20 pts each	120	4.4%
6 Lab Exec. Sum/ Poster/ Report	600	22.1%
6 IPRs @25 pts ea	150	5.5%
6 Lab Execution (aka. lab rubric)	450	16.5%
2 *WPRs @ 350 pts each:	**700**	25.7%
1 TEE	**700**	25.7%
Total:	**2720**	
*Individual Points :	1400	**~51%**