Department of Chemistry and Life Science

AY26-1 Chemical Engineering Program Brief

03 April 2025

Agenda

- Course Briefings
  - CH350
  - CH363
  - CH365
  - CH459
  - CH485

- 5-year teaching plan

CH350: Introduction to Bioengineering

Course Director: LTC Hummel

Course Supervisor: Dr. Yuk

Credit Hours: 3.0 (BS=1.0, ET=2.0, MA=0)
Prerequisites: CH102, MA205, and PH202
Co-requisite: None
Lessons: 30 @ 75 min
Special Requirements: None

The purpose of this course is to provide the introductory knowledge for understanding the biotechnology/bioprocessing engineering. Topic includes enzyme kinetics, molecular biology, cell growth, bioreactors, and bioprocesses. The bioprocess control and its application to different biological systems are covered in the classroom instruction. An important emphasis is made on the use of kinetics and process controls on the biological systems for engineering application.

Topics – by Chapter

1) *Bioprocess Engineering Basic Concepts,* 3rd Ed., by Michael L. Shuler, Fikret Kargi, Matthew DeLisa, Prentice Hall.
2) *Quantitative Fundamentals of Molecular and Cellular Bioengineering,* by K. Dane Wittrup, Brice Tidor, Benjamin J. Hackel, and Casim A. Sarkar, The MIT Press.

- Introduction (Ch 1, Shuler et al)
- Enzyme Kinetics (Ch 2-3, Shuler et al; Ch 2-3, Wittrup et al)
- Central Dogma to Molecular Biology (Ch 4-5, 8, Shuler et al)
- Cell Growth (Ch 6-7, Shuler et al)
- Bioreactor Selection (Ch 9-10, Shuler et al)
- Bioprocess Consideration (Ch 11-13, Shuler et al)

Course Assessment – Items from Section III

Sustain:

1. TEE – required to access the Cadets' understanding of overall course contents.
2. Capstone Project – development of bioreactors based on the material balance applied for cellular system.

Improve:

1. General – switch out the core problems in the problem sets and WRPs.
2. More in-class activities to enhance the classroom experience, especially with the physical and chemical intuition in coding.

Assessment – Graded Events

Requirement	# of Event	Points/Event	Total Points	%
Problem Set	6	50	300	20
Instructor Points	4-5	Varies	50	3
Capstone IPR	1	50	50	3
Capstone Presentation	1	100	100	6
Capstone Paper	1	200	200	14
WPR	2	200	400	27
TEE	1	400	400	27
TOTAL (*Individual Points = 1500 (100%))			**1500**	**100**

CH363: Separations Processes

Course Director: COL James

Course Supervisor: LTC Cowart

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:

- Capstone project – Ties all key concepts together. Assesses communication outcome.
- ChemCAD use in concert with theory/ every day CHEMCAD
- Use of sub-basement for demos (absorber and distillation columns)

Improve:

- Review/rewrite labs (rigor/length/ChemCAD integration)
- **Continue** to renew focus on NTUs

Assessment – Graded Events

8 Problem Sets @ 30 pts each:	240	14%
3 *In-Class Prob. Sets @ 100 pts each:	300	14%
3 *WPRs @ 200 pts each:	600	28%
7 Labs @ 30 pts each:	210	10%
1 *Term End Exam @ 500 pts:	500	23%
1 Capstone	300	14%
Total:	2150	
*Individual Points :	1400	65%

CH365: Chemical Engineering Thermodynamics

Course Director: Dr. Biaglow

Course Supervisor: LTC Cowart

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, 9th Edition (2021)

- 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 – grading intense, but introspective for cadets.

Capstone project – calculate solution properties and compare to CC; AI/ML; Excess Gibbs Energy (rec. from last AY; course obj. score in activity decreased slightly over last AY from 4 to 3.8/5. Student self correction in grading.

Improve:

Excess Properties – Continue to develop creative ways to emphasize on Ch 11, specifically excess properties. Have cadets construct plot and *interpret* it.

Communication – Develop grading rubric for capstone writing assignment.

Assessment – Graded Events

1 *Term End Exam @ 500 pts:	500	21.01%
1 *Capstone Design Project @ 300 pts	300	12.61%
1 *Capstone IPR, pass/fail:	0	0.00%
3 *WPRs @ 200 pts each:	600	25.21%
66 *Problems @ 10 pts each:	660	27.73%
1 *SIS Quiz @ 60 pts:	60	2.52%
1 *Mathematica Quiz @ 60 pts:	60	2.52%
1 *Writing Assignment @ 200 pts:	200	8.40%
Total:	2380	100.00%
*Individual Points:	2380	100.00%

CH459: Chemical Engineering Lab

Course Director: Dr. Yuk
Course Supervisor: Dr. Biaglow

Credit Hours: 3.5 (BS=0, ET=3.5, MA=0)
Prerequisites: CH362, CH363, and 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.

Topics – by Chapter

1. *Unit Operations of Chemical Engineering*, 7th Ed., 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. Timmerhaus, McGraw-Hill, New York 2003, ISBN-10: 0071240446.

- Batch and CSTR
- Cooling Tower
- Hydrogen Fuel Cell
- Single-Effect Evaporator
- Distillationn Column
- Carbon Dioxide Absorber

Course Assessment – Items from Section III

<u>Sustain</u>:

1. Integration of SWE – DIST EXSUM (Individual Submission).
2. Update guidance documents for each lab with specific direction for calculations.
3. Continue to update HW for each experiment – Pull from textbooks and new problems.

<u>Improve</u>:

1. Use Laplace Block Diagram where controls is obvious for cadets conducting experiments.
2. Re-integrate roles/duties specific for each experiment.

Assessment – Graded Events

6 Pre-Lab HWs @ 25 pts ea.	150*	4.0%
1 Exec. Sum + Lab **(SWE)**	200*	6.7%
1 SWE IPR	25*	0.83%
5 Exec. Sum/Poster/Report @ 100 pts	500	16.7%
5 IPRs @25 pts ea.	125	4.16%
5 Lab Execution @ 100 pts ea.	500	16.7%
2 WPRs @ 400 pts each:	800*	26.7%
1 Term End Exam @ 700 pts:	700*	23.3%
Total:	**3000**	
(*Individual Points :	1875	62.5%)

CH485: Heat and Mass Transfer

Course Director: LTC Cowart

Course Supervisor: Dr. Biaglow

Credit Hours: 3.5 (BS=0, ET=3.5, MA=0)
Prerequisites: MA364 and ME362
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, 2008

- Introduction (1 Lesson)
- Macroscopic mass, energy, and species balances
  - Chemical reactors (2 lessons)
  - Heat exchangers (4 lessons)
  - Mass contactors (2 lessons)
- Microscopic mass, energy, and species balances
  - Conduction, diffusion, and radiation (9 lessons)
  - Special cases (curved geometries, composites, membrane diffusion, transient heat & mass transfer) (4 lessons)
  - Convective heat and mass transfer (7 lessons)
  - Transport Analogies (4 lessons)

Course Assessment – Items from Section III

<u>Sustain</u>:

- Problem solving days prior to WPR/ICPS
- Lesson structure & content (radiation heat transfer)
- Continue Arnold Cell Lab (two different cells)
- Convective H/T Lab – continue concepts; get hands-on

<u>Improve</u>:

- Introduce cooling fin experiment (hands-on) for Lab 3
- Build bench of alternate labs
  - Wetted wall column
  - Membrane gas diffusion (air separation)

Assessment – Graded Events

10	Problem Sets @ 50 pts each:	500	22%
2	In-Class Prob. Sets @ 100 pts each:	200	9%
3	WPRs @ 200 pts each:	600	26%
1	Writing Assignment @ 200 pts:	225	10%
7	Labs @ 40 pts each:	280	12%
1	Term End Exam @ 500 pts:	500	22%
Total:		2305	
Individual Points:		2025	88%

Considerations

- Growth of ChemE enrollment

- *ChemE Majors:*
  32 (Class ‘25)
  27 (Class ’26)
  33 (Class ‘27)
  27 (Class ‘28)

- **ABET Record Year in AY26**
  ABET visit in Fall AY27-1

- **Next PhDs:**
  MAJ Plante **(**AY27)
  LTC Corrigan (AY28)
  MAJ Bowers (AY29)

AY25		AY26		AY27	
AY25-1 (Fall)	AY25-2 (Spring)	AY26-1 (Fall)	AY26-2 (Spring)	AY27-1 (Fall)	AY27-2 (Spring)
CH363 (James)	CH362(Tobergte)	CH363 (James)	CH362 (Tobergte)	CH363 (James)	CH362 (Rogers)
CH459 (Nagelli)	CH364 (Cowart)	CH459 (Yuk)	CH364 (Nagelli)	CH459 (Nagelli)	CH364 (Plante)
CH485 (Cowart)	CH402 (Biaglow)	CH485 (Cowart)	CH402 (Biaglow)	CH485 (Plante)	CH402 (Biaglow)
CH365 (Biaglow)	CH400 (Nagelli)	CH365 (Biaglow)	CH400 (Cowart)	CH365 (Biaglow)	CH400 (Nagelli)
CH350 (Yuk)	CH367 (James)	CH350 (Hummel)	CH367 (James)	CH350 (Yuk)	CH367 (James)
	CH300 (Yuk)		CH300 (Yuk)		CH300 (Yuk)
	CH450 (Burpo)	**Nagelli Sabbatical*	CH450 (Yuk)		CH450 (Yuk)
		Tobergte (GC)		Yuk (GC)	
		Lowell (GC + OPSO)	Lowell (GC + OPSO)	Golonski (GC)	
Tobergte (GC)	Yuk (GC)	Golonski (GC)	Rogers (GC)	Rogers (GC)	Golonski(GC)
Lowell (GC+OPSO)	Lowell (GC+OPSO)	Rogers (GC)	Golonski (GC)	Frey(GC)	Frey (GC)
Golonski(GC)	Golonski (GC)	Frey (GC)	Frey (GC)	Stewart (GC)	Stewart (GC)
Rogers (GC)	Rogers (GC)	Stewart (GC)	Stewart (GC)	Glinski(GC)	Glinski (GC)
Frey (GC)	Frey (GC)	Glinski (GC)	Glinski (GC)	Breed (GC)	Breed (GC)

AY28		AY29		AY30	
AY28-1 (Fall)	AY28-2 (Spring)	AY29-1 (Fall)	AY29-2 (Spring)	AY30-1 (Fall)	AY30-2 (Spring)
CH363 (James)	CH362 (Nagelli)	CH363 (Nagelli)	CH362 (Nagelli)	CH363 (James)	CH362 (TBD: T10)
CH459 (Nagelli)	CH364 (Plante)	CH459 (Yuk)	CH364 (Plante)	CH459 (Yuk)	CH364 (Bowers)
CH485 (Plante)	CH402 (Biaglow)	CH485 (Plante)	CH402 (Biaglow)	CH485 (Bowers)	CH402 (Nagelli)
CH365 (Biaglow)	CH400 (Yuk)	CH365 (Biaglow)	CH400 (Yuk)	CH365 (Nagelli)	CH400 (Yuk)
CH350 (Corrigan)	CH367 (James)	CH350 (Corrigan)	CH367 (James)	CH350 (Corrigan)	CH367 (James)
	CH300 (Corrigan)		CH300 (Corrigan)		CH300 (Corrigan)
**Yuk Sabbatical*	CH450 (Corrigan)		CH450 (Corrigan)		CH450 (Corrigan)
Corrigan (GC)		James (GC)			
Stewart (GC)	Glinski (GC)	Corrigan (GC)			
Glinski (GC)	Stewart (GC)	Breed (GC)	Breed (GC)		
Breed (GC)	Breed (GC)	Turner (GC)	Turner (GC)	Brown (GC)	Turner (GC)
Turner(GC)	Turner (GC)	Brown (GC)	Brown (GC)	Turner (GC)	Brown (GC)