AY23-2 Chemical Engineering Course and Program Brief

Dr. Enoch Nagelli
LTC Sam Cowart
LTC John Belanger
MAJ Jeff Chin
MAJ Patrick Bowers
CPT Sam Lowell
Dr. Andrew Biaglow
Dr. Russ Lachance
Dr. Simuck Yuk
MAJ Caspar Yi
MAJ Galen Mandes
Mr. Abhilash Mathew

25 October 2022

ABET Engineering Technology Accreditation Commission

Agenda

- Course Briefings
  - CH402
  - CH400
  - CH367
  - CH364
  - CH362
  - CH450
  - CH300
- Bioengineering update: timeline; curriculum committee proposals, ET review
- Future Chem. E. faculty update: mentor, degree, research, duties
- Teaching Slate (5 year projected)
  - Bioengineering Courses 5 year and beyond
  - CH450 Team Teaching Model
  - Proposal for CH362
- Program updates
  - CH459 update, ABET Record Year in 2025 (visit Fall 2026), Advisory Board, & Instructor Observation

CH402: Chem. Eng. Process Design
Course Director: Dr. Andy Biaglow
Course Supervisor: Dr. Enoch 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 - petroleum refinery project – standardized crude analysis method, required working design earlier, professional P&IDs, discussion of logistics and profitability measures.

Improve:

Communication skills (written). Some reports very good, others were fair. Goal is all excellent.

Contemporary issues for capstone (optimization, bitumen, dieseline, etc.).

Possible AIChE Contest – purification of pyoil from plastics recovery.

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%

CH400: Chemical Engineering Professional Practice

Course Director: Dr. Enoch Nagelli

Course Supervisor: LTC Sam 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 once per week 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. 9.4 for Computer
FEE Chemical sample questions + solutions

- Chemical reaction engineering
- Thermodynamics
- Heat Transfer
- Mathematics/probability and statistics
- Safety, Health and Environmental
- Process control
- Fluid mechanics
- Separations
- Ethics
- Chemistry

Course Assessment – Items from Section III

Sustain:
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 between15FEB-1APR
Improve:
Conduct General Chemistry review
Use discipline specific FEE manual

Assessment – Graded Events

10 Problem Sets @ 25 pts each:	200	22.2%
10 Quizzes @25 pts each:	200	22.2%
2 Practice Exams @ 50 pts each:	100	11.0%
1 WPR @ 200 pts each:	200	22.2%
2 Control ex. @100 pts each:	200	22.2%
Total:	900	
Individual Submission:	**900**	**100%**

CH367: Intro. to Auto. Process Control

Course Director: COL Corey James

Course Supervisor: Dr. Andy 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%

CH364: Chemical Reaction Engineering

Course Director: Dr. Simuck F. Yuk

Course Supervisor: LTC Sam Cowart

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

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)
- Nonisothermal Reactor Design (Ch. 11, 12)

Course Assessment – Items from Section III

Sustain:
Continue open-feedback questions in end-of-course surveys.
Maintain the current number of in-class and quiz problems.

Improve:
Improved feedback to cadets regarding written work quality.
Improve/change the type of problems introduced in problem sets and WPRs/TEE.

Assessment – Graded Events

3 WPRs @ 250 pts each:	750	34.00%
9 Problem Sets @ 35-50 pts each:	365	16.00%
7 Computer Labs @ 40 pts each:	280	13.00%
1 Capstone Project @ 200 pts:	200	9.00%
Instructor Points (Various)	120	5.00%
1 Term End Exam @ 500 pts	500	23.00%
Total:	2215	
Individual Submission:	1815	82.00%

CH362: Mass and Energy Balances
Course Director: LTC Sam Cowart
Course Supervisor: Dr. Enoch Nagelli

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:

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)

Add in lesson to reinforce fundamental engineering calculations (unit systems, dimensional analysis, etc.) – Lesson 3

Assessment – Graded Events

8 *Problem Sets @ 50 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%**

CH300: Introduction to Biomedical Engineering

Course Director: COL John Burpo

Course Supervisor: Dr. Biaglow

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 provide an introduction to 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 as a whole, 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	200	14.3%
1 *TEE	500	35.7%
Total:	1400	
*Individual Points :	1400	100%

CH450: Bioengineering Modeling and Analysis

Course Director: COL John Burpo

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

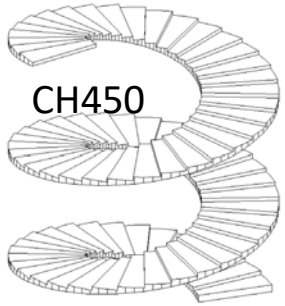
This course provides a broad understanding of bioengineering disciplines to include biomechanics, biomaterials, tissue engineering, biocatalysis, biochemical engineering, and biosensors. Fundamental concepts of molecular kinetics, thermodynamics, and mass transport are applied in problem sets in each 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 Sets@ 25 pts each	500	47.2%
6 *Quizes @ 200 pts each:	180	17.0%
1 *Paper	150	4.1%
1 *Presentation	50	4.7%
6 *Discussion	180	17.0%
Total:	1060	
*Individual Points :	1060	100%

Bioengineering Update
(Track/Sequence/Minor)

Department of Chemistry and Life Science, Chemical Engineering Program

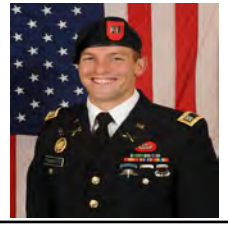
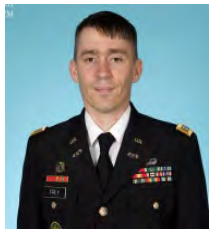
Bio-engineering Track - Timeline

- Select Bioengineering AP…ongoing Fall 2020 ✓
- Select Bioengineering T10 ✓
- QA/QC 3.0 ET credit for CH450 ✓
- Pilot/Teach new courses…CH350 & CH300 ✓
- **3.0 ET credit review process for CH300 and CH350**
  - Met with ABET Committee for ET 3.0 for CH300 and CH350 ✓
  - Internal review in progress
- **Curriculum Proposals for CH300 and CH350**
  - Dr. Jones-Kellogg in AARS for pre-review ✓
  - Program internal review complete to address AARS comments ✓
  - COL Burpo & COL James Final Review/Approval before Staffing to all Depts
- Get to curriculum committee…*Dr. Biaglow is the OIC*
- Get courses in Redbook
- Get Bioengineering sequence approved
- ABET-compatibility (minor point)

Future In-bound Faculty

Chem. E. future faculty updates

- CPT Louis Tobergte (AY24)… *sponsor: MAJ Mandes*
- CPT Elizabeth Golonski (AY25)…*sponsor: MAJ Bowers*
- CPT Nigel Rogers (AY25)…*sponsor: MAJ Mandes*
- *MAJ Frey (AY25)..sponsor: LTC Belanger*
- *CPT Stewart (AY26)…sponsor: CPT Lowell*
- *MAJ(P) Plante (AY27)…sponsor: LTC Cowart*

	Future Faculty Member	ACS Start	USMA Arrival	School	Cost Category	Research Focus
	**CPT Louis Tobergte** (Sponsor MAJ Mandes)	AUG 2022	JUN 2023	Carnegie Mellon	High	Thesis completed at Leeds: Water
	**CPT Liz Golonski** (Sponsor MAJ Bowers)	AUG 2022	JUN 2024	Colorado School of Mines	Low	Catalytic membrane reactors
	**CPT Nijel Rogers** (Sponsor MAJ Mandes)	AUG 2022	JUN 2024	Princeton University	High	Soft matter
	**MAJ Joshua Frey** (Sponsor LTC Belanger)	N/A	JUN 2024	N/A	N/A	nuclear fuel cycle material forensic analysis
	**CPT Christopher Stewart** (Sponsor CPT Lowell)	AUG 2023	JUN 2025	TBD	TBD	TBD
	**MAJ Luke Plante** (Sponsor LTC Cowart)	AUG 2023	JUN 2026	Cornell Columbia Arkansas	High High Low	Bioreactors Wastewater Biofuels

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)
  37 (Class '25)
  TBD (Class '26)

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

- Proposal: CPT Golinski & CPT Tobergte – **Teach CH362 in AY26-2 and AY27-2**

- **Next PhD is MAJ Plante** in AY27 (Research: Bioreactors/Bio-energy)

AY22		AY23		AY24	
AY22-1 (Fall)	AY22-2 (Spring)	AY23-1 (Fall)	AY23-2 (Spring)	AY24-1 (Fall)	AY24-2 (Spring)
CH363 (Lachance)	CH362 (Cowart)	CH363 (Lachance)	CH362 (Cowart)	CH363 (Lachance)	CH362 (Cowart)
CH459 (Nagelli)	CH364 (Yuk)	CH459 (Nagelli)	CH364 (Yuk)	CH459 (Belanger)	CH364 (Nagelli)
CH485 (Cowart)	CH402 (Biaglow)	CH485 (Cowart)	CH402 (Biaglow)	CH485 (Cowart)	CH402 (Biaglow)
CH365 (Biaglow)	CH400 (Nagelli)	CH365 (Biaglow)	CH400 (Nagelli)	CH365 (Biaglow)	CH400 (Belanger)
CH350 (Yuk)	CH367 (James)	CH350 (Yuk)	CH367 (James)	CH350 (Yuk)	CH367 (James)
	CH300 (Burpo)		CH300 (Burpo)		CH300 (Yuk)
	CH450 (Burpo)		CH450 (Burpo+CME)		CH450 (Yuk+CME)
			Nagelli (1 Section GC)	James (GC)	
Yi (2x GC sections)	Mandes (2x GC sections)	Mandes (GC)	Mandes (GC)	Mandes (GC)	Mandes (GC)
Bowers (GC 3x sections)	Bowers (GC 3x sections)	Yi (GC + ACD+ OPSO)	Belanger (GC)	Bowers (GC+CD)	Bowers (GC+CD)
Mandes (GC 3x sections)	Yi (2x GC sections)	Chin (GC+ ACD+S1)	Chin (GC+CD+S1)	Lowell (GC+OPSO)	Lowell (GC+OPSO)
Chin (2x sections+S1)	Chin (2x sections+S1)	Bowers (GC)	Bowers (GC+ACD)	Tobergte(GC)	Tobergte (GC)
		Lowell(GC)	Yi (GC+CD)	Yuk (GC)	Belanger(GC 1 section)
		Belanger (GC)	Lowell(GC)	*Nagelli(Sabbatical)	*Burpo (Sabbatical)

AY25		AY26		AY27	
AY25-1 (Fall)	AY25-2 (Spring)	AY26-1 (Fall)	AY26-2 (Spring)	AY27-1 (Fall)	AY27-2 (Spring)
CH363 (Nagelli)	CH362 (Cowart)	CH363 (Biaglow)	CH362 (Tobergte)	CH363 (Biaglow)	CH362 (Golinski)
CH459 (Belanger)	CH364 (Nagelli)	CH459 (Belanger)	CH364 (Nagelli)	CH459 (Belanger)	CH364 (Nagelli)
CH485 (Cowart)	CH402 (Biaglow)	CH485 (Nagelli)	CH402 (Biaglow)	CH485 (Nagelli)	CH402 (Biaglow)
CH365 (Biaglow)	CH400 (Belanger)	CH365 (Cowart)	CH400 (Belanger)	CH365 (Cowart)	CH400 (Belanger)
CH350 (Yuk)	CH367 (James)	CH350 (Yuk)	CH367 (Cowart)	CH350 (Yuk)	CH367 (Cowart)
	CH300 (Yuk)		CH300 (Yuk)		CH300 (Yuk)
James (GC)	CH450 (Burpo+CME)	James (GC)	CH450 (Burpo+CME)	James (GC) Yuk (GC)	CH450 (Burpo+CME)
Tobergte(GC - 151)	Tobergte(GC 102)	Yuk(GC)		Tobergte(GC)	Tobergte(GC)
Rogers (GC)	Rogers (GC)	Rogers (GC)	Rogers (GC)	Rogers (GC)	Rogers (GC 102)
Lowell(GC+OPSO)	Lowell(GC+OPSO)	Golonski(GC)	James (GC)	Golonski(GC)	James(GC)
Golonski(GC)	Golonski(GC)	Tobergte(GC)	Golinski(GC 102)	Frey(GC)	Frey(GC)
Frey (GC)	Yuk (GC)	Frey(GC)	Frey(GC)	Stewart(GC)	Stewart(GC)
Yuk (GC)	Frey(GC)	Stewart(GC)	Stewart(GC)	Plante (GC)	Plante(GC - 102)

Program Updates

- **CH459 Chemical Engineering Laboratory**
  - LTC Belanger Transition/Spring Training/Summer FDW as CD (Dr. Nagelli/LTC Cowart)
  - SWE Transition (AY24-1)
  - New Evaporator (Delivery Projected AY23-2? – POC: Mr. Mathew)

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

- **ABET Advisory Board Meeting AY23-2 (Friday in April 2023)**
  - Coordinate dates with Mrs. Costain before contact with Board

- **Chemical Engineering Program Instructor Observation**

Instructor	Course	Teaching Hours		Observer	Week of	Possible Lessons
Dr. Biaglow	CH365 Chemical Engineering Thermo	A1, B1		Dr. Yuk	19-23 SEP	13, 14, 15
LTC Cowart	CH485 Heat and Mass Transfer	H2, I2		Dr. Nagelli	19-23 SEP	10, 11
Dr. Lachance	CH363 Separation Processes	H2, I2		Dr. Biaglow	19-23 SEP	10, 11
Dr. Yuk	CH350 Bioprocess Engineering	G2		LTC Cowart	19-23 SEP	10,11
Dr. Nagelli	CH459 Chemical Engineering Lab	C1D1, E1F1		LTC Belanger	19-23 SEP	13, 14, 15
Instructor	**Course**	**Teaching Hours**		**Observer**	**Week of**	**Possible Lessons**
LTC Belanger	CH101 General Chemistry I	A1B1, C1D1, E1F1		LTC Cowart	19-23 SEP	13, 14, 15
MAJ Bowers	CH101 General Chemistry I	G2, H2, I2		Dr. Biaglow	19-23 SEP	10, 11
MAJ Mandes	CH101 General Chemistry I	A1B1, C1D1		Dr. Nagelli	19-23 SEP	13, 14, 15
MAJ Yi	CH102 General Chemistry II	G1, H1		LTC Cowart	19-23 SEP	10, 11
CPT Lowell	CH101 General Chemistry I	A1B1, C1D1, E1F1		Dr. Nagelli	19-23 SEP	13, 14, 15
MAJ Chin	CH101 General Chemistry I	A1B1, E1F1		Dr. Yuk	19-23 SEP	14, 14, 15

Questions?

Backup Slides

Program Mission/Vision

PROGRAM MISSION

The mission of the chemical engineering program is to prepare commissioned leaders of character who are proficient in applying chemical and engineering principles to solve problems in a complex operational environment.

Chemical Engineering Program
10+ year vision

1. **Stabilized** at **~40** +/- (1-5) cadets per class year; if >40 establish OML; Recommended GPA: ~2.5

2. Chemical engineering **faculty**:
   a. Senior faculty: AP; 2nd time rotators; Associate Professors; Title 10s; PhDs. Teach chemical engineering course 3-6 years in a row.
   b. Junior faculty: 1st time rotators. Teach CH101/102 (not both); collaborate with Senior Faculty on research. No CH102 without CH101.
   c. Minimize churn; "Do less better."…Stability; efficiency; optimization; transparency

3. Curriculum:

Bioengineering
   a. 3x Bio.-Eng. track: CH300, CH350, CH450; validate the ET credit
   b. Stand up bioengineering sequence
   c. Stand up bioengineering major
   d. Currently: Bio.-Eng. AP search; Ongoing Title10 hiring action

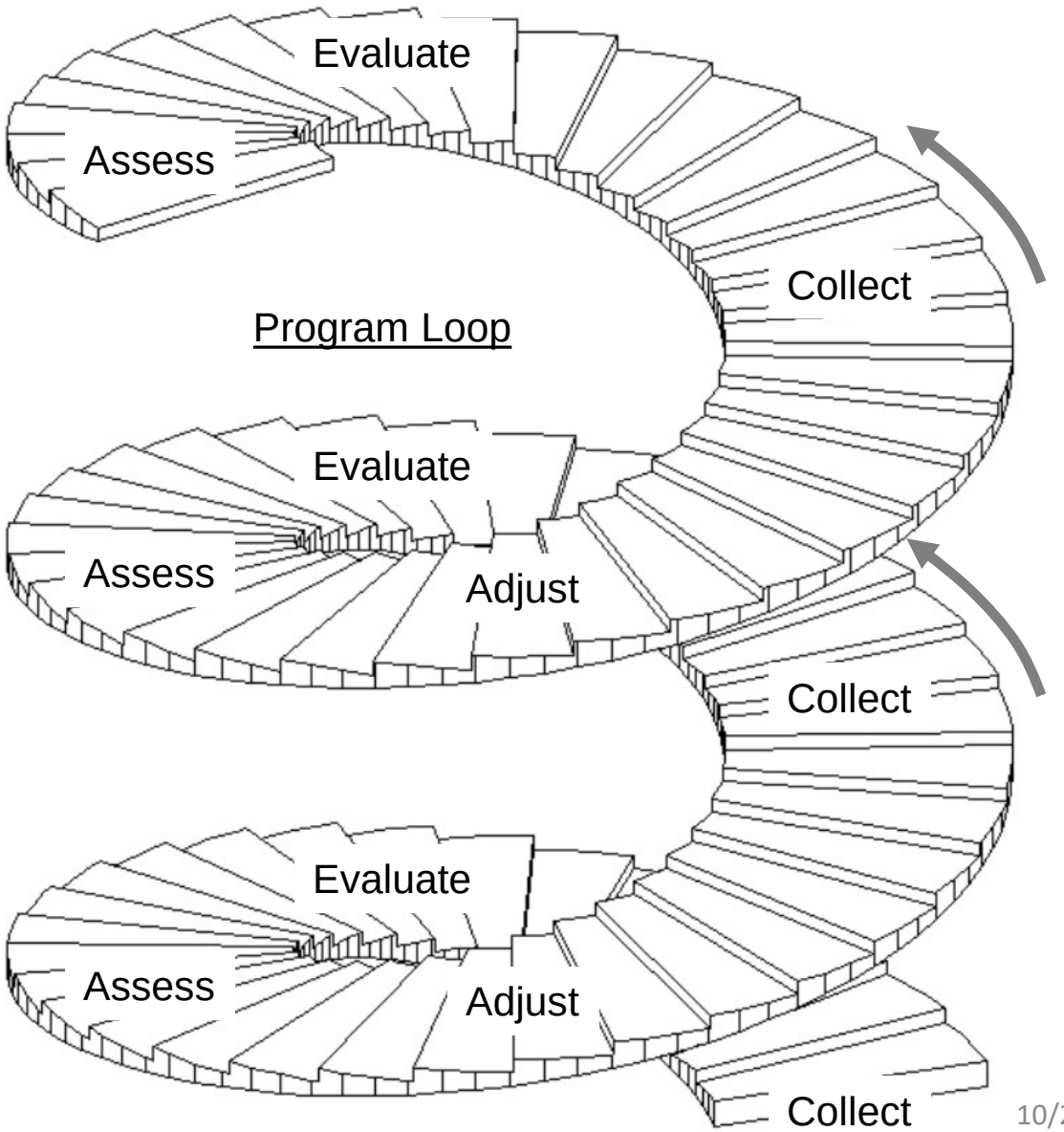
Chemical Engineering:
   a. Expand CH400 to 3.0 credits
   b. Expand CH459 to 4.0 credits – cadet feedback
   c. Expand CH402 to 7.0 credits (2 sem.)
   d. Other Chem E. electives: (Numerical methods; explosives)

4. Pedagogy:
   a. Intensive problem solving with instructors as coaches and role models
   b. classroom/lab workshop experience (theory + demo + practice)
   c. faculty <u>demonstrate</u> proficiency at problem solving as well as depth of knowledge; multi-year faculty development

5. **Ranked** undergraduate program
   a. ABET recertifications (15-18 NOV 20); maintain ABET efforts; assessment
   b. Establish "footprint" at National level conferences: AIChE; SOR; ACS & communicate USMA Chem. E. vision to other Universities
   c. Get more Chemical Engineers PEV training here (Cowart, Nagelli)
   d. **Maintain** BH331 computer room; chemical engineering work/research space (Applications Rm.; BH136); Network

6. AIChE Club stability…and consistency of student involvement; strength of last ABET certification in 2014

Program Assessment Cycle

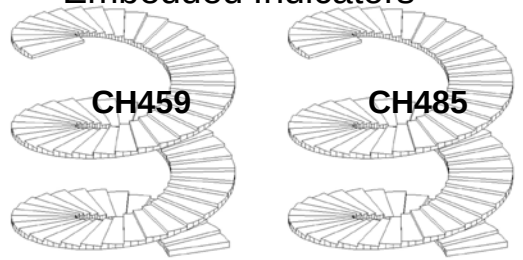


Performance Indicators:
FE Exam Results
Coursework Embedded Indicators
Surveys (Cadet, Faculty, Adv. Board)
Course Grades

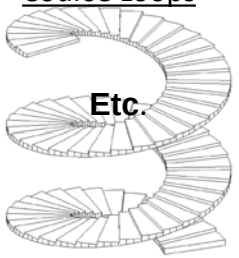
Program-level

Course-level

Course Assessments (Sect. III)
Embedded Indicators



Course Loops



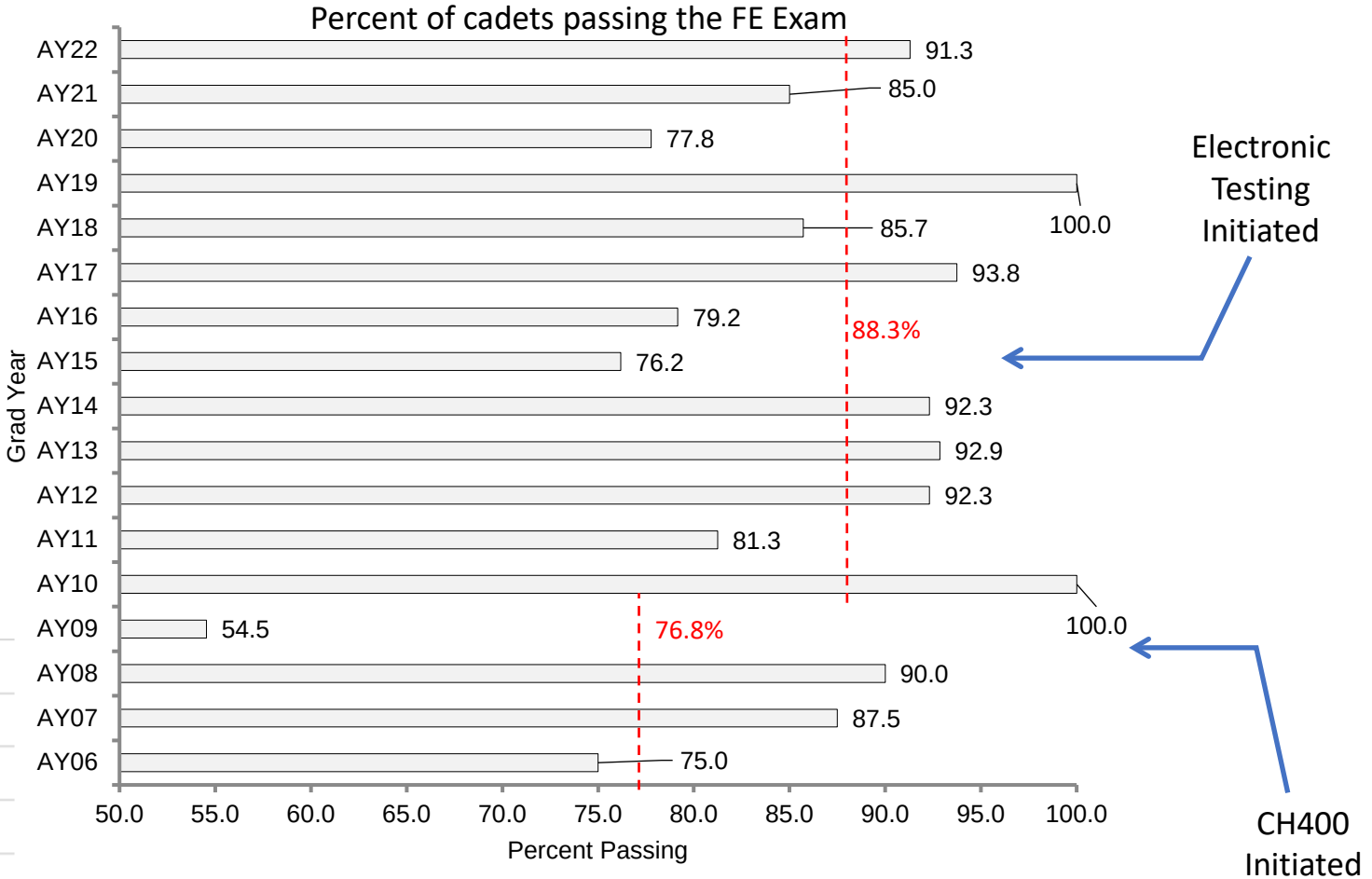
Program Assessment: FEE

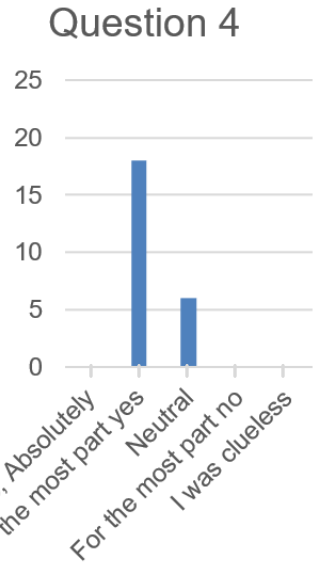
Fundamentals of Engineering Exam

Student Outcome 7: Acquire and apply new knowledge as needed, using appropriate learning strategies

National, (+/- ~1%):

2022	70.7%
2021	74.0%
2020	74.6%
2019	77.0%
2018	75.0%
2017	74.0%
2016	79.0%
---	---
2015	77.4%
2014	89.0%
2013	86.3%
2012	85.1%
2011	87.0%
2010	87.0%
2009	84.0%
2008	87.0%
2007	87.0%
2006	87.0%



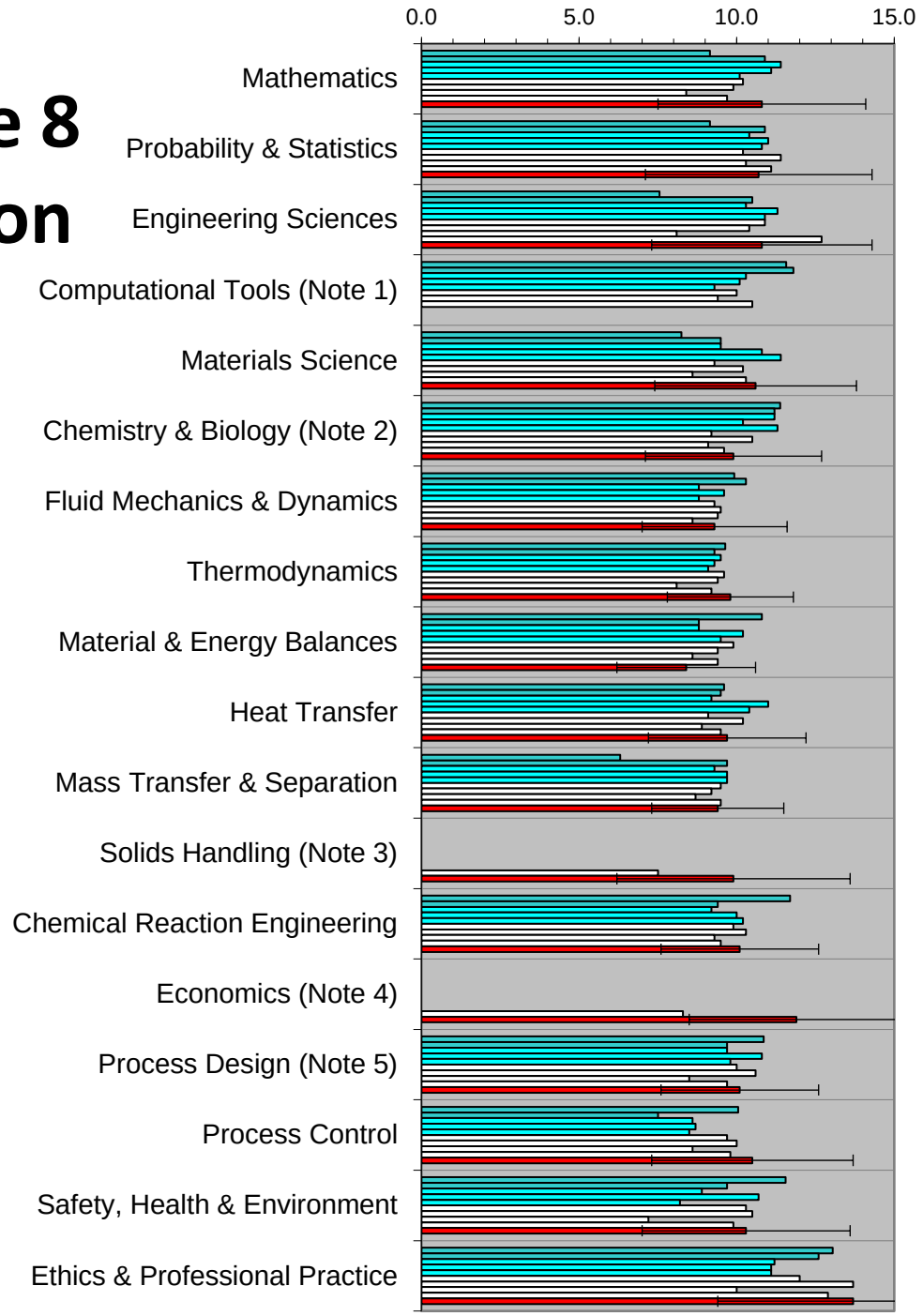


Question 4, Post FEE Survey: For the questions on the exam that seemed new to you, were you able to learn the material on the spot?

Outcome 8 Evaluation

FEE Results by Topic

AY13 to AY22



The error bars are the individual standard deviations for the AY22 data.

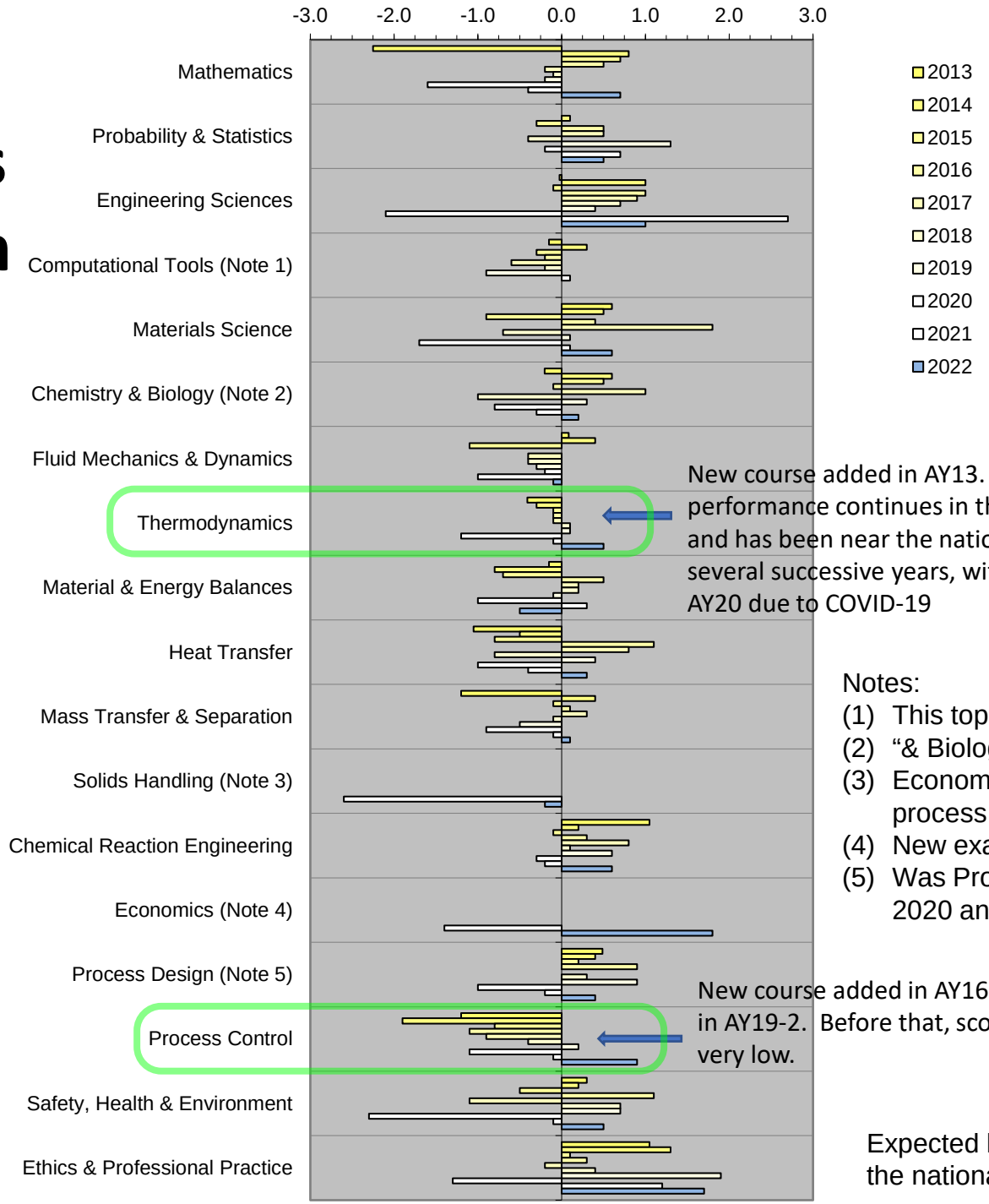
The average standard deviation over all data is 3.0.

Year-to-year variations in the difficulty of the exam are accounted for by normalizing with respect to the national average on the next slide.

Notes:
(1) This topic dropped in 2021.
(2) "& Biology" added in 2021
(3) Economics. separated from process design in 2021.
(4) New exam spec in 2021
(5) Was Proc Design & Econ for 2020 and before

Topical Outcomes Evaluation

Deviations from National Averages AY13 to AY22



New course added in AY13. Trend in performance continues in the right direction and has been near the national average for several successive years, with a setback in AY20 due to COVID-19

Notes:
(1) This topic dropped in 2021.
(2) "& Biology" added in 2021
(3) Economics. separated from process design in 2021.
(4) New exam spec in 2021
(5) Was Proc Design & Econ 2020 and before

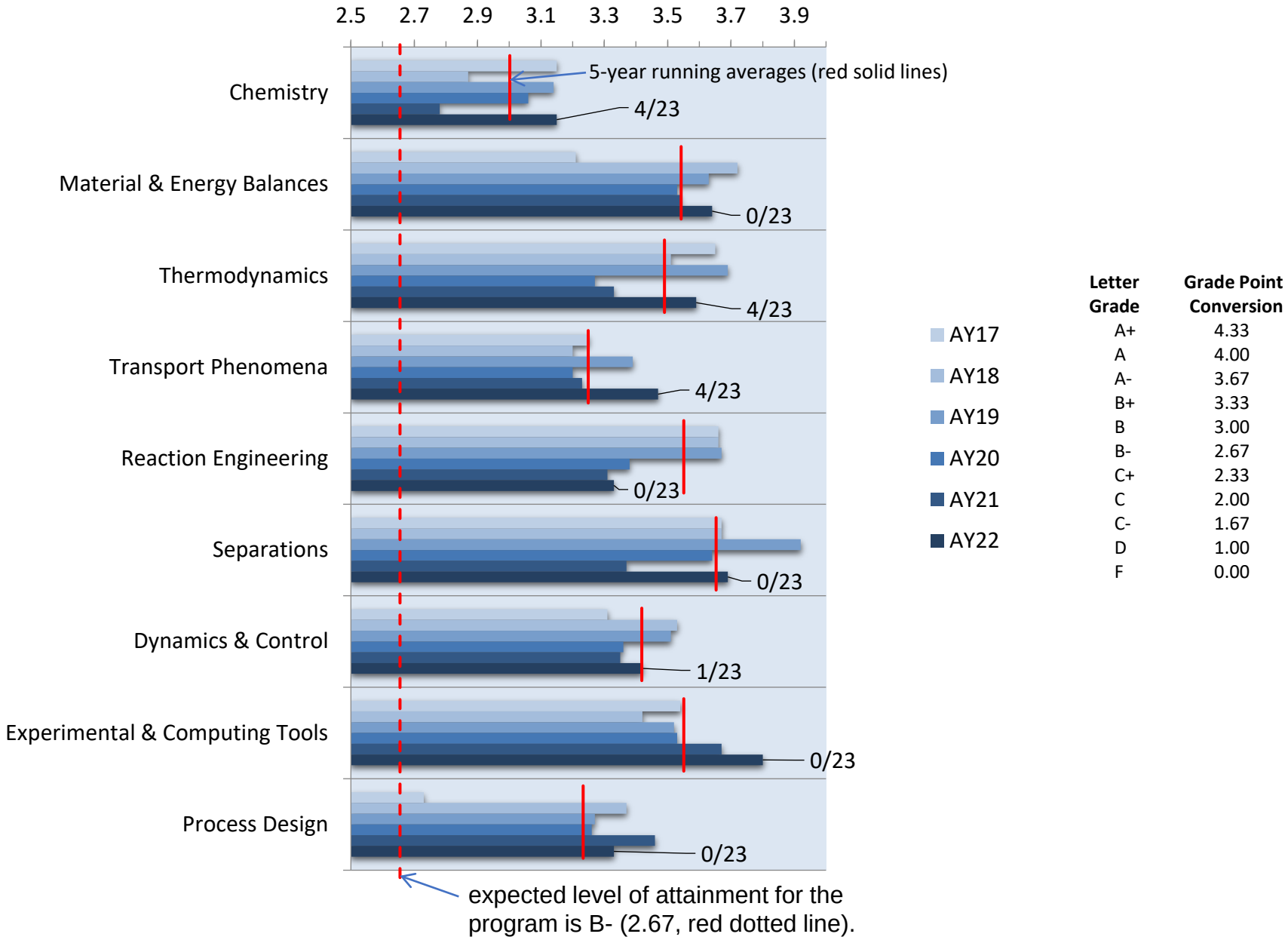
New course added in AY16 and implemented in AY19-2. Before that, scores were always very low.

Expected level of attainment is the national average (0.0 line)

Topical Outcomes Evaluation

Student Outcome 8: Understanding of the Chemical Engineering Curriculum

Average GPA from Transcripts, AY2017 to AY2022



Letter Grade	Grade Point Conversion
A+	4.33
A	4.00
A-	3.67
B+	3.33
B	3.00
B-	2.67
C+	2.33
C	2.00
C-	1.67
D	1.00
F	0.00

ABET Process & Advisory Board

ABET Advisory Board

- Combination of representatives from our constituencies:
  - Industry
  - Academia
  - Army
- Review data; take survey; interact with Chemical Engineering Cows and Firsties
- Give curriculum advice
- Inform program decisions
- Helps write the program educational objectives and mission statement (these are ABET requirements)

Advisory Board 2021-2022

No.	Name	Title	School - Company	Email	Best Dates
1	Kevin Shipe	Automation Engineer	NALCO Champion	kevin.a.shipe@gmail.com	
2	Lucy Hair	EleCent Team Leader	LLNL	hair1@llnl.gov	
3	COL (Ret) Paul Dietrich	Chemical Officer	Chemical Officer/Industry	paul@the-dietrichs.com	7,8 APR; or 21,22 APR
4	Kisondra Waters	Principal Analyst	Margin Analytics	kisondra@gmail.com	14,15APR preferred; all work
5	Donald Glaser	President	Simulation Solutions	dglaser@simulation-solutions.com	No preference.
6	Matt Garvey	Engineer	Simulation Solutions	mgarvey@simulation-solutions.com	
7	Kelly Schutz	Assistant Professor	Lehigh University	kes513@lehigh.edu	No preference; maybe remote?
8	Lynn Walker	Professor	Carnegie Mellon University	lwalker@anderw.cmu.edu	
9	Matthew Liberatore	Professor	University of Toledo	matthew.liberatore@Utoledo.edu	21,22 APR; or 7,8APR
10	Greg Ritch	COL(RET)/ Engineering Officer	MIL/Industry	garitch@cvzoom.net	
11	Mike Deforest	Industry, Chem E (Old Grad '07)	SMK Packaging	mike@smkpackaging.com	
12	COL Aaron Hill	Academy Professor	USMA; CME	aaron.hill@westpoint.edu	
13	Patrick Underhill	Professor	RPI	underhill@rpi.edu	No preference.
14	Gautham Krishnamoorth	Professor	UND	gautham.krishnamoorthy@und.com	No preference.

ABET | Engineering Technology Accreditation Commission

Accredited 1 October 2012 to present

Next Record Year: AY2025-2026

Next ABET Visit: Fall 2026

Why ABET Accreditation?

- An external certification of quality
- Keeps us in touch with the engineering profession
- Helps USMA (and ChemE) recruiting (classes of 2020 and 2021 each signed 25+ plebes – new highs; 80 total)
- Provides important opportunities for graduates
- Allows USMA engineering majors to take the Fundamentals of Engineering Examination
- It is required by Army Regulations (10-87)
- Almost everything that ABET expects us to do is something we should be doing anyway

Thoughts to Consider

- The ABET process is expensive in terms of faculty time
  - USMA is a small undergraduate college with limited human resources (faculty) and high faculty turnover
- The ABET accreditation is important to the institution and to the Army (so we try to do it well – due diligence each semester makes the process easier)
- The best way we can be successful with ABET is to orient our program processes around the ABET criteria
  - By doubling up our efforts we obtain some efficiency
  - Much of what follows is oriented around the ABET processes and terminology
  - We need to be strategic in deciding on new initiatives
  - Must to have a “feedback loop closure”; and communicate a story that includes assessment loop closure

Terms You Should Know

- **Program Educational Objectives (PEOs)**
  - Gleaned by asking *program constituents*
    - For us: Army, profession, graduate schools, other
  - Advisory Board represents constituencies; (6 – 10 members/yr.)/bench of 15 members
  - Desired professional accomplishments of graduates **5-7 years after graduation**
  - Adjust every 3 years or so…
- **Student Outcomes (1-8) *listed on future slide***
  - What students should be able to do **at graduation**
  - Must be **measurable**
  - Designed to lead naturally to the PEOs
  - Assess/evaluate yearly

- **Assessment → Continuous improvement**
  - Collect meaningful data to evaluate performance indicators (PIs)
  - Assess PIs for outcome attainment → information → COAs for change
  - Implement change
  - Assess its effects and level of success ("closing the loop")
  - Repeat all the above
  - Periodically check and adjust both Student Outcomes and PEOs

Loop closure

Course Assessment Cycle

Table 4-1. Outline of the course assessment process

Course details **Assessment** **Recommendations**

SECTION I. COURSE DESCRIPTION: This section summarizes the course, exactly as it was taught in the most recently completed semester.	SECTION II. COURSE ASSESSMENT - This section provides data and analysis to answer the following questions:	SECTION III. RECOMMENDED CHANGES – All proposed changes to the course, in each of the specified areas. Recommendations should be based on assessments from Section II.
1. Redbook description - List the current Redbook description.	1. Redbook Description - Does the Redbook description match what is taught in the course?	1. Redbook Description- For changes, include a cut and paste Redbook entry and use "track changes" when submitting recommendation.
2. Enrollment - This AY and next AY (projected)	2. Enrollment - How does the student population compare from one year to the other? Assess effect of population on course.	2. Enrollment - Recommended teaching style considerations associated with the student population.
3. Course Content - Abbreviated list of subjects or lesson blocks covered in the course (not the syllabus).	3. Course Content - Is the course content appropriate?	3. Course Content - Recommended changes to course content.
4. Course Objectives - List course objectives here.	4. Course Objectives - Were the course objectives achieved? Do the course objectives cover the body of knowledge appropriately? Do the course objectives lend themselves to assessment?	4. Course Objectives - Recommended changes to objectives.
	4a. Coverage - Indicate coverage of objectives by graded events.	4a. Coverage – Recommended changes to coverage of objectives by graded events.
	4b. Performance - Indicate performance on course objectives.	4b. Performance - Recommendations to address shortcomings in performance on course objectives.
5. Survey Questions - List web-based and any other survey questions administered to cadets (if used).	5. Survey Questions - Are the survey questions appropriate?	5. Survey Questions - Recommended changes to survey questions.
Examples include course questions, program questions, and USMA web-based survey questions.	5a. Survey Results – Include analysis of Course-End Feedback or other surveys to include significant trends, suggestions or input that you believe should be incorporated into the course in the future.	5a. Survey Results – Recommendations to address any shortcomings identified by survey results (if necessary).
	5b. Survey Freeform Comments - (If used.) Results of any free-form comments from cadets about the course – summarize the most prevalent positive and negative comments.	5b. Survey Freeform Comments - Recommendations to address shortcomings identified from free-form comments, if necessary.
6. Course GPA - List course GPA here. Include numbers from the last six terms.	6. Course QPA – Discuss any discernible trends or abrupt changes in course GPA over past several terms.	6. Course QPA – Recommendations to address any perceived problems.
7. TEE Grade - List course TEE grade here from the last six terms.	7. TEE Grade – Discuss any discernible trends or abrupt changes in TEE grade over past several terms.	7. TEE Grade – Recommendations to address concerns with TEE grades.
8. Course Processes	8. Course Processes	8. Course Process
8a. Textbook - Title, author, and edition	8a. Textbook - Is the current textbook appropriate?	8a. Textbook - Recommended changes to textbook.
8b. Lessons and Labs - List of lessons and labs in the course (syllabus).	8b. Lessons and labs - Are the number of lessons and labs appropriate?	8b. List of lessons and labs - Recommended changes to the number of lessons and labs.
8c. Summary of Graded Requirements - Number, type, and weight of drill problems, Problem Sets, Special Problems, EDP's, Lab Reports, Writs, WPR's, TEE, and Instructor Grade (as applicable).	8c. Summary of Graded Requirements - Are the graded requirements appropriate?	8c. Summary of Graded Requirements - Recommended changes to the graded requirements.
8d. Areas of Special Emphasis - Any special topics not included in the Redbook description or program embedded indicators go here.	8d. Areas of Special Emphasis - Are the areas of special emphasis appropriate?	8d. Areas of Special Emphasis - Recommended changes to the areas of special emphasis.
9. Contribution to Student Outcomes - List student outcomes here.	9. Contribution to the Student Outcomes - Does the course contribute to the student outcomes? How?	9. Contribution to Student Outcomes
	9a. Coverage - Indicate coverage of objectives by graded events.	9a. Coverage - Recommendations to address shortcomings in coverage of outcomes.
	9b. Performance - Indicate performance on course objectives.	9b. Performance - Recommendations to address problems in performance on student outcomes.
10. Resources and Laboratories	10. Resources and Laboratories	10. Resources and Laboratories
10a. Laboratories - List laboratories lab projects used in the course.	10a. Laboratories - Was equipment available for desired experiments? Was equipment working?	10a. Laboratories - Recommendations to address any shortcomings in equipment.
10b. Computer Labs - List computer labs used in the course.	10b. Computer Labs - Were adequate computing facilities available for the course?	10b. Computer Labs - Recommendations to improve computing facilities.
10c. Physical Models & Demos - List physical models and demos used in the course.	10c. Physical Models & Demos - Were physical models and demos adequate? In good working order?	10c. Physical Models & Demos - Recommendations for new demos or models, or to improve condition of existing models and demos.
10d. Technician Support - List technician support used in this course (wet lab or IT).	10d. Technician Support - Was technician support adequate?	10d. Technician Support - Recommendations to improve technician support.
10e. Supplies - List any wet lab or computer supplies used in this course.	10e. Supplies - Were supplies adequate?	10e. Supplies - Recommend additional supplies for this course.
10f. Additional Facilities - List any additional facilities used.	10f. Additional Facilities - Were the additional facilities adequate?	10f. Additional Facilities - Recommendations to address perceived shortcomings in additional facilities?
10g. Unfunded Requests - List any unfunded requests from last AY and whether or not they were funded.	10g. Unfunded Requests - If provided, were the items made available by the unfunded requirements adequate?	10g. Unfunded Requests - Recommendations for any additional unfunded requirements.
11. Recommendations from last AY - List recommendations from last year's course assessment and describe how they were implemented this AY.		

- Published guidance in CD Handbook
- Required for all chemical engineering courses used for assessment (not optional)
- Similar system for courses outside department

- Sustain and improve from last AY

Chemical Engineering Program Objectives

During a career as commissioned officers in the United States Army and beyond, program graduates:

- Contribute to the solution of infrastructure or operational problems in a complex operational environment.
- Succeed in graduate school or other advanced study programs.
- Advance their careers through clear and precise technical communication.
- Demonstrate effective leadership and chemical engineering expertise.

Student Outcomes

Identical to ABET 1-7 plus one additional outcome (8)

On completion of the chemical engineering program, our graduates will be able to:	
1.	Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2.	Apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3.	Communicate effectively with a range of audiences.
4.	Recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5.	Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6.	Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7.	Acquire and apply new knowledge as needed, using appropriate learning strategies.
8.	Understand the chemical engineering curriculum, including chemistry, material and energy balances, safety and environmental factors, thermodynamics of physical and chemical equilibria, heat, mass, and momentum transfer, chemical reaction engineering, continuous and staged separation processes, process dynamics and control, modern experimental and computing techniques, and process design.

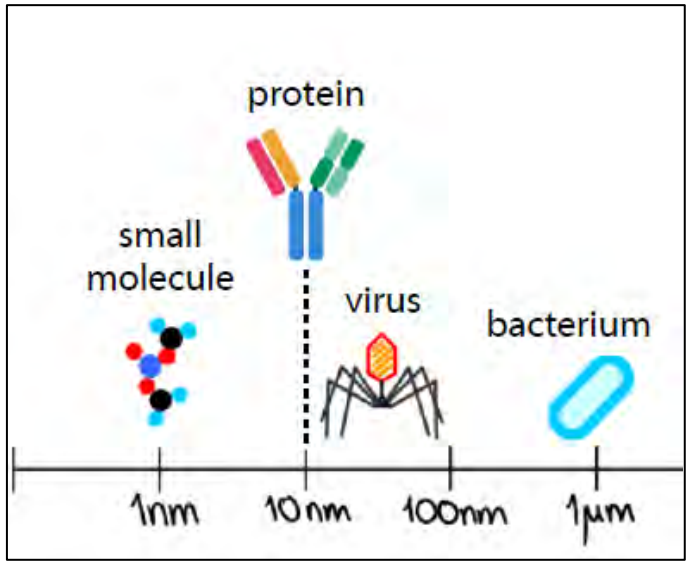
Required Courses *	(for classes 2020 and beyond)
MA364	Engineering Mathematics
CH362	Mass & Energy Balances
CH363	Separation Processes
CH364	Chemical Reaction Engineering
CH367	Introduction to Automatic Process Control
CH485	Heat & Mass Transfer
CH459	Chemical Engineering Laboratory
CH402	Chemical Engineering Process Design
CH400	Professional Practice
MC311	Thermal-Fluid Systems I
MC312	Thermal-Fluid Systems II
EE301	Fundamentals of Electrical Engineering
MC300	Fundamentals of Engineering Mechanics & Design (Statics & Dynamics)
CH365	Chemical Engineering Thermodynamics
CH383	Organic Chemistry 1

***Not including prerequisites**

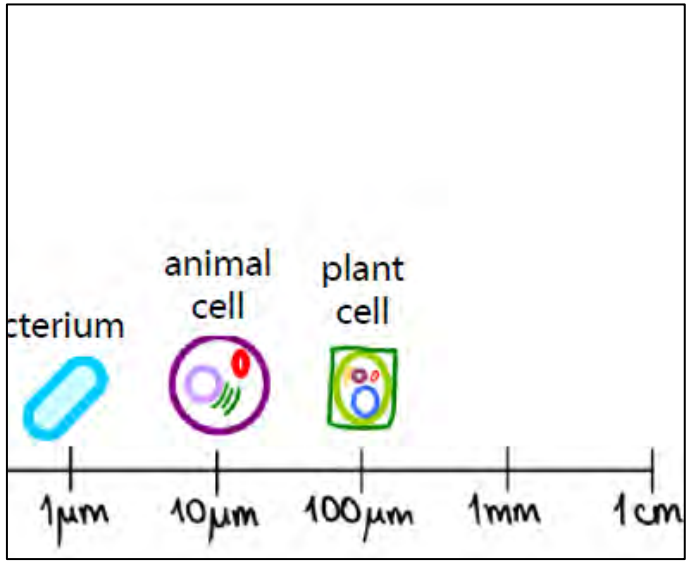
Bioengineering

CH350 Updates

Molecular Scale



Cellular Scale



- Finished with the block 1/2 and on-going with the block 3 of CH350.
- Cadets were introduced to both <u>quantitative and qualitative</u> perspectives of bioprocess engineering:
  1) Qualitative:
     a. Cell types (animal vs. plant)
     b. Central dogma of molecular biology
     c. Metabolic pathways and regulations
  2) Quantitative:
     a. Enzyme kinetics
     b. Mass transfer at immobilized enzymes
     c. Material balances on bioreactors
- Mathematica and excel were utilized to develop governing models for enzyme kinetic description and reactor designs.
- The block 1 was ended with WPR #1.
- The block 2 was ended with guest lectures and WPR #2.
- Curriculum memo to add CH350 permanently to REDBOOK.
- Assessment data to reinforce the memo.
- Dr. Biaglow/Dr. Yuk spearheading this effort JAN22.

CH300 Updates

- Majority of block 1 of CH350 will be moved into the block 1 and 2 of CH300:
  a) Molecular description of cells (animal vs. plant)
  b) Central dogma of molecular biology (DNA, RNA, protein, etc)
  c) Genetic engineering
  d) Enzyme functionality and inhibitions
  e) Metabolic pathways (respiration and digestion)
- Block 3 will be focused on biomedical engineering application.
- Suggesting that concepts related to enzyme kinetics (especially quantitative perspective) and metabolic pathways to be reintroduced in CH350.
- Curriculum memo to add CH300 permanently to REDBOOK.
- Assessment data to reinforce the memo.
- Dr. Biaglow/Dr. Yuk spearheading this effort JUN22.

Bio-engineering Track/Sequence/minor

IN PROGRESS

COA 1	COA 2	COA 3
CH362-CH364-CH450	**CH300-CH350-CH450**	**CH362-CH350-CH450**
Will require minimum of 2 additional faculty (if new sections added)	Will require additional faculty, minimum of 2. Ongoing AP searches. Faculty allocation will be the same in either COA, so use new faculty to develop new courses.	Will require additional faculty, minimum of 1. Ongoing AP searches. Faculty allocation will be the same in either COA, so use new faculty to develop new courses.
Does not give Chem E cadets new electives.	*Chem E cadets currently have no electives in DCLS. Continuing area of concern.* Chem E cadets get 3x elective courses.	*Chem E cadets currently have no electives in DCLS. Continuing area of concern.* Chem E cadets get 2x elective courses.
Existing course material/objectives are tied to ABET outcomes. These courses are highly optimized for chemical engineering content leading to high performance in these areas. Will require extensive re-configuring of **two** key program courses for a different audience without basis in assessment; max. 2 sections	Courses should be designed to meet student needs. Memo constructed in AY18 was reviewed by other programs and is ready to drop now. Even if proposed courses are not optimal or we do not agree on content, get the courses in Redbook.	Courses should be designed to meet student needs. Memo constructed in AY18 was reviewed by other programs and is ready to drop now. Even if proposed courses are not optimal or we do not agree on content, get the courses in Redbook.
Less resource encumbered	Better for the department. Opportunity for interdisciplinary collaboration and team building.	Better for the department. Opportunity for interdisciplinary collaboration and team building.
Course material/objectives tied to ABET outcomes 1-7,8		
Cannot dilute or alter content		