AY24-2 Chemical Engineering Course and Program Brief

Dr. Enoch Nagelli
LTC Sam Cowart
MAJ Patrick Bowers
CPT (P) Louis Tobergte
Mr. Abhilash Mathew
Dr. Andrew Biaglow
MAJ Galen Mandes
CPT (P) Sam Lowell
Dr. Simuck Yuk
COL Kit Parker

24 October 2023

ABET Engineering Technology Accreditation Commission

Agenda

- Course Briefings
  - CH300
  - CH450
  - CH362
  - CH364
  - CH367
  - CH400
  - CH402
- Bioengineering update
- Incoming Chem. E. faculty update
- Teaching Slate (5 year projected)
- Program updates
  - Lab updates, ABET Record Advisory Board, & Instructor Observation

CH300: Introduction to Biomedical Engineering
Course Director: COL Parker
Course Supervisor: Dr. Yuk

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

This course provides a basis for understanding the application of engineering principles to problems in medicine and biology. It provides preparation for future graduate work in medical school, biomedical engineering, and chemical engineering. Specifically, the objectives of the course are: (1) to introduce the field and how it relates to other fields of engineering and science, (2) the develop the ability to apply mathematics, science, and engineering to solve problems, (3) to develop an understanding of the impact of engineering solutions on the medical field and society, and (4) to understand current topics within the field.

Topics – by Chapter

TEXT: Introduction to Biomedical Engineering, 3rd Edition, by John Enderle and Joseph Bronzino; Academic Press, 2012 & Physical Biology of the Cell, 2nd Ed by Rob Phillips

- Part I: Molecular and Cellular Properties (Ch.1, Ch.2, & Ch.3 of Enderle Text and Ch.2, Ch.3, & Ch.4 of Phillips Text)
- Part II: Cellular Considerations (Ch.4, Ch.5, Ch.8, and Ch.13 of Enderle Text)
- Part III: Downstream Considerations (Ch.10, Ch.11, Ch.12, Ch.14, Ch.15 of Enderle Text)

Course Objectives

1) Understand the broad meaning of the term "biomedical engineering" and the interface between research, engineering, and clinical fields.

2) Synthesize math, science, and engineering concepts from the Core Sequence and major courses in a biomedical engineering context.

3) Understand, apply, and manipulate models for biomedical engineering design.

4) Reinforce and strengthen conceptual and practical understanding of fundamental thermodynamics, kinetics, and mass transport.

5) Develop oral and written communication skills and continue to develop cadets' ability to prepare technical reports.

Assessment – Graded Events

6 HWs @ 50 pts each	300	21.4%
2 WPRs @ 200 pts each:	400	28.6%
1 Capstone Project	200	14.3%
1 TEE	500	35.7%
Total:	**1400**	
*Individual Points :	1400	100%

CH450: Bioengineering Modeling and Analysis

Course Director: Dr. Yuk

Course Supervisor: Dr. Biaglow

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

This course provides a broad understanding of bioengineering disciplines to include biomechanics, biomaterials, tissue engineering, biocatalysts, biochemical engineering, and biosensors. Fundamental concepts of molecular kinetics, thermodynamics, and mass transport are applied in problem sets in each bioengineering sub-discipline and capstone design project providing students the opportunity for modeling, analysis, and design from the biomolecular to physiological length scale and across multiple time scales. Modeling software such as MATLAB and Mathematica is extensively used.

Topics – by Chapter

TEXT: Introduction to Biomedical Engineering, 3rd Edition, by John Enderle and Joseph Bronzino; Academic Press, 2012.

- Part I: Biomechanics (Ch. 1 and 4)
- Part II: Biomaterials (Ch. 5)
- Part III: Tissue Engineering (Ch. 6)
- Part IV: Biomedical Enzyme Kinetics (Ch. 7 and 8)
- Part V: Biochemical Engineering (Handouts)
- Part VI: Biosensors (Ch. 10)

Course Assessment – Items from Section III

- Strong instructor personal experience in mathematics, engineering, and chemistry
- Each lesson considers interdisciplinary science and engineering topics –science topics are taught in context of engineering applications
- Quantitative modeling of biological systems at biomolecular to physiological length scales

Assessment – Graded Events

5 *Problem Set @ 25 pts each	500	47.2%
6 *Quiz @ 200 pts each:	180	17.0%
1 *Capstone Paper	150	4.1%
1 *Capstone Presentation	50	4.7%
6 *Instructor Points	180	17.0%
Total:	**1060**	
*Individual Points :	1060	100%

CH362: Mass and Energy Balances
Course Director: MAJ Mandes
Course Supervisor: LTC Cowart

Credit Hours: 3.5 (BS=0, ET=3.5, MA=0)
Prerequisites: CH102 or CH152
Co-requisite: None
Lessons: 40 @ 55 min, Labs: 7 @ 120 min
Special Requirements: None

Introduction to mass and energy balances in single phase and multiphase, nonreactive and reactive systems. Course topics include an introduction to engineering calculations and process variables, use of computers in solving chemical engineering problems, fundamentals of material balances in single-phase and multi-phase systems, energy balances on nonreactive and reactive processes, applications of combined material and energy balances, introduction to chemical engineering unit operations, and a general introduction to the field of chemical engineering.

Topics – by Chapter

Elementary Principles of Chemical Processes, Felder, Rousseau, Bullard, 4th Edition (2016)

- Introduction to Chemical Engineering (Ch. 1)
- Introduction to Engineering Calculations and Process Variables (Ch. 2 & 3)
- Single and Multi-unit Material Balances (Ch. 4.1-4.5)
- Reactive System Material Balances (Ch. 4.6-4.10)
- Multiphase Systems (Ch. 6)
- Energy Balances on Non-reactive Sys (Ch. 5, 7, 8)
- Energy Balances on Reactive Sys (Ch. 9)

Course Assessment – Items from Section III

Sustain:

Add in lesson to reinforce fundamental engineering calculations (unit systems, dimensional analysis, etc.) – **sustain from last year**

Modeling projects in labs and problem sets using software for analytical techniques

Continue to use applied problems to reinforce concepts

Current textbook; decided against zyBook

Improve:

Additional emphasis on energy balances (15 MB, 2 PE, 10 EB)

Two additional problem sets (one every 3 lessons)

Assessment – Graded Events

10 *Problem Sets @ 40 pts each:	400	16%
4 *In-Class Prob. Sets @ 100 pts ea.:	400	16%
3 *WPRs @ 200 pts each:	600	24%
7 Labs @ 30 pts each:	210	9%
1 *Research Paper	150	6%
1 *Capstone Project	150	6%
1 *Term End Exam @ 500 pts:	550	22%
Total:	2460	
*Individual Submission:	2250	**91%**

CH364: Chemical Reaction Engineering

Course Director: LTC Cowart

Course Supervisor: Dr. Yuk

Credit Hours: 3.5 (BS=0, ET=3.5, MA=0)
Prerequisites: CH362
Co-requisite: None
Lessons: 40 @ 55 min, 7 @ 120 min
Special Requirements: None

This course studies the effects of chemical reaction kinetics on systems of engineering significance. It introduces selection and operation of commercial chemical reactors, emphasizing chemical kinetics and transport phenomena. It studies currently practiced engineering techniques associated with each of these reactors. Topics covered in this course include ideal reactors; batch, CSTR and PFR, isothermal and non-isothermal. Other topics may include catalytic reactors, bioreactors, transient and steady state reactor design, pressure drop in reactors, recycle, stability, and numerical methods.

Topics – by Chapter

Textbook*: Elements of Chemical Reaction Engineering*, Fogler, Prentice Hall, 6th Edition (2020)

- Mole Balances (Ch. 1)
- Conversion and Reactor Sizing (Ch. 2)
- Rate Laws (Ch. 3)
- Stoichiometry (Ch. 4)
- Isothermal Reactor Design (Ch. 5, 6)
- Collection and Analysis of Rate Data (Ch. 7)
- Multiple Reactions and Bioreactors (Ch. 8, 9)
- Catalysis & Catalytic Reactors (Ch. 10)
- Non-isothermal Reactor Design (Ch. 11, 12)

Course Assessment – Items from Section III

<u>Sustain</u>:

- Number and type of in-class example problems to reinforce concepts.
- Intro to bioreactors at end of course.
- Development of reactor design from fundamental MEB.

<u>Improve</u>:

- Numerical solver skill in solving differential equations.
- Shorten problem sets but increase frequency.
- Capstone focused on **reactor design.**

Assessment – Graded Events

3 WPRs @ 250 pts each:	750	34%
10 Problem Sets @ 50 pts each:	500	22%
7 Labs @ 40 pts each:	280	13%
1 Capstone Project @ 200 pts:	200	9%
1 Term End Exam @ 500 pts	500	22%
Total:	2230	
Individual Submission:	2230	100%

CH367: Intro. to Auto. Process Control
Course Director: COL James
Course Supervisor: Dr. Biaglow

Credit Hours: 3.0 (BS=0, ET=3.0, MA=0)
Prerequisites: CH459, CH485, CH365
Co-requisite: None
Lessons: 30 @ 75 min
Special Requirements: None

This course covers the principles necessary to understand the automatic control of chemical processes. Students learn the current mathematical models and mechanical details of various control elements, including sensors, transmitters, actuators, and controllers. Application of mathematical models will be covered with dynamic modeling techniques as well as real-time training using process simulators. The course will also cover tuning of controllers as well as safe response to process upsets. A capstone project will involve dynamic modelling of an integrated process control system.

Topics – by Chapter

Process Dynamics and Control, Seborg, Edgar, Mellichamp, Doyle 4th Edition (2017)

- Introduction to Process Control (Ch. 1)
- Developing Chemical Process Models (Ch. 2,3,4,7)
- Dynamic Response of Chemical Processes (Ch. 5,6)
- Designing Feedback Controllers (Ch. 8,12)
- Control System Instrumentation and Final Control Elements (Ch. 9)
- Dynamic Behavior and Stability (Ch. 11)
- Feedforward, Ratio Control, and Advanced Topics (Ch. 15, 16, 18)

Course Assessment – Items from Section III

- Fully integrate and refine the new “furnace” capstone.
- Begin earlier with modeling and spend more time with the SB processes.
- Continue to improve problems sets, new problems.

Assessment – Graded Events

Term End Exam (TEE)	1	500	500	25%
Written Partial Reviews (WPRs)	3	250	750	37.5%
Problem Sets	7	50	350	17.5%
Daily Questions/Quizzes	30	5	150	7.5%
Capstone	1	250	250	12.5%
		Total	2000	100%
		Individual	1400	70%

CH400: Chemical Engineering Professional Practice
Course Director: Dr. Nagelli
Course Supervisor: LTC Cowart

Credit Hours: 1.5 (BS=0, ET=1.5, MA=0)
Prerequisites: CH459, CH485, CH365
Co-requisite: None
Lessons: 20 @ 55 min
Special Requirements: None

The course will meet on 1-Days (E1 & F1) and will cover topics such as ethics, continuing education, and global and social issues within chemical engineering. Special emphasis will be placed on preparation for the Fundamentals of Engineering Exam using practice problems and graded practice exams. The course also covers professional plant engineering using plant simulators and mock exercises to teach proper troubleshooting and response techniques.

Topics – by Chapter

FEE Supplied-Reference Handbook Ed. 10.2
FE Chem. E sample questions + solutions

- Mass & Energy Balances
- Chemical reaction engineering
- Thermodynamics
- Heat Transfer
- Mathematics/prob. & stat.
- Engineering Sciences
- Safety, Health and Environmental
- Fluid mechanics/Dynamics
- Ethics & Prof. Practice
- Mass Trans & Separations
- Chemistry & Biology
- Solids Handling
- Economics
- Process Design
- Process Controls
- Materials Science

Course Assessment – Items from Section III

<u>Sustain</u>:
Continue to have graded events per topic
Continue to go over all graded events before FEE
Probability and Statistics review
New WPRs with Chem E. FEE problems
Take FEE 18, 19, 20 & 21MAR23 (Cadets sign up)
<u>Improve</u>:
Continue to update topic specific FE problems
More SSI Process Sim Sessions in addition to DIST
P&ID Problems with Controls

Assessment – Graded Events

10 Problem Sets @ 25 pts each:	200	21.05%
10 Quizzes @25 pts each:	250	26.31%
2 Practice Exams @ 50 pts each:	100	10.52%
1 WPR @ 200 pts each:	200	21.05%
2 SSI Exercises @100 pts each:	200	21.05%
Total:	950	
Individual Submission:	**950**	**100%**

CH402: Chem. Eng. Process Design
Course Director: Dr. Biaglow
Course Supervisor: Dr. Nagelli

Credit Hours: 3.5 (BS=0, ET=3.5, MA=0)
Prerequisites: CH459, CH485, CH365
Co-requisite: None
Lessons: 40 @ 55 min, 7 @ 120 min
Special Requirements: None

This course provides a capstone experience that brings together material from previous courses to examine contemporary problems in chemical engineering process design. The course provides instruction in the conceptual design of processes to achieve design goals, as well as the economic optimization of the process. The course emphasizes the use of computer simulations, theory of unit operations, process control, safety, environmental and economic factors. The effect of changes in design on the process economics will be investigated. Written and oral design reports for the capstone design project are required.

Topics – by Chapter

Plant Design and Economics for Chemical Engineers, Peters, Timmerhaus, West, 5th Edition (2002)

- Introduction to Process Design (Ch. 1)
- Heat Exchanger Design (Ch. 14)
- Fluid Handling (Ch. 12)
- Flowsheet Synthesis (Ch. 4)
- Cost Estimation (Ch. 6)
- Process Economics (Ch. 7,8)
- Design Project and Reports (Ch. 11)

Course Assessment – Items from Section III

Sustain:

- Emphasis on written "professional quality" reports (communication efforts per program assessment).
- Capstone project – plastic recycling – excellent problem. Uses standardized characterization methods, topics from coursesrequires earlier working design, professional P&IDs, discussion of logistics and profitability measures.

Improve:

- Research on capstone project. Cadets need to reach deeper into independent study to produce novel methods.
- Energy integration – teach networked exchangers with pinch analysis..
- Possible AIChE Contest – TBD. Obtain submission-quality reports.
- Group composition and size for optimal productivity.

Assessment – Graded Events

10 Problem Sets @ 25 pts each:	250	13.51%
4 Small Design Probs. @ 50 pts each:	200	10.81%
2 WPRs @ 200 pts each:	400	21.62%
1 Design Report @ 400 pts:	400	21.62%
2 IPRs @ 100 pts each:	200	10.81%
4 Quizzes @ 25 pts each:	100	5.41%
1 Term End Exam @ 300 pts:	300	16.22%
Total:	1850	
Individual Submission:	1250	67.57%

Bioengineering Update
(Track/Sequence/Minor)

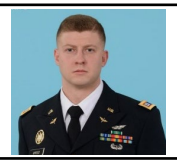
Bioengineering Track - Timeline

- Select Bioengineering AP…ongoing Fall 2020 ✓
- Select Bioengineering T10 ✓
- QA/QC 3.0 ET credit for CH450 ✓
- Pilot/Teach new courses…CH350 & CH300 ✓
- Curriculum Proposals for CH300 and CH350 ✓
- **3.0 ET credit review process for CH300 and CH350** ✓
  - Met with ABET reviewers
  - Recommending 1.0 ET for CH300, 2.0 ET for CH350
- Get to curriculum committee ✓
- Get courses in Redbook ✓
- Get Bioengineering sequence approved

Future Inbound Faculty

Chem. E. future faculty updates

- CPT Elizabeth Golonski (AY25)…*sponsor: CPT Tobergte*
- CPT Nigel Rogers (AY25)…*sponsor: CPT Lowell*
- *MAJ Frey (AY25)..sponsor: LTC Cowart*
- *CPT Stewart (AY26)…sponsor: CPT Rogers*
- *MAJ (P) Plante (AY27)…sponsor: LTC Cowart*
- *CPT Austin Breed (AY27)…sponsor: CPT Stewart*
- *MAJ Corrigan (AY28)…sponsor: LTC Cowart*

	Future Faculty Member	ACS Start	USMA Arrival	School	Cost Category	Research Focus
	**CPT Liz Golonski** (Sponsor CPT Tobergte)	AUG 2022	JUN 2024	Colorado School of Mines	Low	Catalytic membrane reactors
	**CPT Nijel Rogers** (Sponsor CPT Lowell)	AUG 2022	JUN 2024	Princeton University	High	Soft matter
	**MAJ Joshua Frey** (Sponsor LTC Cowart)	N/A	JUN 2024	N/A	N/A	Nuclear fuel cycle material forensic analysis
	**CPT Christopher Stewart** (Sponsor CPT Rogers)	AUG 2023	JUN 2025	CalTech	High	Complex fluid mechanics, colloids
	**MAJ Luke Plante** (Sponsor LTC Cowart)	AUG 2023	JUN 2026	Cornell	High	Biomining of heavy metals
	**CPT Austin Breed** (Sponsor CPT Stewart)	AUG 2024	JUN 2026	MIT Princeton Columbia	High High High	TBD
	**MAJ Trevor Corrigan** (Sponsor LTC Cowart)	AUG 2024	JUN 2027	Cornell Washington	High Low	Bioengineering related

Teaching Slate (5 Year Projected)

Considerations

- Potential for 2 Sections going forward for **CH300, CH350, and CH450** as enrollment grows
- *ChemE Majors:*
  20 (Class '24)
  36 (Class '25)
  30 (Class '26)

- **ABET Record Year** in AY25 for visit in Fall 2026 (Continuity at CDs in AY25)

- Junior rotators teach CH362 for next 3 AY; impacts GC

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

(Aligned against bioengineering)

AY24		AY25		AY26	
AY24-1 (Fall)	AY24-2 (Spring)	AY25-1 (Fall)	AY25-2 (Spring)	AY26-1 (Fall)	AY26-2 (Spring)
CH363 (James)	CH362 (Mandes)	CH363 (James)	CH362 (Tobergte)	CH363 (James)	CH362 (Tobergte)
CH459 (Belanger)	CH364 (Cowart)	CH459 (Nagelli)	CH364 (Cowart)	CH459 (Yuk)	CH364 (Cowart)
CH485 (Cowart)	CH402 (Biaglow)	CH485 (Cowart)	CH402 (Biaglow)	CH485 (Biaglow)	CH402 (Biaglow)
CH365 (Biaglow)	CH400 (Nagelli)	CH365 (Biaglow)	CH400 (Nagelli)	CH365 (Cowart)	CH400 (Yuk)
CH350 (Yuk)	CH367 (James)	CH350 (Yuk)	CH367 (James)	CH350 (Nagelli)	CH367 (James)
	CH300 (Parker)		CH300 (Yuk)		CH300 (Nagelli)
	CH450 (Yuk)		CH450 (Burpo+CME)		CH450 (Yuk+CME)
Mandes (GC)		Tobergte (GC - 102/151)	Nagelli (1 Section GC)	Nagelli (GC)	Nagelli (GC)
Bowers (GC+CD)	Bowers (GC+CD)	Lowell (GC + OPSO)	Lowell (GC+OPSO)	Tobergte(GC)	
Lowell (GC+OPSO)	Lowell (GC+OPSO)	Rogers (GC)	Rogers (GC)	Rogers (GC)	Rogers (GC)
Tobergte(GC)	Tobergte (GC - 102)	Golonski (GC)	Golonski (GC)	Golonski (GC)	Golonski (GC)
Yuk (GC)	Yuk (GC)	Frey (GC)	Frey (GC)	Frey (GC)	Frey (GC)
*Nagelli(Sabbatical)	*Burpo (Sabbatical)	Yuk (GC)	Yuk (GC)	Stewart (GC)	Stewart (GC)

AY27		AY28		AY29	
AY27-1 (Fall)	AY27-2 (Spring)	AY26-1 (Fall)	AY26-2 (Spring)	AY27-1 (Fall)	AY27-2 (Spring)
CH363 (Nagelli)	CH362 (Golonski)	CH363 (Nagelli)	CH362 (Plante)	CH363 (Nagelli)	CH362 (Plante)
CH459 (Yuk)	CH364 (Cowart)	CH459 (Yuk)	CH364 (Cowart)	CH459 (Cowart)	CH364 (Cowart)
CH485 (Biaglow)	CH402 (Biaglow)	CH485 (Biaglow)	CH402 (Biaglow)	CH485 (Nagelli)	CH402 (Biaglow)
CH365 (Cowart)	CH400 (Yuk)	CH365 (Cowart)	CH400 (Yuk)	CH365 (Yuk)	CH400 (Yuk)
CH350 (Plante)	CH367 (James)	CH350 (Corrigan)	CH367 (James)	CH350 (Corrigan)	CH367 (James)
	CH300 (Plante)		CH300 (Corrigan)		CH300 (Corrigan)
	CH450 (Burpo+CME)		CH450 (Burpo+CME)		CH450 (Burpo+CME)
Nagelli (GC)	Nagelli (GC)		Nagelli (GC)		Nagelli (GC)
Breed (GC)	Breed (GC)	Breed (GC)	Breed (GC)	Breed (GC)	Breed (GC)
Rogers (GC)	Rogers (GC)	Plante (GC)		Plante (GC)	Yuk (GC)
Golonski(GC)	Yuk (GC)				
Frey (GC)	Frey(GC)				
Stewart(GC)	Stewart(GC)	Stewart(GC)	Stewart(GC)		

Program Updates

- **Chemical Engineering Laboratories**
  - CH459: SWE Transition this term
  - New Evaporator (POCs: Dr. Lundell & Mr. Mathew) – or repair to current evaporator
  - BH136 reset complete as of August; fully functioning materials lab

- **ABET Record Year in 2025**
  - Kept CDs with experience in respective course in AY25-1/25-2
  - PEV Visit Fall 2026
  - Focus Areas: Bioengineering Electives for Majors, FEE Performance, and Program/Course Assessment

- **ABET Advisory Board Meeting AY24-2 (Friday in April 2024, 12 APR)**
  - Will coordinate dates with Mrs. Costain before contact with Board

- **Chemical Engineering Program Instructor Observation (AY24-1)**

Instructor	Course	Teaching Hours		Observer	Week of	Possible Lessons
Dr. Biaglow	CH365 Chemical Engineering Thermo	A1, B1		LTC Cowart	11-15 SEP	10, 11, 12
LTC Cowart	CH485 Heat and Mass Transfer	H2, I2		Dr. Yuk	11-15 SEP	11, 12
COL James	CH363 Separation Processes	H2, I2		LTC Cowart	11-15 SEP	11, 12
Dr. Yuk	CH350 Bioprocess Engineering	G2		LTC Belanger	11-15 SEP	11, 12
LTC Belanger	CH459 Chemical Engineering Lab	C1D1, E1F1		Dr. Biaglow	11-15 SEP	10, 11, 12
Instructor	**Course**	**Teaching Hours**		**Observer**	**Week of**	**Possible Lessons**
CPT Tobergte	CH101 General Chemistry I	A1B1, C1D1, E1F1		LTC Cowart	11-15 SEP	10, 11, 12
MAJ Bowers	CH101 General Chemistry I	C1D1, E1F1		Dr. Yuk	11-15 SEP	10, 11, 12
MAJ Mandes	CH101 General Chemistry I	A1B1, C1D1, E1F1		LTC Belanger	11-15 SEP	10, 11, 12
CPT Lowell	CH101 General Chemistry I	A1B1, C1D1, E1F1		Dr. Biaglow	11-15 SEP	10, 11, 12

Questions?