Biaglow, Andrew Dr

Subject: FW: USMA West Point Chemical Engineering Advisory Board Meeting on April 11-12, 2024 (Schedule and Readahead)
Attachments: Program Assessment Data Pack - 2023.pdf; Advisory Board 12Apr2024_Final - Readahead.pdf; AY24 Advisory Board Survey - Fillable.pdf

From: Nagelli, Enoch Dr <enoch.nagelli@westpoint.edu>
Sent: Wednesday, April 10, 2024 01:08
To: michaeldeforest@fortna.com <michaeldeforest@fortna.com>; Kisondra Waters <kisondra@gmail.com>; Paul Dietrich <paul@the-dietrichs.com>; Kevin Shipe <kevin.a.shipe@gmail.com>; Michael Theising <m.theising@gmail.com>; Liberatore, Matthew <Matthew.Liberatore@UToledo.edu>; Krishnamoorthy, Gautham <gautham.krishnamoort@und.edu>; ake7@cornell.edu <ake7@cornell.edu>; sd386@cornell.edu <sd386@cornell.edu>; Robert Savinell <RFS2@case.edu>
Cc: Cowart, Samuel V LTC <samuel.cowart@westpoint.edu>; Costain, Kristen Mrs <kristen.costain@westpoint.edu>
Subject: Re: USMA West Point Chemical Engineering Advisory Board Meeting on April 11-12, 2024 (Schedule and Readahead)

Dear Board Members,

Attached is the readahead slides and the program assessment data pack in reference to our upcoming meeting. I look forward to seeing all of you.

Thank you again for making the trip to West Point and for agreeing to serve on the Board.

Sincerely,

Enoch A. Nagelli, Ph.D.

Associate Professor
Director, Chemical Engineering Program
Department of Chemistry & Life Science
Bartlett Hall, Room 433A
United States Military Academy, West Point, NY 10996
W: 845.938.3904
C: 630.452.3653

From: Nagelli, Enoch Dr <enoch.nagelli@westpoint.edu>
Sent: Tuesday, April 9, 2024 17:03
To: michaeldeforest@fortna.com <michaeldeforest@fortna.com>; Kisondra Waters <kisondra@gmail.com>; Paul Dietrich <paul@the-dietrichs.com>; Kevin Shipe <kevin.a.shipe@gmail.com>; Michael Theising <m.theising@gmail.com>; Liberatore, Matthew <Matthew.Liberatore@UToledo.edu>; Krishnamoorthy, Gautham <gautham.krishnamoort@und.edu>; ake7@cornell.edu <ake7@cornell.edu>; sd386@cornell.edu <sd386@cornell.edu>; Robert Savinell <RFS2@case.edu>
Cc: Cowart, Samuel V LTC <samuel.cowart@westpoint.edu>; Costain, Kristen Mrs <kristen.costain@westpoint.edu>
Subject: USMA West Point Chemical Engineering Advisory Board Meeting on April 11-12, 2024 (Schedule)

Dear Advisory Board Members,

Thank you for agreeing to serve and join our Advisory Board Meeting this year. Your valuable feedback on our chemical engineering program is critical to our ABET Accreditation Process as well as our program educational outcomes. As you have already seen, Mrs. Costain has sent all of you your DTS orders with your travel and hotel reservations. As you

travel to your respective NJ/NY are airports or traveling via personal vehicle, please let me know when you arrive at the hotel for check in (my cell phone number is 630-452-3653 so please call/text me any time). Upon check-in, please let the front desk hotel representative know to change the reservation you have to be charged to your personal credit card instead of the card on file.

I will send you the readahead containing the program assessment data for your reference as soon as possible. Let me know if you have any questions. We are looking forward to seeing all of you.

The following is a schedule for our upcoming meeting:

Date	Time	Event	Location
11-Apr	NLT1300	Pick up 15 PAX van	M
	1730-1745	Pick up Board Members From Hotel	Holiday
	1830 - UTC	Dinner	MacArth Restarant Thayer Rd, V
12-Apr	0730	Pick up Board Members From Hotel	Holida 110 Fort Montgo
	0745 - 0800	Arrival and Coffee/Light Breakfast Items	Bartl (ta
	0800 - 0830	**Session 1:** Introductory remarks and ABET orientation	BH465
	0830 - 0915	**Session 2:** Assessment & Program Objectives	BH465
	0915 - 0930	**Break**	
	0930 - 0950	**Session 3:** Mission Statement & Program Educational Outcomes (AY23 Board and Cadet Feedback Results)	BH465
	0950 - 1000	**Cadets Arrive:** Firsties and Cows (C1 Hour)	
	1000 - 1050	**Session 4:** Small Groups (Board + Cadets)	BH465 (b
	1050 - 1100	**Cadets Arrive:** Cows (D1 Hour) join Firsties & Board	
	1100 - 1145	**Session 4 (cont):** Small Groups (Board + Cadets)	BH465 (b
	1145 - 1300	**Lunch** for Board, Firsties, & Faculty	BH465
	1300 - 1330	**Session 5:** Board Survey	BH465
	1330 - 1400	**Session 6:** Mission Statement & PEOs Workshop (Board + Faculty)	BH465 (b
	1400 - 1430	**Session 7:** Future Challenges - Growth, Senior Lab and Courseload (Board + Faculty)	BH465 (b
	1430 - 1500	**Session 8**: Department Name & Undergrad Rankings (Board + Faculty)	BH465 (b
	1500 - 1600	Meeting Closeout/Lab Tour	
	1600	Return to Hotel	

Dr. Enoch Nagelli. Cell: (630) 452 3653

Wishing you safe travels and thank you for your service to the West Point chemical engineering program!

Sincerely,

Enoch A. Nagelli, Ph.D.
Associate Professor
Director, Chemical Engineering Program
Department of Chemistry & Life Science
Bartlett Hall, Room 433A
United States Military Academy, West Point, NY 10996
W: 845.938.3904
C: 630.452.3653

UNITED STATES MILITARY ACADEMY
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Chemical Engineering

Advisory Board Meeting

11-12 April 2024

United States Military Academy
Department of Chemistry and Life Science

UNITED STATES MILITARY ACADEMY
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Meeting Schedule

Date	Time	Event	Location	OIC	Task
11-Apr	NLT1300	Pick up 15 PAX van	Motorpool	CPT Tobergte	
	1730-1745	Pick up Board Members From Hotel	Holiday Inn Express	CPT Tobergte/Dr. Nagelli	Transport of Board Members to Thayer Hotel
	1830 - UTC	Dinner	MacArther's Riverview Restarant (Thayer Hotel) 674 Thayer Rd, West Point, NY 10996	Dr. Nagelli	Reservation at 1830 - 20 people Pre-Fix Menu is Option
12-Apr	0730	Pick up Board Members From Hotel	Holiday Inn Express 1106 Route 9W Fort Montgomery, NY (845) 446 - 4277	CPT Tobergte	Pick Up Board (CPT Tobergte); Escort to BH465 (Dr. Yuk)
	0745 - 0800	Arrival and Coffee/Light Breakfast Items	Bartlett Hall 465 (table side)	Dr. Nagelli, LTC Cowart	Light Breakfast Items (LTC Cowart)
	0800 - 0830	**Session 1:** Introductory remarks and ABET orientation	BH465 (table side)	COL James/LTC Kick Dr. Nagelli/LTC Cowart	
	0830 - 0915	**Session 2:** Assessment & Program Objectives	BH465 (table side)	Prof. Biaglow	
	0915 - 0930	**Break**	BH465		
	0930 - 0950	**Session 3:** Mission Statement & Program Educational Objectives (AY23 Board and Cadet Feedback Results)	BH465 (table side)	Prof. Biaglow	
	0950 - 1000	**Cadets Arrive:** Firsties and Cows (C1 Hour)			
	1000 - 1050	**Session 4:** Small Groups (Board + Cadets)	BH465 (breakout tables)	Dr. Nagelli/LTC Cowart	
	1050 - 1100	**Cadets Arrive:** Cows (D1 Hour) join Firsties & Board			
	1100 - 1145	**Session 4 (cont):** Small Groups (Board + Cadets)	BH465 (breakout tables)		CPT Tobergte & Mr. Mathew Pick up Lunch and set up in Break room
	1145 - 1300	**Lunch** for Board, Firsties, & Faculty	BH465 & Breakroom	Dr. Nagelli/LTC Cowart	
	1300 - 1330	**Session 5:** Board Survey	BH465 (table side)	Dr. Nagelli/LTC Cowart	
	1330 - 1400	**Session 6:** Mission Statement & PEOs Workshop (Board + Faculty)	BH465 (breakout tables)		
	1400 - 1430	**Session 7:** Future Challenges - Growth, Senior Lab and Courseload (Board + Faculty)	BH465 (breakout tables)	LTC Cowart	
	1430 - 1500	**Session 8**: Department Name & Undergrad Rankings (Board + Faculty)	BH465 (breakout tables)	Dr. Nagelli/LTC Cowart	
	1500 - 1600	Meeting Closeout/Lab Tour	BH465	Dr. Nagelli/LTC Cowart	
	1600	Return to Hotel		CPT Tobergte	CPT Tobergte - Pick Up Board from Library Corner to return to

Dr. Enoch Nagelli. Cell: (630) 452 3653

Meeting Goals

1. **Advisory Board Members Roles**
   - **Assessment Data**
   - **Objectives Assessment**
   - **Curricular Challenges**
   - **Complete Surveys**

2. **Board Members have discussions with chemical engineering faculty and cadets**

3. **Board Members review mission statement, PEOs and future challenges with the anticipated growth of the program/major.**

Chemical Engineering

Advisory Board Meeting

11-12 April 2024

1. Introductory Remarks

COL Corey James Ph.D., Deputy Head CLS

United States Military Academy
Department of Chemistry and Life Science

Chemical Engineering

2. ABET Accreditation

LTC Sam Cowart, Ph.D.

Accredited **1 October 2012** to present
Next Record Year: **AY2025-2026**
ABET Visit: **Early September 2026**

United States Military Academy
Department of Chemistry and Life Science

Why ABET Accreditation?

- Confidence that program has met standards essential to prepare graduates to enter STEM fields
- Keeps us in touch with the engineering profession
- Helps USMA (and ChemE) recruiting (2020 – 29; 2021 - 20; *2022 - 23; 2023 -13; 2024 ~21; 2025~31; 2026~28; 2027~43*)
- Provides important opportunities for graduates
- Allows USMA engineering majors to take the Fundamentals of Engineering (FE) Exam
- It is required by Army Regulations (10-87).

Thoughts to Consider

- The ABET process is impacts faculty time
  - USMA is a small undergraduate college (<5,000 students) with limited faculty and high faculty turnover
- The ABET accreditation is important to the institution and to the Army
- The only 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

ABET Definitions

Program Educational Objectives
Program educational objectives are broad statements that describe what graduates are expected to attain within a few years of graduation.

Student Outcomes
Student outcomes describe what students are expected to know and be able to do by the time of graduation (skills, knowledge, and behaviors).

(ABET EAC Criteria)

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Terms You Should Know

- **Program Educational Objectives (PEOs)**
  - Gleaned by asking *program constituents*
    - For us: Army, profession, graduate schools, other
  - **Our external *Advisory Board* a key resource.**
  - Desired professional accomplishments of graduates **5-7 years after graduation**
  - Adjust every 3 years or so…

- **Student Outcomes**
  - What students should be able to do **at graduation**
  - Must be **measurable**
  - Designed to lead naturally to the PEOs
  - Assess/evaluate some fraction 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

Chemical Engineering

2. Program Assessment and Objectives

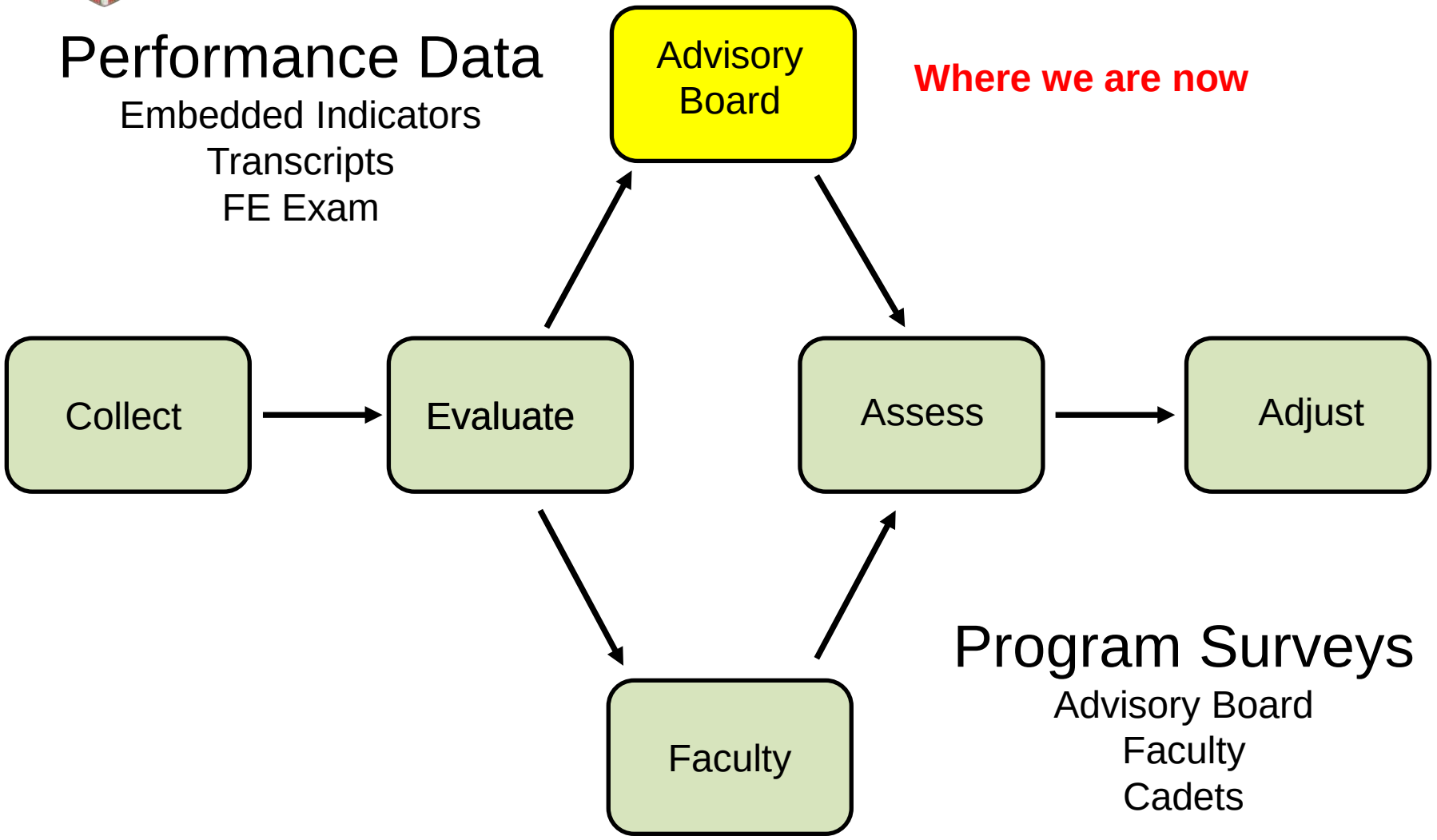
Prof. Andrew Biaglow

United States Military Academy
Department of Chemistry and Life Science

Assessment Process

Performance Data

Embedded Indicators
Transcripts
FE Exam



Where we are now

Program Surveys

Advisory Board
Faculty
Cadets

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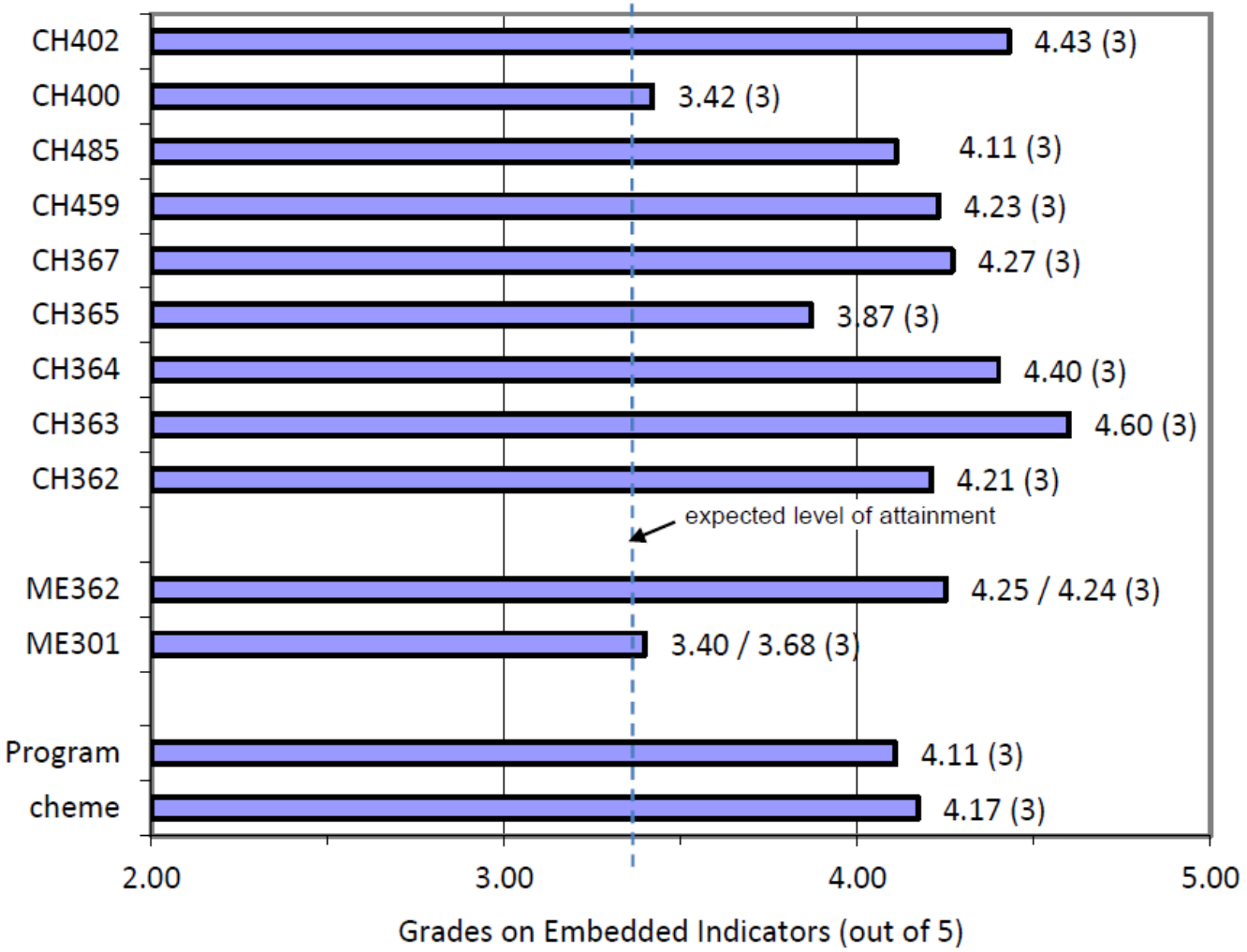
Student Outcomes (AY19 & beyond)

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.

Example Data: Coursework Embedded Indicators

Student Outcome 1



MC311 and MC3 have two scores. The first is for chemical enginee and the second is course-wide.

Values in parentheses are coverage ratings from Table 5-4

Rubric:.

3: Unique embedded indicator with clear rubric or cut scale.

2: Outcome was graded but grades are convoluted, or part of the outcome is not covered.

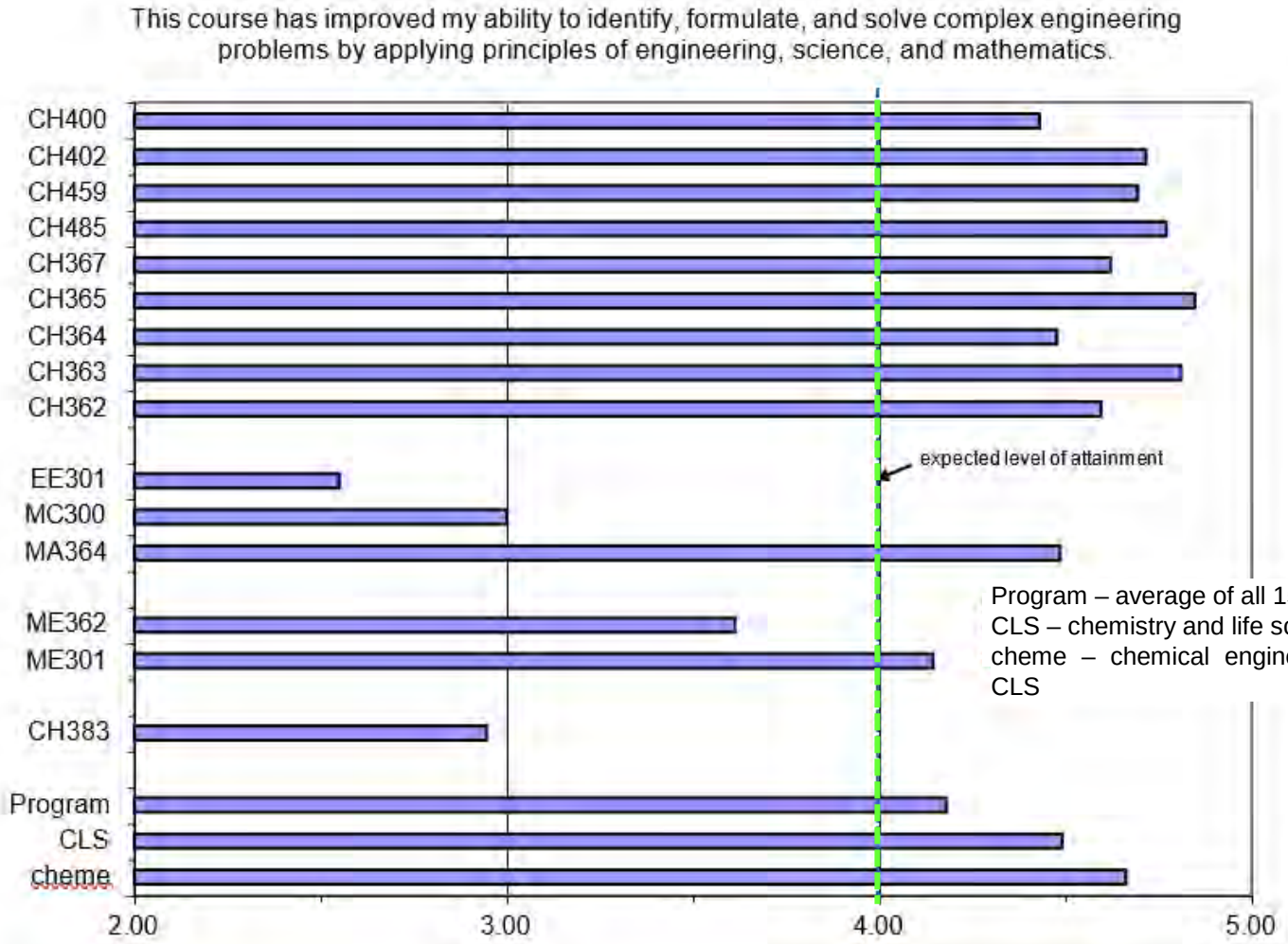
1: Correlation to outcome but no assessment

0: No coverage or correlation

Data shown here is for Class of 2023
Similar data is collected for all 7 ABET student outcomes
Summary of all data is shown on next slide

Example Data: End-of-Semester Surveys

Student Outcome 1



Program – average of all 15 courses above
CLS – chemistry and life science courses
cheme – chemical engineering courses in CLS

Data shown here is for Class of 2023
Similar data is collected for all 8 ABET student outcomes
Summary of all data is shown on next slide

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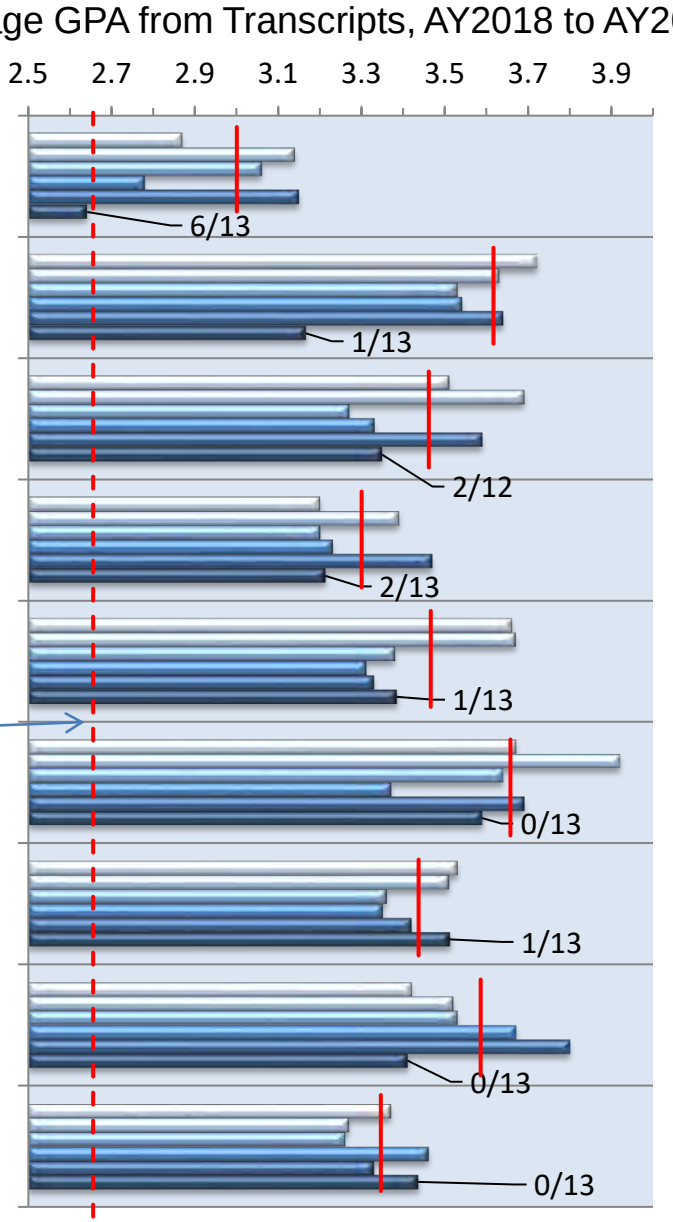
Topical Outcomes Evaluation

Student Outcome 8: Understanding of the Chemical Engineering Curriculum

Average GPA from Transcripts, AY2018 to AY2022

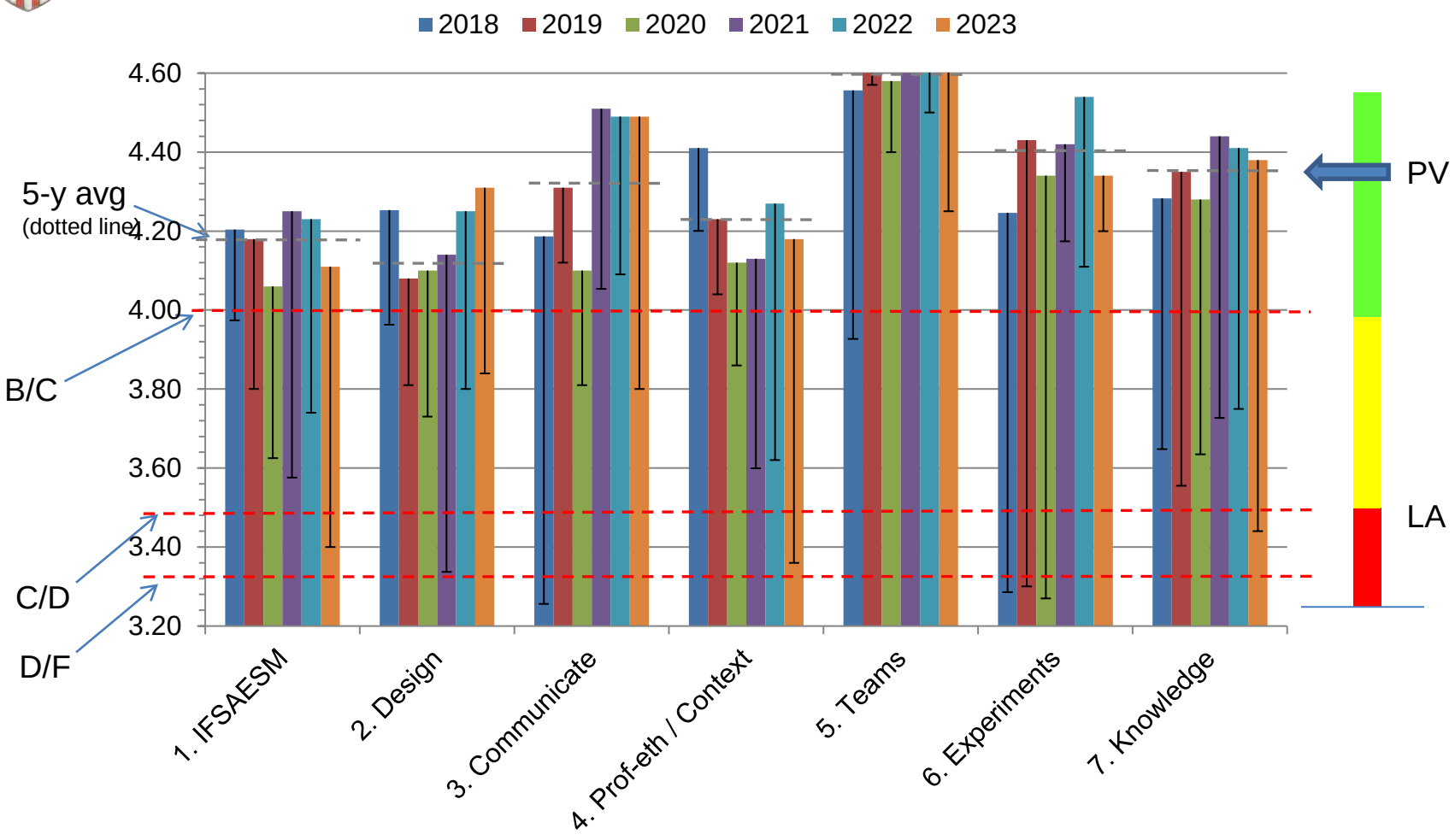


expected level of attainment for the program is B- (2.67, red dotted line).

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

Performance on Embedded Indicators

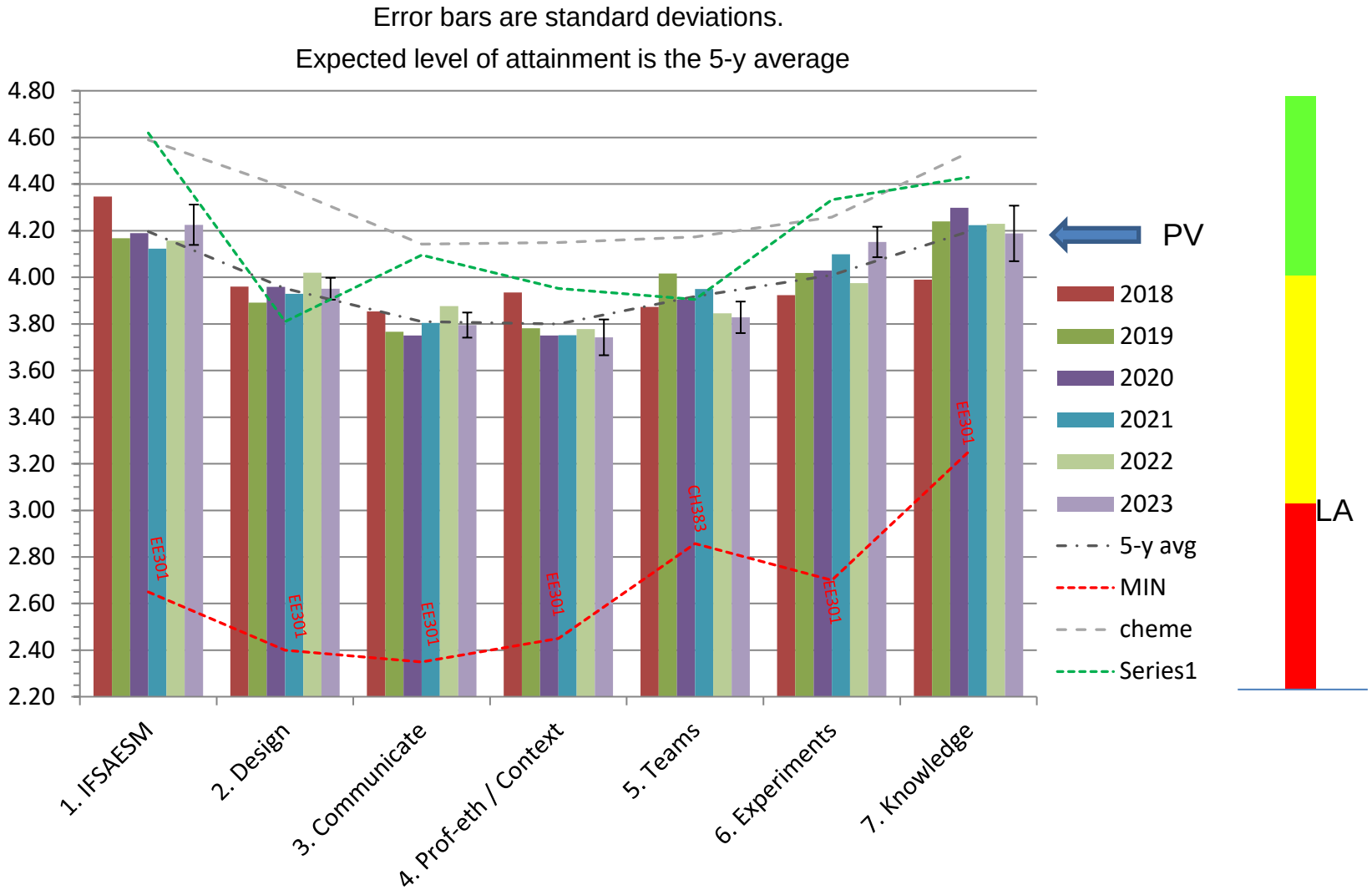
Program Averages AY2018-23



Error bars are minimum scores from course assessments.

Expected levels of attainment are the 5-year averages

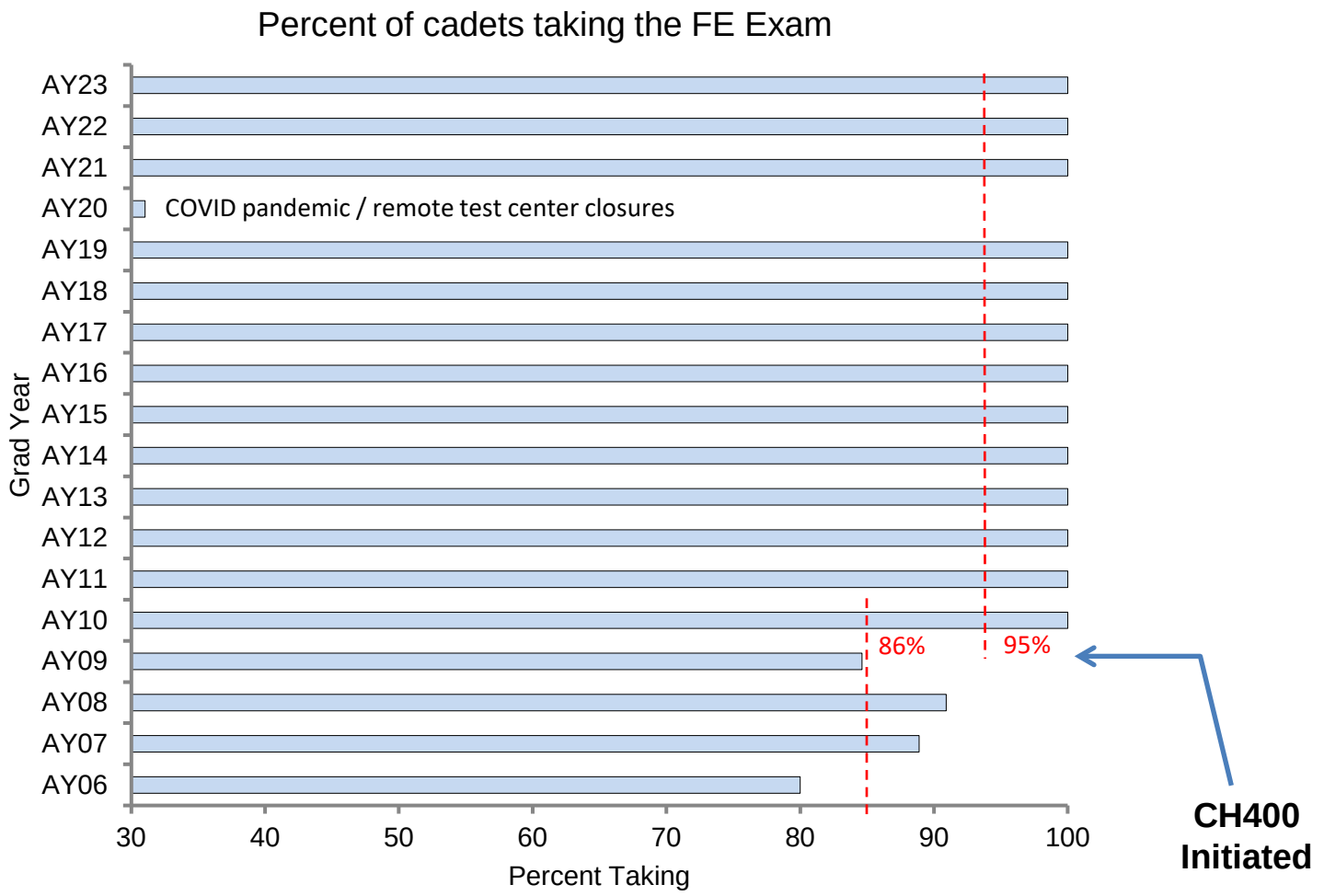
End-of-Semester Surveys Program Aves. From AY18-AY23



Fundamentals Engineering Exam Results

Fundamentals of Engineering Exam

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

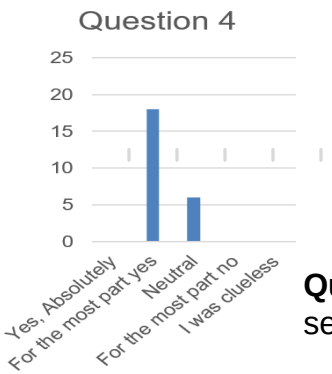


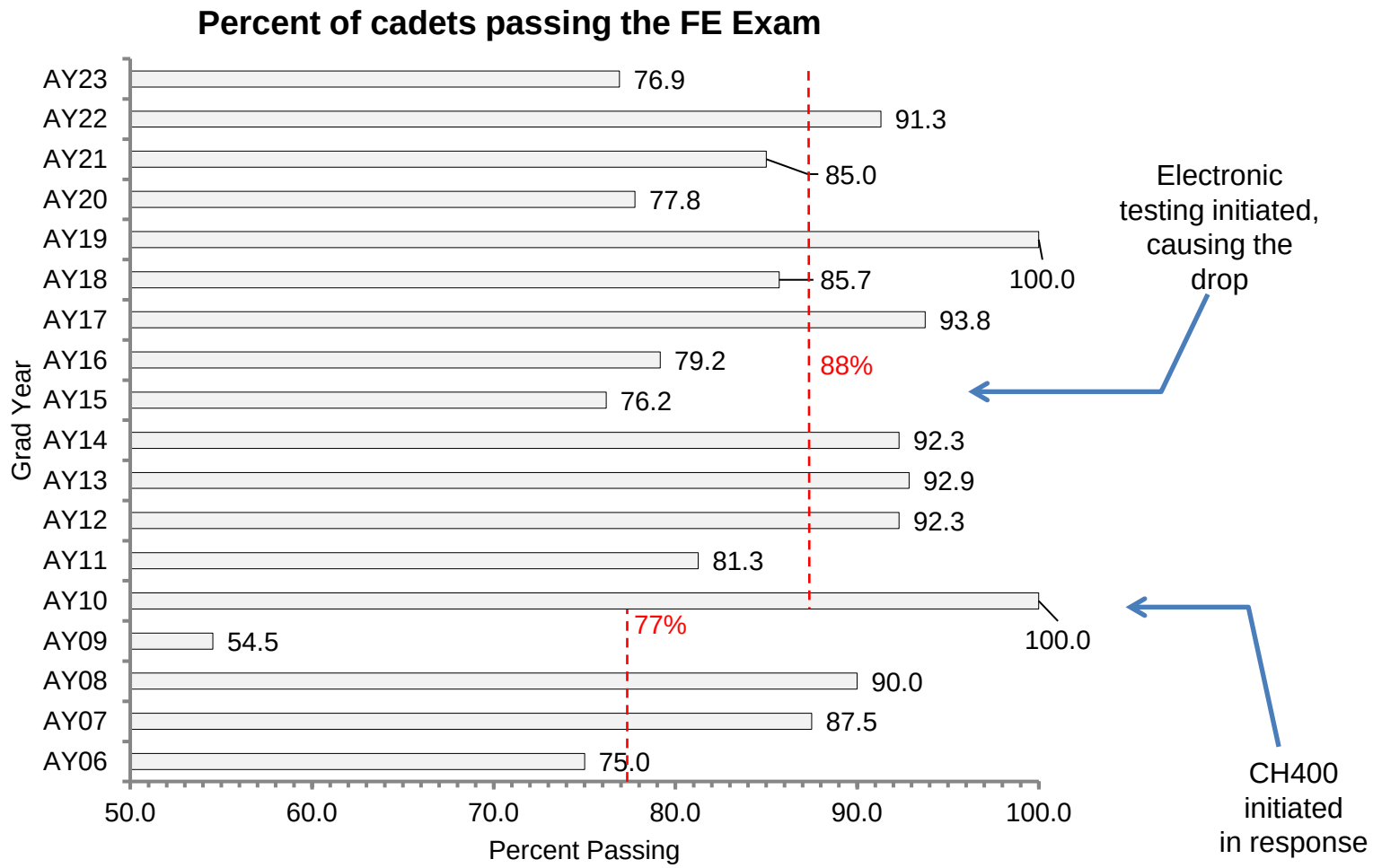
Fundamentals of Engineering Exam

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

National, (+/- ~1%):

2023	70.2%
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%

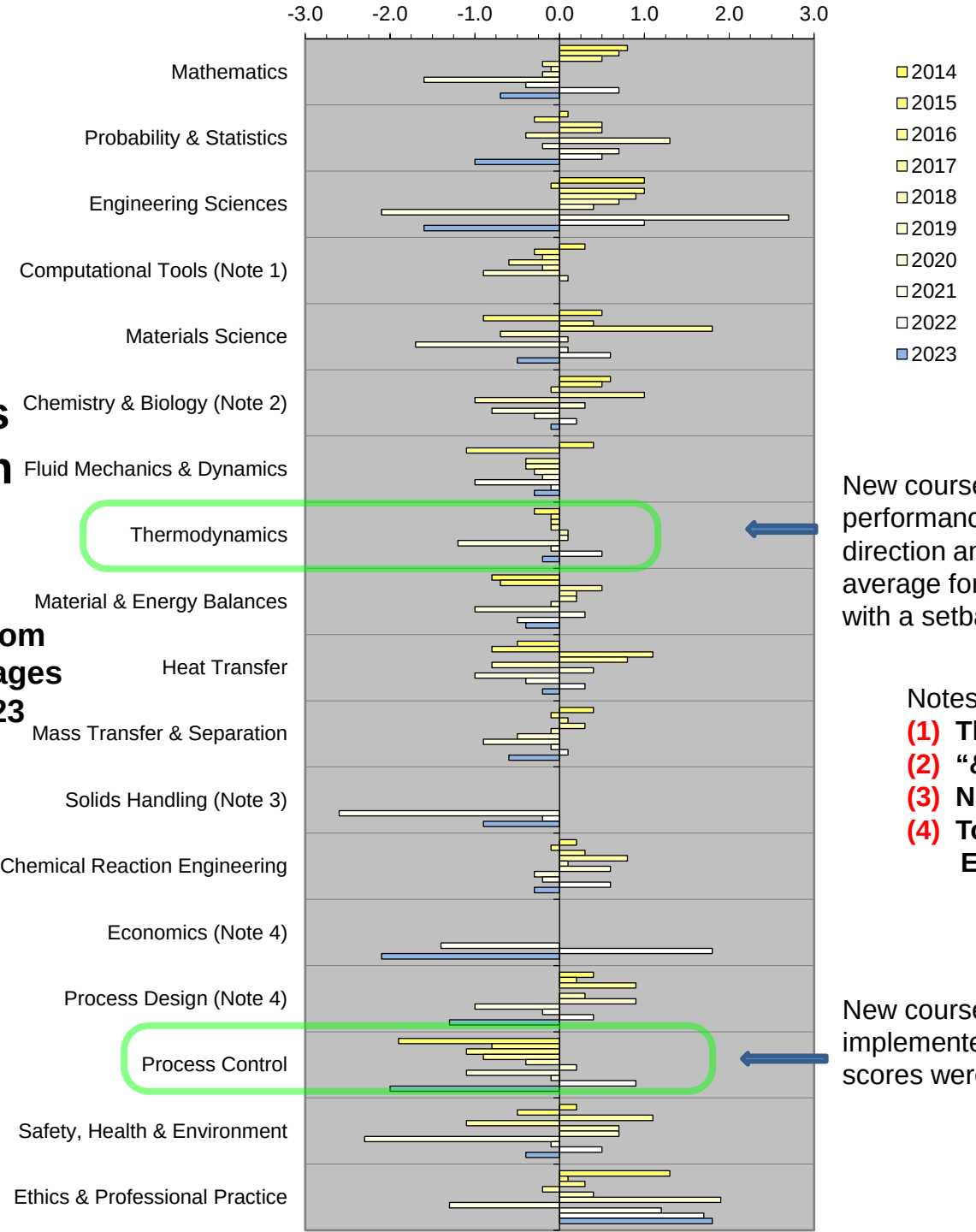




Question 4, Post FEE Survey: For the questions on the exam that seemed new to you, were you able to learn the material on the spot?

Topical Outcomes Evaluation

Deviations from National Averages AY14 to AY23



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 was dropped in 2021.**
(2) **"& Biology" added in 2021**
(3) **New exam spec in 2021**
(4) **Topic was "Process Design & Economics" before 2020**

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)

Break

0915-0930

Chemical Engineering

3. Mission Statement and PEOs (Board and Cadet Feedback)

Prof. Andrew Biaglow

United States Military Academy
Department of Chemistry and Life Science

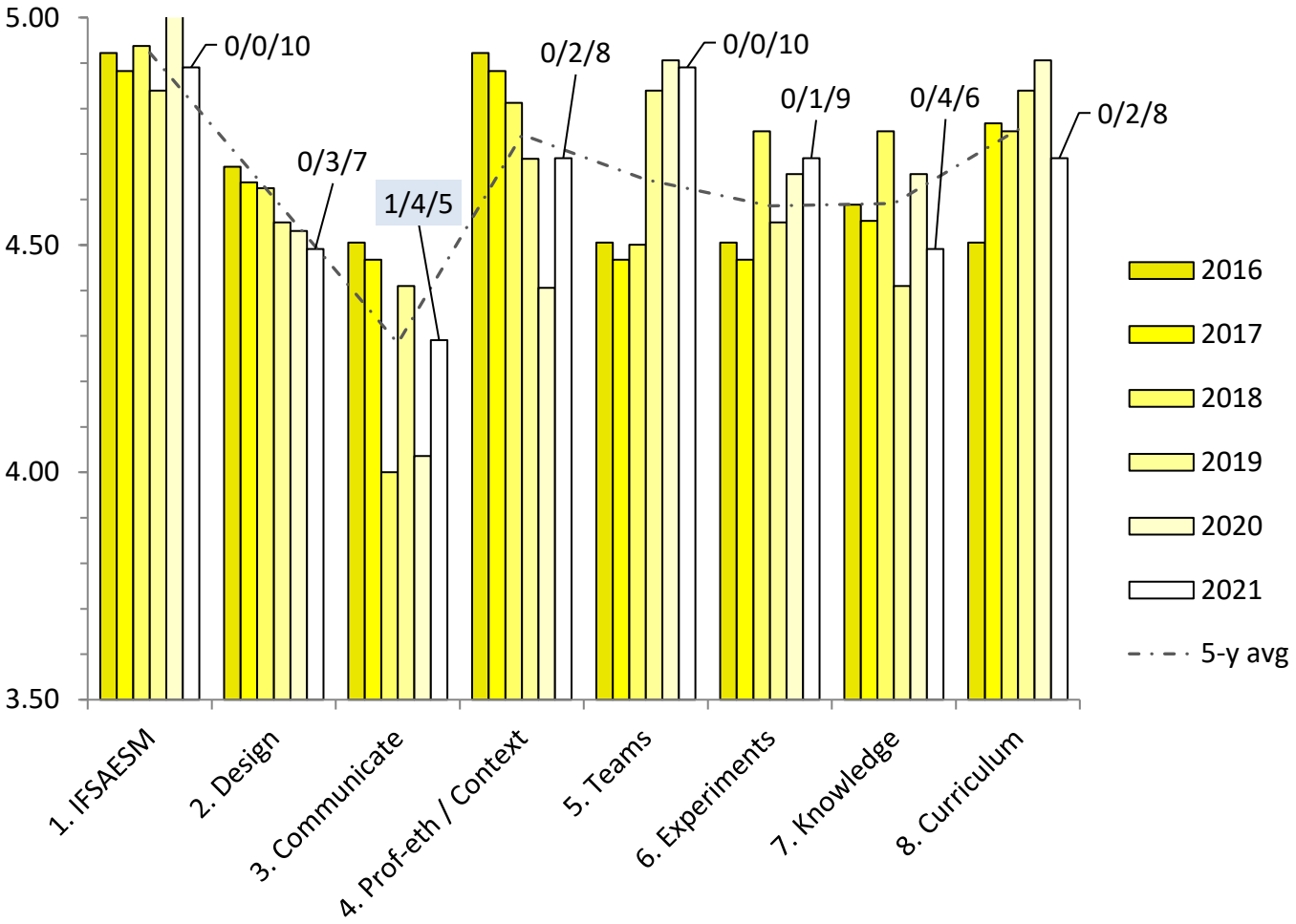
Faculty & Advisory Board Survey Results

Faculty Student Outcomes Surveys

Student Outcomes 1-8

Program Averages from AY16-21

Data labels are response frequencies on the 1-5 Survey Likert Scale (# of 3 / # of 4 / # of 5).
The average standard deviation is 0.46 and ranges from .00 to .70.

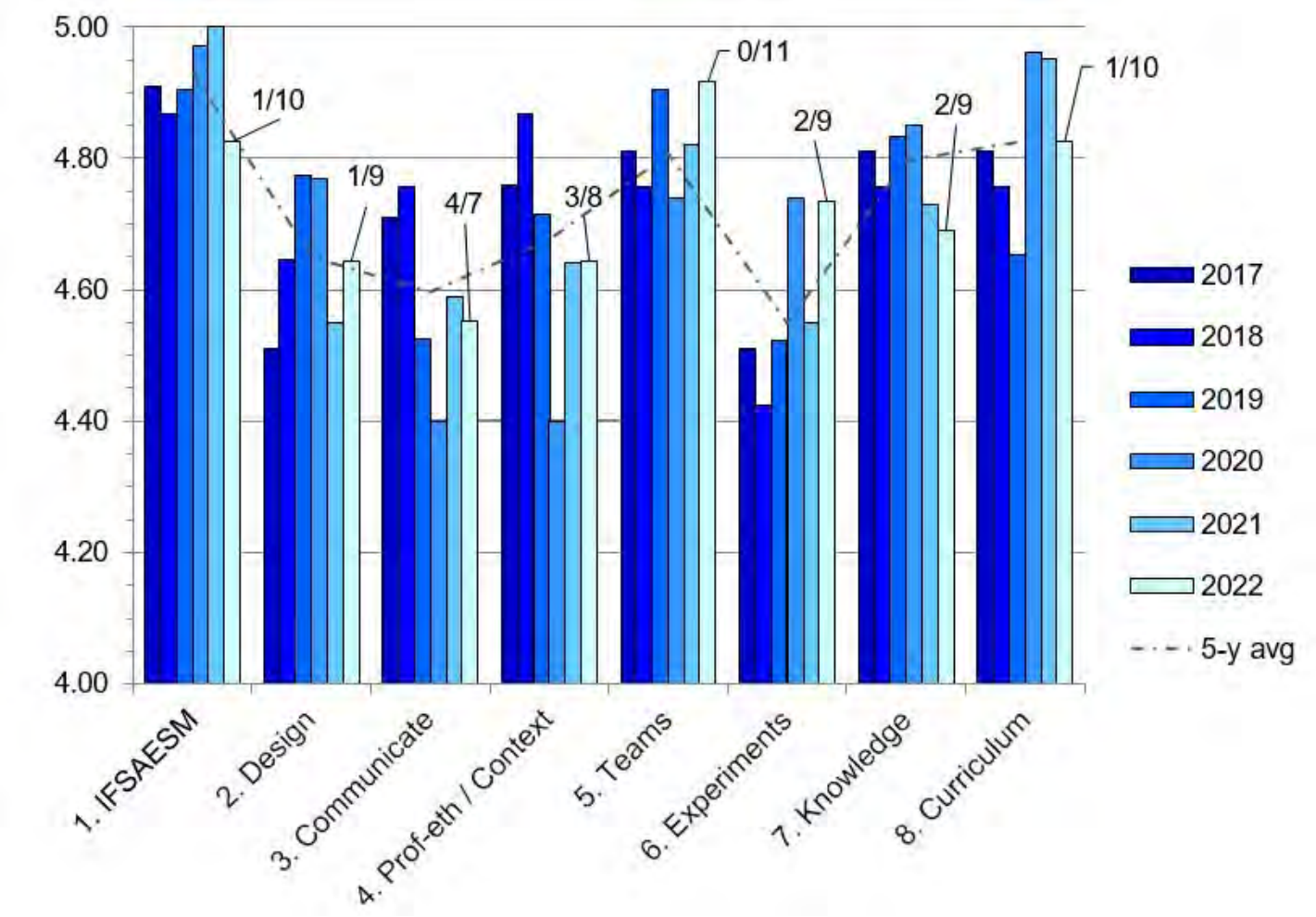


Advisory Board Student Outcomes Surveys

Student Outcomes 1-8

Program Averages from AY17-22

Data labels are response frequencies for 4 or 5 (# of 4s / # of 5s) on the 1-5 Survey Likert Scale
Standard deviations range from .00 to .52



Advisory Board Feedback

Excerpts from Minutes of 14 April 2023

- Reconsider MC300 and its role in the curriculum,
- Adding Organic Chemistry 2 to the curriculum and removing redundant material.
- Interactions in smaller groups to facilitate conversations (round-robin interviews, lunches).
- Tours for new members, such as cadet mess, museum, visitor center.
- More interactions with faculty.
- Student orientation on surveys.
- Faculty are appreciated by cadets.

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ChemE Vision Statement AY23 Board Feedback

Mission:

The mission of the chemical engineering program is to prepare commissioned leaders of character who possess the intellectual capital to leverage new and emerging technologies. ~~are proficient in applying chemical and engineering principles to solve problems in a complex operational environment~~.

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

(1) Demonstrate effective leadership and chemical engineering expertise.
(2) Contribute to the solution of infrastructure or operational problems in a ~~complex~~ operational environment.
(3) ~~Succeed in graduate school or other advanced study programs.~~ Apply disciplined technical expertise to succeed in advanced study programs or graduate school.
(4) Advance their careers through clear and precise technical communication.

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Vision Statement & PEOs Cadets Feedback

Chemical Engineering

4. Cadets and Board Panels

Dr. Nagelli

United States Military Academy
Department of Chemistry and Life Science

Discussions with Cadets (Firsties & Cows)

Talking points:

- Program Sustains/Improves
- Any courses in curriculum cadets are unhappy with?
- Any general issues with the program they would like to discuss?
- Any thoughts on fundamental courses preparing the cadets for upper level courses (i.e. EE301 prep for CH367, CH362 prep for pretty much everything else, ME362 prep for CH485, ME301 prep for CH365, etc.)
- Any thoughts on structure of labs associated with most courses (vice a dedicated lab course per year/semester).
- For Firsties: If you were going into the civilian job market as a new engineer, do you feel prepared?

Small Group Panels with Board Members Class of 2024 and 2025 Cadets (Cows and Firsties)

Timeline:

0950-1000 Cadets Arrive: Firsties and Cows (C1 Hour)

1000-1050 Session 4: Small Groups with Cadets & Board

1050-1100 Cadets Arrive: Cows (D1 Hour) join Firsties

1100-1145 Session 4 (cont): Small Groups with Cadets & Board

1145- 1300 Lunch

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Lunch – Sandwiches and Chips

1145- 1300 Lunch with Firsties

Menu:
1. Cold cut sub sandwiches (Italian/turkey/ham&cheese)
2. Chips: regular/barbeque/sour cream & onion/Cheetos/Doritos
3. Water

Chemical Engineering

5. Advisory Board Survey (Part 1)

Dr. Nagelli

United States Military Academy
Department of Chemistry and Life Science

Advisory Board Completes Survey Part 1

Chemical Engineering

6-8. Small Groups Panel with Faculty

Dr. Nagelli & LTC Cowart

United States Military Academy
Department of Chemistry and Life Science

Small Group Discussion Topics

1. **Vision Statement and PEOs Workshop (1330-1400)**

2. **Future Challenges (1400-1500)**
   - **Growth of Major (Class of 2027 = 43)!**
   - **Unit Operations Lab (Senior Lab) Design of Course**
     - ***Current = 2 round robin (3 experiments in each)***
   - **Instructor Teaching Load/Resourcing**
     - ***3 sections for each course?***

3. **Department Name and Undergraduate Rankings (1500-1530)**

Chemical Engineering

5. Advisory Board Survey (Part 2)

Dr. Nagelli

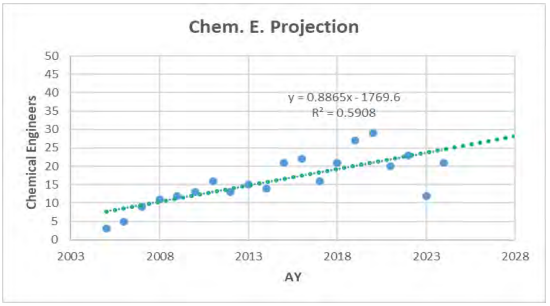
United States Military Academy
Department of Chemistry and Life Science

Advisory Board Completes Survey Part 2

Challenges Ahead

Chemical Engineering Program

1. Program Growth
- CH459 Impacts (Unit Operations Lab)



2. National Rankings for Undergraduate Programs

3. Probably the biggest factor in future challenges is our faculty allocation. Factors that affect us differently than most other schools:
- No graduate students (for TA, RA, etc.)
- No post-docs (for the majority of us)
- A large array of service obligations to USMA
- Army requirements (think ACFT, personnel actions, deployability requirements, etc.)
- Faculty allocations that are directed externally (DA level at least, if not DOD level).

4. This problem affects us every term in different ways (using Dr. Lachance from Registrar, sending first-time rotators to the chemistry program, sabbaticals, etc.)

5. One option is to reduce the major to a maximum of 20 high-achieving cadets and have faculty be available to teach more than one course per semester -OR- teach one course and gain efficiency in research (and other areas).

Thank you!

- For the opportunity to show you America's Military Academy
- For your service and insights to help our program improve
- For the time you have dedicated to this visit
- For your dedication to the profession

Admin Notes for End of Meeting

- Next Advisory Board on-site
  - Early/Late April 2025…close out Class of ’24
- Travel Paperwork/Receipts
  - DTS Voucher Mrs. Kristen Costain
- Tour of Unit Operations Lab and BH labs…UTC
- Shuttle back to Hotel – Pick up in front of BH (~1600)

Extra Slides

Chemical Engineering

United States Military Academy

Example Schedule for Chemical Engineering, Classes of 2024 and Beyond

Fall Term 4th CLASS	Course	Credit Hours	Spring Term	Course	Credit Hours
MA103	Math. Modeling & Intro. Calculus	4.5	MA104	Calculus I	4.5
CH101	General Chemistry I	4.0	CH102	General Chemistry II	4.0
EN101	Composition	3.0	EN102	Literature	3.0
HI101	The Army of the Republic	3.0	HI108	Regional Studies in World History	3.0
CY105	Introduction to Computing & IT	3.0	PL100	General Psychology	3.0
PE11x	Combatives / Boxing / Movement	0.5	MS100	Introduction to Warfighting	1.5
			PE150	Fundamentals/Personal Fitness	1.5
3rd CLASS		Total 18.0			Total 20.5
MA205	Calculus II	4.0	*CH362*	*Mass and Energy Balances*	*3.5*
PH205	Physics I	4.0	*MA364*	*Engineering Mathematics*	*3.0*
Lx203	Foreign Language	4.0	PH206	Physics II	4.0
SS201	Economics	3.0	Lx204	Foreign Language	4.0
PY201	Philosophy	3.0	SS202	American Politics	3.0
MS200	Fundamentals: Army Operations	1.5	EV203	Physical Geography	3.0
			PE 2xx	Lifetime Physical Activity	0.5
2nd CLASS		Total 19.5			Total 21.0
CH363	*Separation Processes*	*3.5*	*CH364*	*Chemical Reaction Engineering*	*3.5*
EE301	*Fundamentals of Electrical Engineering*	*3.5*	*CH367*	*Introduction to Automatic Process Control*	*3.0*
CH383	*Organic Chemistry I*	*3.5*	*ME362*	*Fluid Mechanics*	*3.5*
ME301	*Thermodynamics*	*3.5*	*MC300*	*Fundamentals of Eng. Mech. & Design*	*3.0*
PL300	Military Leadership	3.0	SS307	International Relations	3.0
MA206	Probability and Statistics	3.0	MS300	Platoon Operations	1.5
PE32x	Survival Swimming	0.5	PE360	Combat Applications	1.5
1st CLASS		Total 20.5			Total 19.0
CH459	*Chemical Engineering Laboratory*	*3.5*	*CH402*	*Chemical Engineering Process Design*	*3.5*
CH365	*Chemical Engineering Thermodynamics*	*3.0*	*CH400*	*Chemical Engineering Professional Practice*	*1.5*
CH485	*Heat & Mass Transfer*	*3.5*	*Elective*	*Engineering Elective 3*	*3.0*
Elective	*Engineering Elective 1*	*3.0*	HI302	History of the Military Art	3.0
Elective	*Engineering Elective 2*	*3.0*	LW403	Constitutional & Military Law	3.0
PE450	Army Fitness Development	1.5	MX400	Officership	3.0
		Total 17.5			Total 17.0

Engineering Elective Tracks

Pre-approved elective sequences,
but ultimately cadet choice (can choose any 3)

Materials Engineering
MC364 Mechanics of Materials
MC380 Engineering Materials
Open Elective

Nuclear Engineering
NE300 Nuclear Reactor Analysis
NE350 Nuclear Reactor Design
NE450 Nuclear Systems Design

Decision Analysis
SE301 Foundations of Engineering Design & Systems Management
SE 481 Systems Simulation
EM484 Dynamic Systems Analysis

Advanced Control Systems
EE360 Digital Computer Logic
EM484 Dynamic Systems Analysis
XE475 Mechatronics

Energy Conversion Systems
EE377 Electrical Power Generation
ME472 Energy Conversion Systems
ME480 Heat Transfer

Power Systems
ME306 Dynamics
ME491 Mechanical Power Plants
EE377 Electrical Power Generation
XE442 Alternative Energy Engineering

Industrial Engineering
SE301 Foundations of Engineering Design & Systems Management
EM411 Project Management
EM420 Production Operations Management

Other Advanced Engineering Electives
Satisfy prerequisites
Engineering Science or design = 3.0 credits
Program director approval

UNITED STATES MILITARY ACADEMY
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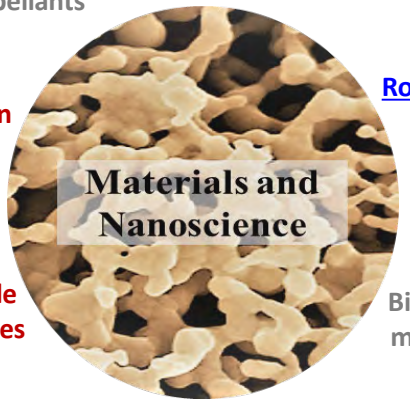
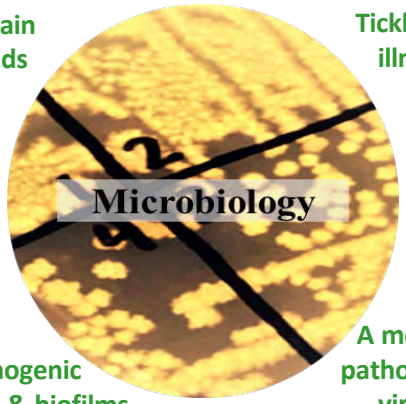
Research Areas

Blood rheology
Neuroscience
Protein aggregation
ACL injury
Public Health
3D Bioprinting & Autoimmunity
Bacteriophage

Instructional design
Laboratory design
Learning Outcomes
CWMD Operations



Propellants
Recycled polymers
Munition degradation
Robotics
Flowable electrodes
Bio-nano-materials
Field expedient batteries & energy storage



Short-chain fatty acids
Tickborne illness
DNA aptamers
A model pathogenic virus
Pathogenic bacteria & biofilms

Energy systems
Combustion systems

Toxic chemical & chemical warfare agent degradation
Nanomaterials for threat detection & mitigation
Metal Organic Frameworks
Countermeasure development
Non-linear optical applications

Program Lead: Bioengineering Chemical Engineering Chemistry Life Science

CMS: Dr. Limbocker & LTC Fallot

Research Model

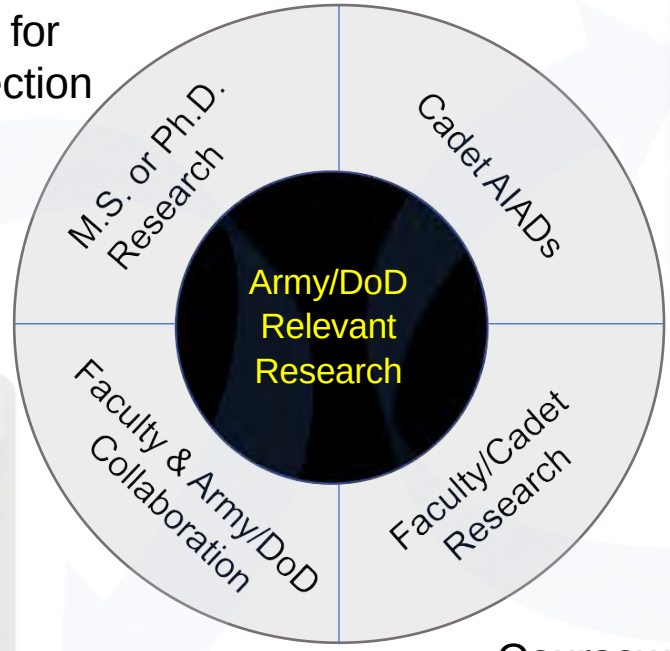
Developmental Opportunities Afforded by Faculty Research Collaboration with an Army/DoD Laboratory

Cadet Development

Mentoring for School Selection

Faculty Selection into a Discipline

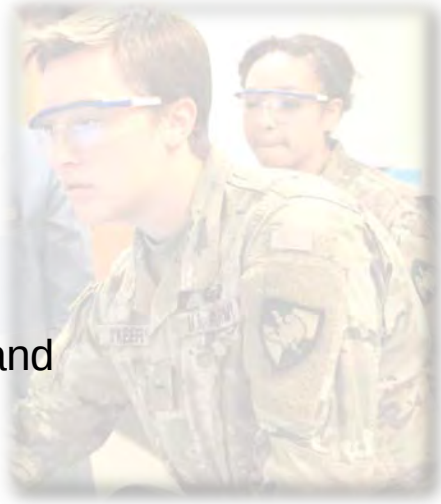
Recruiting



Intellectual Capital

Faculty Development

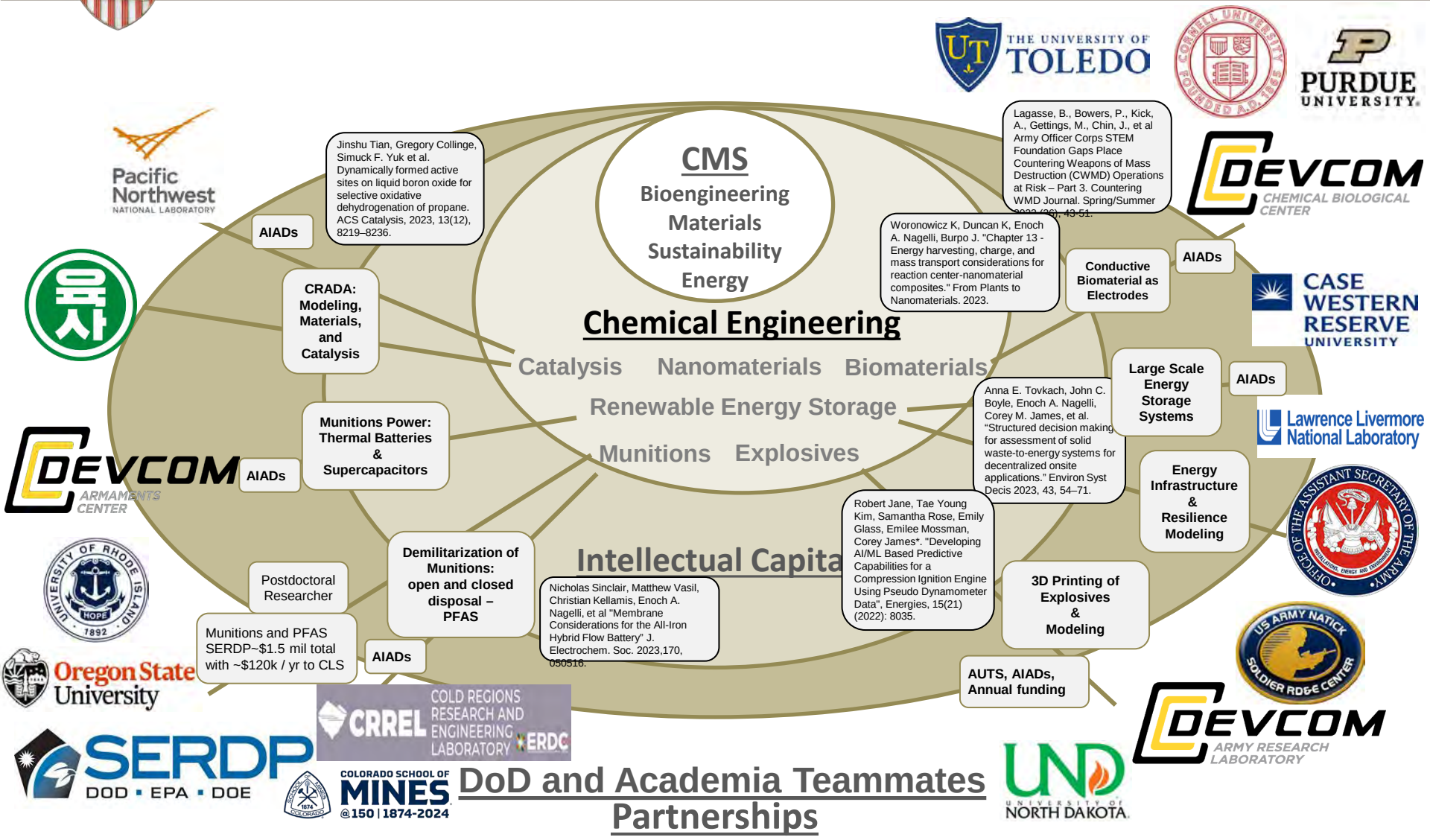
Return to Operational Force



Coursework and Interest

Every interaction is a developmental event

Research Collaborations



DoD and Academia Teammates Partnerships

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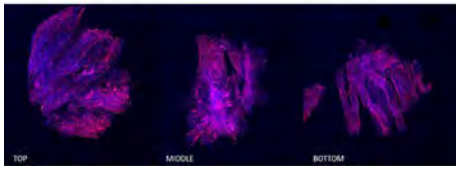
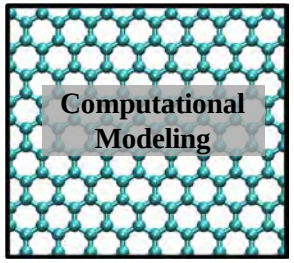
Multidisciplinary Research Areas



Non-linear optical applications

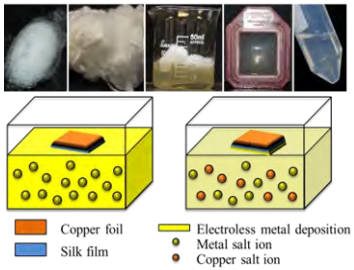
Bioengineering

Neuroscience



Public Health

ACL injury



Toxic chemical & chemical warfare agent degradation

Protein aggregation

3D Bioprinting & Autoimmunity

Tickborne illness

DNA aptamers

Bacteriophage therapeutics

Pathogenic bacteria and viruses

Computational modelling

AI/ML soft sensors

Materials

Energy Storage

Nanomaterials for threat detection & mitigation

Metal Organic Frameworks

Flowable electrodes

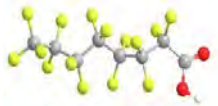
Countermeasure development

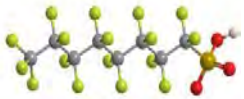
Robotics

Field expedient batteries & energy storage

Infrastructure process optimization

Bio-nano-materials



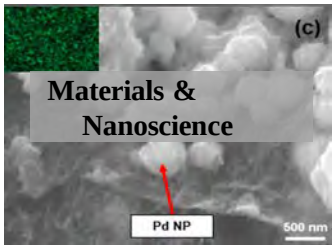


Combustion systems

STEM education

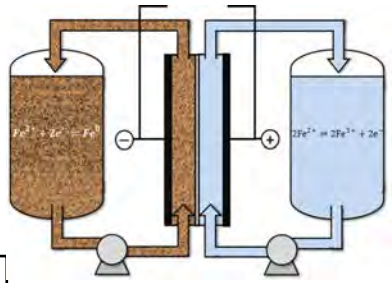
Recycled polymers

Munition degradation



Renewable energy

Per- and Poly-Fluoroalkyl Substances (PFAS)



Propellants

Sustainability

Program Lead: Chemical Engineering Chemistry Life Science

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Scholarship & Excellence

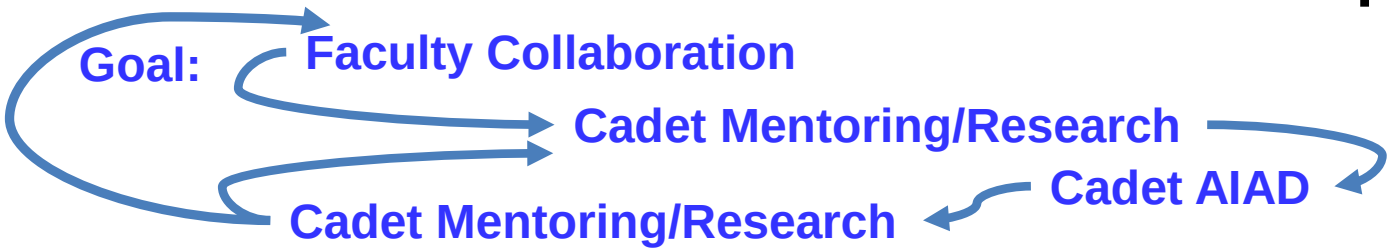
Chemical Engineering Program in 2022

- **14** peer-reviewed publications
- **27** conference presentations (oral + posters)
- Scholarship winners
  - **Alexa Zammit, 2022** – MIT Lincoln Labs Fellowship and National Science Foundation Fellowship at *Massachusetts Institute of Technology*
  - **Andre Pincot, 2022** – Draper Scholar in Bioengineering at *Massachusetts Institute of Technology*

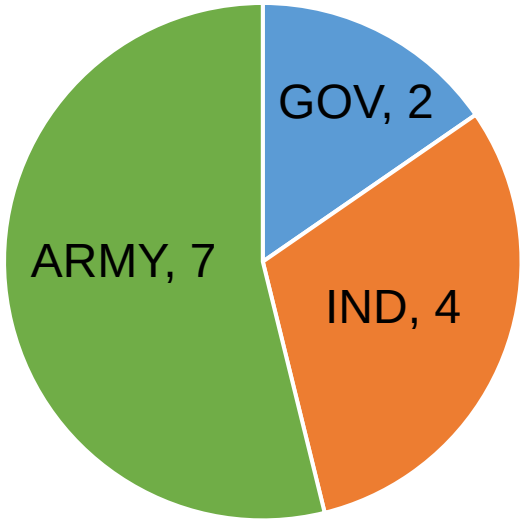
- ChemE FEE Pass Rate 1st Attempt (annual national avg ~75%)
  - AY22 (**82%**), AY21 (**75%**), AY20 (**80%**), AY19 (**88%**), AY18 (**88%**)

Enrichment Opportunities

Advanced Individual Academic Development (AIAD)



- Lawrence Livermore National Lab
- Sandia National Lab
- Army Research Labs
- Picatinny Arsenal
- BAE Systems – Radford AAP
- BAE Systems – Holston AAP
- Southern Polymer
- Uniform Color Company
- Renewable Energy Group



UNITED STATES MILITARY ACADEMY
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CDT Alexa Zammit, '22
Chemical Engineering

- Aviation Officer
- NSF Fellow and Lincoln Labs Fellow
- Tau Beta Phi Honor Society
- Society of American Military Engineers Scholarship Winner
- Won 1st Place in Warfighter Innovation in Science and Engineering Competition
- Best Chemical Engineering/Interdisciplinary Project at USMA Projects Day
- President of AIChE
- Superintendent's Achievement Award
- Distinguished Cadet Award
- Dean's List
- FAA Private Pilot License
- Air Assault School, Battalion Commander (1st Battalion, 2nd Regiment)

Massachusetts Institute of Technology

AIAD at LANL

Fourth Class	Third Class	Second Class	First Class	Beyond
CH289/CH290	CH389/CH390	CH489/490	CH491/492	

Aviation Officer

Future Faculty

USMA Independent Research

Alexa was a part of the MFML team and has led a research team since her cow year to create conductive and high surface area biomaterials energy storage applications. Alexa has presented her research at professional scientific society and DoD conferences and has co-authored a peer reviewed journal article during her time at USMA. She was an active member of the West Point Flying Team/Aviation Club which connected her passion for materials for lightweight power research to the Aviation branch and inspired her interests in pursuing a career as an Aviation Officer. Building on her four-year research experience here at USMA, she is currently completing her MS in Materials Science at MIT through the Lincoln Labs fellowship and hopes to pursue advanced graduate studies in Materials Science through the NSF scholarship towards becoming a future faculty member in CLS.

NSF Graduate Research Fellowship Program

MIT LINCOLN LABORATORY

Assessment, Program Objectives and Mission/Vision Statements

USMA MISSION

To *educate, train, and inspire*

the Corps of Cadets so that each graduate

is a commissioned *leader of character*

committed to the values of

Duty, Honor, Country

and prepared for a career of professional

excellence and service to the Nation as

an officer in the United States Army.

USMA Vision

Within an Army in transition,
West Point is the preeminent leader development and academic institution whose graduates thrive in tomorrow's complex security environments,
and are inspired to a lifetime of service to our Army and the Nation as leaders of character.

West Point is the preeminent leader development institution in the world.

Program Vision

We envision an Army that is prepared for all dimensions of modern warfare, drawing upon disciplined, highly trained chemical engineers to develop solutions to the challenges facing the nation.

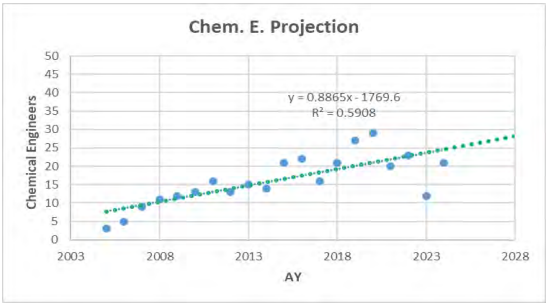
Program Mission

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.

Challenges Ahead

Chemical Engineering Program

1. Program Growth
- CH459 Impacts (Unit Operations Lab)



2. National Rankings for Undergraduate Programs

3. Probably the biggest factor in future challenges is our faculty allocation. Factors that affect us differently than most other schools:
- No graduate students (for TA, RA, etc.)
- No post-docs (for the majority of us)
- A large array of service obligations to USMA
- Army requirements (think ACFT, personnel actions, deployability requirements, etc.)
- Faculty allocations that are directed externally (DA level at least, if not DOD level).

4. This problem affects us every term in different ways (using Dr. Lachance, sending first-time rotators to the chemistry program, sabbaticals, etc.)

5. One option is to reduce the major to a maximum of 20 high-achieving cadets and have faculty be available to teach more than one course per semester -OR- teach one course and gain efficiency in research (and other areas).

Admin Notes for End of Meeting

- Next Advisory Board on-site
  - Early/Late April 2024…close out Class of ‘23
- Travel Paperwork/Receipts
  - DTS Voucher Mrs. Kristen Costain
- Tour of Unit Operations Lab…UTC

UNITED STATES MILITARY ACADEMY
WEST POINT®

Chemical Engineering Program Facts

ABOUT UNITED STATES MILITARY ACADEMY WEST POINT

- Founded in 1802, the first engineering school in the country
- Circa 1840: Applied Chemistry includes "preparation of..propellants & explosives and assembling them into munitions."
- Located on high ground overlooking the Hudson River in West Point,
  NY, 50 miles north of New York City
- 4294 cadet undergraduate students
- All cadets graduate with a Bachelor of Science (B.S.) degree

RESEARCH HIGHLIGHTS

- 22 On-campus Research Centers
- 10 Engineering Focused Research Centers

NOTABLE ALUMNI

- **Ben Barclay, 2016** – Lincoln Fellowship, MIT graduate, M.S. Chemical Engineering
- **Liam Comidy, 2017** – Lincoln Fellowship, MIT graduate, M.S. Chemical Engineering
- **Jesse Palmer, 2019** – Stamps Scholarship, Winston Churchill Scholar, University of Cambridge for MS in Chemical Engineering
- **Kenneth Brinson, 2019** – 4 year starter Football; 4.0; Stanford Medical School, Knight-Hennessey Scholar for MD/PhD Materials Science and Engineering
- **Anchor Losch, 2020** – Fulbright Fellowship, M.A. in Hydrodiplomacy at Tel Aviv University
- **Thomas Alvermann, 2021** - Army Health Professions Scholarship Program, MD at Dartmouth University Medical School
- **Alexa Zammit, 2022** – MIT Lincoln Labs Fellowship and National Science Foundation Fellowship at Massachusetts Institute of Technology
- **Andre Pincot, 2022** – Draper Scholar in Bioengineering at Massachusetts Institute of Technology

ABOUT DEPARTMENT OF CHEMISTRY AND LIFE SCIENCE CHEMICAL ENGINEERING PROGRAM

STUDENT ENROLLMENT

- **98** Undergraduates (AY23)

CHEMICAL ENGINEERING FACULTY

- **COL John Burpo**, Head of Department and Professor U.S. Military Academy
- **COL Corey James**, Deputy Department Head, Professor of U.S. Military Academy
- **Prof. Andrew Biaglow**, Professor of Chemical Engineering
- **Dr. Enoch Nagelli**, Associate Professor and Chemical Engineering Program Director
- **LTC Sam Cowart**, Academy Professor, Deputy Program Director
- **Dr. Simuck Yuk**, Assistant Professor
- **LTC John Belanger**, Assistant Professor
- **MAJ Galen Mandes**, Instructor
- **MAJ Patrick Bowers**, Instructor
- **CPT Sam Lowell**, Instructor
- **CPT Louis Tobergte**, Instructor

PROGRAM HISTORY

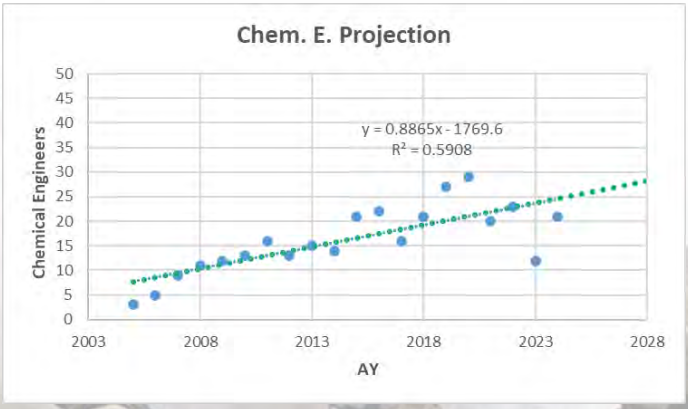
- **Begin 2002**
- **ABET Accredited 2012**
- **14 Research and industry AIADs**
- **Technical Scholarship winners**
- **Medical School**
- **Branch Demographics**
  - **Engineers**
  - **Aviation**
  - **Field Artillery**
  - **Air Defense Artillery**
  - **Infantry**
  - **Military Intelligence**
  - **Armor**

RESEARCH AREAS

- Advanced Materials
- Biochemical Engineering
- Rheology of Biomaterials
- Energy Storage and Conversion
- Complex Fluids
- Nanotechnology
- Process Control and Design
- Separations and Bioseparations
- System Modeling and Optimization
- Chemical Engineering Education
- Multi-Functional Materials

AFFILIATED RESEARCH CENTERS

- Center for Molecular Science (CMS)
- Photonics Research Center



Contact the Chemical Engineering Program:
https://westpoint.edu/academics/academic-departments/chemistry-and-life-science/chemical-engineering

Student Outcomes (new used for AY19 & beyond)

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.

Courses Mapped to Student Outcomes (new used for AY19 & beyond)

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 (XE472 2019 and previous)
CH485	Heat & Mass Transfer
CH459	Chemical Engineering Laboratory
CH402	Chemical Engineering Process Design
CH400	Professional Practice
ME301	Thermodynamics
ME362	Fluid Mechanics
EE301	Fundamentals of Electrical Engineering
MC300	Fundamentals of Engineering Mechanics & Design (Statics & Dynamics)
CH365	Chemical Engineering Thermodynamics
CH383	Organic Chemistry 1

***Not including prerequisites**

Chemical Engineering

United States Military Academy

Example Schedule for Chemical Engineering, Classes of 2024 and Beyond

Fall Term 4th CLASS	Course	Credit Hours	Spring Term	Course	Credit Hours
MA103	Math. Modeling & Intro. Calculus	4.5	MA104	Calculus I	4.5
CH101	General Chemistry I	4.0	CH102	General Chemistry II	4.0
EN101	Composition	3.0	EN102	Literature	3.0
HI101	The Army of the Republic	3.0	HI108	Regional Studies in World History	3.0
CY105	Introduction to Computing & IT	3.0	PL100	General Psychology	3.0
PE11x	Combatives / Boxing / Movement	0.5	MS100	Introduction to Warfighting	1.5
			PE150	Fundamentals/Personal Fitness	1.5
3rd CLASS		Total 18.0			Total 20.5
MA205	Calculus II	4.0	*CH362*	*Mass and Energy Balances*	*3.5*
PH205	Physics I	4.0	*MA364*	*Engineering Mathematics*	*3.0*
Lx203	Foreign Language	4.0	PH206	Physics II	4.0
SS201	Economics	3.0	Lx204	Foreign Language	4.0
PY201	Philosophy	3.0	SS202	American Politics	3.0
MS200	Fundamentals: Army Operations	1.5	EV203	Physical Geography	3.0
			PE 2xx	Lifetime Physical Activity	0.5
2nd CLASS		Total 19.5			Total 21.0
CH363	*Separation Processes*	*3.5*	*CH364*	*Chemical Reaction Engineering*	*3.5*
EE301	*Fundamentals of Electrical Engineering*	*3.5*	*CH367*	*Introduction to Automatic Process Control*	*3.0*
CH383	*Organic Chemistry I*	*3.5*	*ME362*	*Fluid Mechanics*	*3.5*
ME301	*Thermodynamics*	*3.5*	*MC300*	*Fundamentals of Eng. Mech. & Design*	*3.0*
PL300	Military Leadership	3.0	SS307	International Relations	3.0
MA206	Probability and Statistics	3.0	MS300	Platoon Operations	1.5
PE32x	Survival Swimming	0.5	PE360	Combat Applications	1.5
1st CLASS		Total 20.5			Total 19.0
CH459	*Chemical Engineering Laboratory*	*3.5*	*CH402*	*Chemical Engineering Process Design*	*3.5*
CH365	*Chemical Engineering Thermodynamics*	*3.0*	*CH400*	*Chemical Engineering Professional Practice*	*1.5*
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Elective	*Engineering Elective 1*	*3.0*	HI302	History of the Military Art	3.0
Elective	*Engineering Elective 2*	*3.0*	LW403	Constitutional & Military Law	3.0
PE450	Army Fitness Development	1.5	MX400	Officership	3.0

Engineering Elective Tracks

Pre-approved elective sequences,
but ultimately cadet choice (can choose any 3)

Materials Engineering
MC364 Mechanics of Materials
MC380 Engineering Materials
Open Elective

Nuclear Engineering
NE300 Nuclear Reactor Analysis
NE350 Nuclear Reactor Design
NE450 Nuclear Systems Design

Decision Analysis
SE301 Foundations of Engineering Design & Systems Management
SE 481 Systems Simulation
EM484 Dynamic Systems Analysis

Advanced Control Systems
EE360 Digital Computer Logic
EM484 Dynamic Systems Analysis
XE475 Mechatronics

Energy Conversion Systems
EE377 Electrical Power Generation
ME472 Energy Conversion Systems
ME480 Heat Transfer

Power Systems
ME306 Dynamics
ME491 Mechanical Power Plants
EE377 Electrical Power Generation
XE442 Alternative Energy Engineering

Industrial Engineering
SE301 Foundations of Engineering Design & Systems Management
EM411 Project Management
EM420 Production Operations Management

Other Advanced Engineering Electives
Satisfy prerequisites
Engineering Science or design = 3.0 credits
Program director approval

ABET Criteria

- ABET Criteria changed this year, officially
  - Critical change is the reduction of dedicated engineering credit hours from 48.0 to 45.0

- Also, the Student Outcomes, what graduates of programs are expected to be able to do upon graduation, have changed
  - Fundamentally the same, but some consolidation, wording changes, and enhancements that may impact the collection of some assessment data
  - We already leaned forward to include the new SOs in our AY19 assessments, and are currently utilizing during AY20 record year.

ABET Criterion 2: Objectives

The program must have published program educational objectives that are consistent with the mission of the institution, the needs of the program's various constituencies, and these criteria.

There must be a documented, systematically utilized, and effective process, involving program constituencies, for the periodic review of these program educational objectives that ensures they remain consistent with the institutional mission, the program's constituents' needs, and these criteria.

(ABET EAC Criteria)

Program Objectives (Current Redbook)

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

1. Demonstrate effective leadership and chemical engineering expertise.

2. Contribute to the solution of infrastructure and operational problems in a complex operational environment.

3. Succeed in graduate school or advanced study programs.

4. Advance their careers through clear and precise technical communication.

Advisory Board Recommended: October 2012

Assessment Instruments for Objectives

Program Surveys

Program Advisory Board Surveys
Program Faculty Surveys
Program Cadet Surveys

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Chemical Engineering Faculty

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 (Nagelli)	CH364 (Cowart)	CH459 (Nagelli, Yuk)	CH364 (Cowart)	CH459 (Yuk)	CH364 (Cowart)
CH485 (Cowart)	CH402 (Biaglow)	CH485 (Cowart)	CH402 (Biaglow)	CH485 (Cowart)	CH402 (Biaglow)
CH365 (Biaglow)	CH400 (Nagelli)	CH365 (Biaglow)	CH400 (Nagelli)	CH365 (Biaglow)	CH400 (Nagelli)
CH350 (Yuk)	CH367 (James)	CH350 (Yuk)	CH367 (James)	CH350 (Yuk)	CH367 (James)
	CH300 (Parker)		CH300 (Yuk)		CH300 (Carlson)
	CH450 (Yuk)		CH450 (Burpo)	* Nagelli (sabbatical)	CH450 (Yuk)
				Carlson (GC)	
			Nagelli (1 Section GC)	Tobergte (GC)	Nagelli (GC 1 section)
Mandes (GC)	Bowers (GC+CD)	Tobergte (GC)	Belanger (GC)	Rogers (GC)	Rogers (GC)
Bowers (GC+CD)	Lowell (GC+OPSO)	Rogers (GC)	Rogers (GC+CD)	Golonski (GC)	Golonski (GC)
Lowell (GC+OPSO)	Tobergte (GC)	Lowell (GC + OPSO)	Lowell (GC + OPSO)	Frey (GC)	Frey (GC)
Tobergte (GC)	Nagelli (GC 1 section)	Golonksi (GC)	Golonksi (GC)	Glinski (GC)	Glinski (GC)
Yuk (GC)	* Burpo (Sabbatical)	Frey (GC)	Frey (GC)	Stewart (GC)	Stewart (GC)

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

Program Objectives

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

1. Demonstrate effective leadership and chemical engineering expertise.

2. Contribute to the solution of infrastructure and operational problems in a complex operational environment.

3. Succeed in graduate school or advanced study programs.

4. Advance their careers through clear and precise technical communication.

Advisory Board Recommendation + Cadet Approval

Bio-engineering Courses - Milestones

- Select Bioengineering AP ✓
- Select Bioengineering T10 ✓
- QA/QC 3.0 ET credit for CH450 ✓
- Pilot/Teach new courses…CH350 & CH300 ✓
- **Curriculum Proposals for CH300 and CH350** ✓
  - Program internal review complete to address AARS comments ✓
  - COL Burpo & COL James Final Review/Approval before Staffing to all Depts ✓
  - Submit proposals to curriculum committee ✓
- **3.0 ET credit review process for CH300 and CH350** ✓
  - Met with ABET Committee for ET 3.0 for CH300 and CH350 ✓
  - ET credits formally approved ✓
- Get courses in Redbook ✓
- Establish Bioengineering minor
  - Internal review; will push to curriculum committee this semester
- Get Bioengineering sequence approved
- Review for ABET-compatibility

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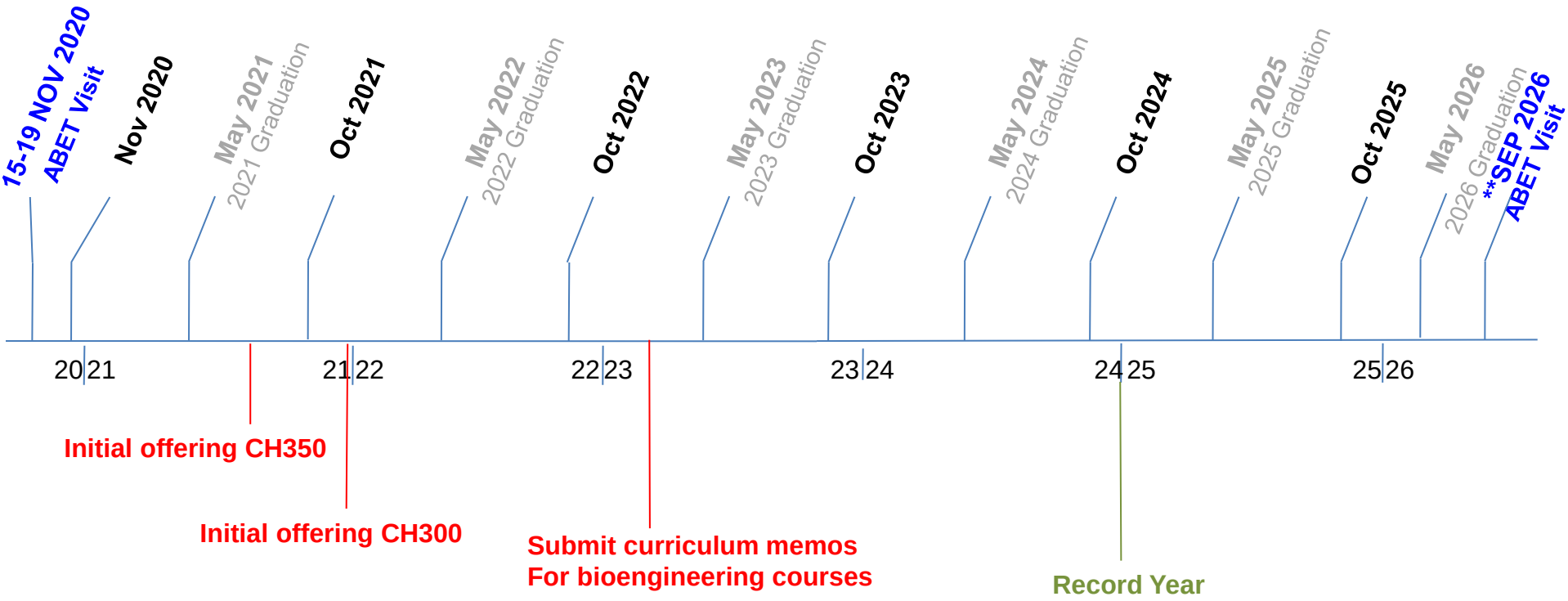
Timeline of Curriculum Updates



Bioengineering Plans

- **Bio-Engineer Title 10 Ph.D. Spring 2020 (Dr. Yuk)**
- **Bioengineer Academy Professor Spring 2021(MAJ Corrigan)**
- **Stand up bioengineering track (1-2 years)**
  - **CH300**
  - **CH350**
- **Bioengineering sequence (2-5 years)**
- **Bioengineering minor/ major (7 – 10 years)**

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Bioengineering Electives

CH300 Biomedical Engineering

- Intro to Biomedical Engr
- Cellular Org & Tissues I-III
- Organ Systems
- Biology by the Numbers
- Time in Biology
- Enzymes & Cell Cycle
- Proteins
- Bacteriophage, E. coli, Yeast
- Cellular Thermodynamics I-II
- Biological Macromolecules
- Genomes & Biotechnology Tools
- Mathematics of Water
- Statistical Biological Dynamics
- Biomedical Sensors I-II
- Biosignal Processing
- Bioelectric Phenomenon I-II
- Biomedical Transport I-II
- Bio-Imaging I-II
- Biomedical Engr Research

CH350 Bioprocess Engineering

- Cells & Biomolecules
- Enzyme Kinetics
- Central Dogma of Biology
- Kinetics
- Metabolic Regulation
- Recombinant DNA
- Protein & Metabolic Engr
- Cell Growth
- Bioreactors
- Recovery & Separation
- Animal & Plant Cells
- Medical Applications
- Industrial Applications

CH450 Bioengineering Modeling, Analysis & Design

- Biomechanics
- Biomaterials
- Tissue Engineering
- Biochemical Enzyme Kinetics & Drug Delivery
- Biochemical Engineering / Synthetic Biology
- Biosensors

UNITED STATES MILITARY ACADEMY
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CH350: Bioprocess Engineering

CH350: Introduction to Bioengineering

Course Director: Dr. Yuk

Course Supervisor: LTC Cowart

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. Capstone Project – need the realistic data for Cadets to process for Bioreactor project.

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**

UNITED STATES MILITARY ACADEMY
WEST POINT

CH300: Intro to Biomedical Engineering

CH300: Introduction to Biomedical Engineering

Course Instructor: 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

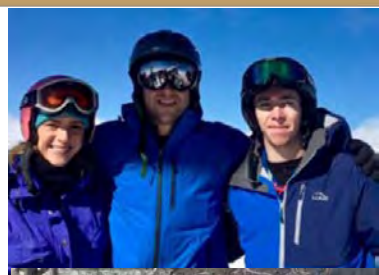
Assessment – Graded Events

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%

UNITED STATES MILITARY ACADEMY
WEST POINT

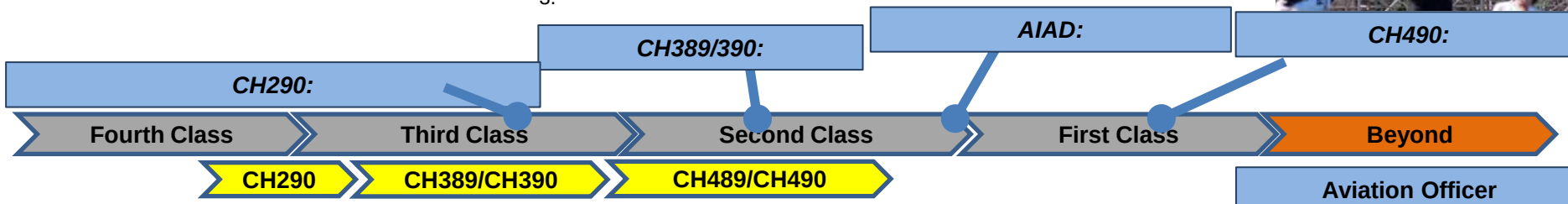
CDT Mark Jaskot, ’21
Chemical Engineering

- **Phi Kappa Phi Honor &Tau Beta Phi Honor Society**
- **Won 1st place undergraduate AIChE Materials Science and Engineering(2019)**
- **Won Physics and Nuclear Engineering Newton’s Principia Award**
- **Dean’s Pentathlete Award**



Co-Authored Conference Proceedings and Publications

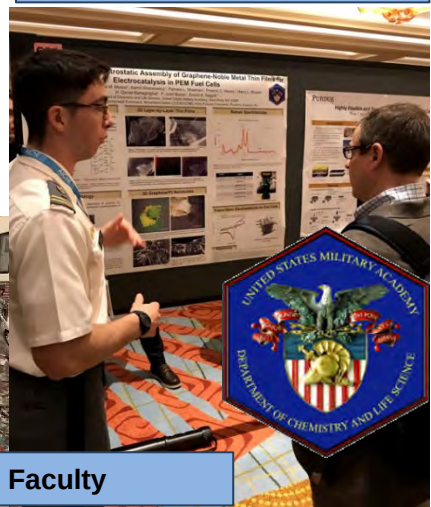
1. Won second place in research paper competition of
2. ACS Mid-Hudson Undergraduate research symposium
3.



Aviation Officer

USMA Independent Research

Cadet Jaskot has been working on a Mark has led a research team since yearling year in creating a new and inexpensive method of synthesizing lightweight catalyst materials for fuel cells. By creating this novel and scalable method of catalyst production, he hopes to drive down the cost and increase the efficiency of fuel cells, making them more realistic for vehicle, home, and grid-level applications. Mark has presented his research at national level conferences and events with the Army Research Laboratories, while also forging a collaborative relationship between his research group and the Department of Energy. The common themes of creativity, learning, and collaboration that exist between his passion for music and research are three qualities that exist in any activity that brings Mark joy.



Future Faculty

UNITED STATES MILITARY ACADEMY
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CDT Matthew Dibiase, ’20
Chemical Engineering

- **Goldwater Scholarship Recipient**
- **Fullbright Scholarship Semifinalist**
- **Phi Kappa Phi Honor &Tau Beta Phi Honor Society**

Co-Authored Conference Proceedings and Publications

1. Army Research Lab (ARL) Technical Symposium “Catalysts for fuel cell electronics”. (Poster)
2. 1st Place Catalysts and Reaction Engineering, Presentation: “Nickel catalysts and graphene for lithium ion batteries”. American Institute of Chemical Engineering Annual Meeting, Orlando, FL, 10-15 NOV19.
2. Manuscript in progress, “Electroless deposition of Noble Metal Nanoparticles onto Silk Fibroin Films”, (*to be submitted, Spring 2020)*

CH290: Modeling; Rheology of Blood
CH389/390: Fuel Cell Polymers
AIAD: ARL, Nickel Based Catalysts
CH490: Functionalized Graphene

Fourth Class → **Third Class** → **Second Class** → **First Class** → **Beyond**

CH290 | **CH389/CH390** | **CH489/CH490**

Future Signal Officer

<u>USMA Independent Research</u>

Cadet Dibiase has been working on a Proton Exchange Membrane (PEM) Fuel Cell project; a field of great interest for their efficiency advantages over combustion technology. However, conventional methods of electrolysis to produce H_2 and O_2 gas necessary for PEM fuel cells rely on expensive catalysts, Pt and IrO_2. Despite exceptional efficiency of these catalysts, their high costs prevent industry scale up and production. We present alternative Ni-based catalysts to replace Pt and IrO2. Of the Ni catalysts characterized, NiS and NiFe LDH together provided the smallest total overpotentials of 1.7 V (vs SHE) for Hydrogen Evolution Reactions (HER) and Oxygen Evolution reactions (OER), respectively. However, Linear Sweep Voltammetry illustrated that NiFe LDH had the lowest overpotential of the two, contributing only 0.3 V to the total overpotential. Nevertheless, the total overpotential of 1.7 V is still only 0.2 V above the industry standard of 1.5 V from a combination of Pt and IrO_2.

Future Faculty

UNITED STATES MILITARY ACADEMY
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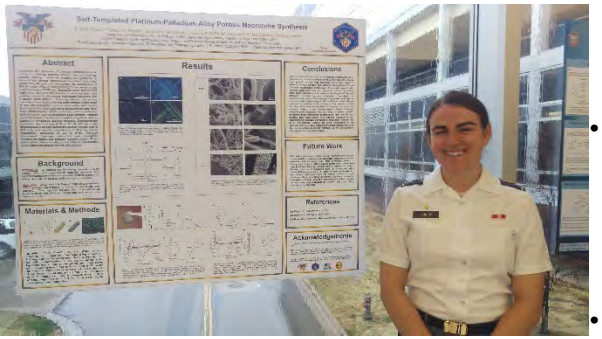
CDT Anchor Losch, ’20
Chemical Engineering



- **Fullbright Scholarship Semifinalist**
- **Anna Sobol Levy Scholarship**
- **Rotary Scholarship – Semifinalist**
- **Tau Beta Phi Honor Society**

Co-Authored Conference Proceedings and Publications

- F. John Burpo*, **Anchor R. Losch**, Enoch A. Nagelli, Stephen J. Winter, Stephen F. Bartolucci, Joshua P. McClure, David R. Baker, Jack Bui, Alvin R. Burns, Sean F. O’Brien, Brittany Aikin, Kelsey Healy, Alexander N. Mitropoulos, J. Kenneth Wickiser, Greg Forcherio, and Deryn D. Chu “Salt-Templated Synthesis Method fo Porous Noble Metal Platinum-based Macrobeams and Macrotubes.” *J. Vis Exp*. (Invited Paper)
- Burpo, F., Nagelli, E., **Losch, A.**, Bui, J., Forcherio, G., Baker, D., McClure, P., Bartolucci, S., Chu, D. “Salt-templated Cu-Pt Alloy Macrobeams for Ethanol Oxidation.” *Catalysts*, 2019, 9(8), 662.
- Burpo, F., Nagelli, E., Bartolucci, S., Mitropoulos, A., McClure, J., Baker, D., **Losch, A.**, Chu, D. “Salt-Templated Platinum-Palladium Porous Macrobeam Synthesis.” *MRS Communications*, 2019, 9(1), 280-287.

CH289/CH290: Multi-Functional Materials

CH489: Multi-Functional Materials

Fourth Class → **Third Class** → **Second Class** → **First Class** → **Beyond**

CH290 → **CH389/CH390** → **CH489/CH490** → **Future Engineer Officer**

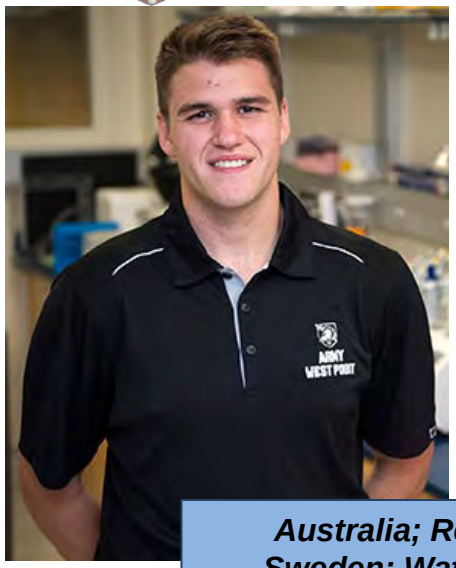
USMA Independent Research and Activities

Cadet Losch researches in the Multi-Functional Materials Laboratory. She has completed synthesis work on Salt-Templated Platinum-Palladium and Copper-Platinum Alloy Porous Macrotubes, and presented at the Inter-Academy Chemistry Symposium and Projects Day. Outside of class and research, Anchor is a conductor in the Cadet Spirit Band, and President of the Model Arab League and American Institute of Chemical Engineers. As a part of the Peace and Dialogue Leadership Initiative, she has traveled to Israel and Palestinian territories to participate in a nuanced conversation about the US role in the Middle East, with a focus on Israeli-Palestinian relations, society, and culture. She studied Arabic abroad in Morocco, where she taught English at a local NGO. She travelled to Qatar with the National Council on U.S-Arab Relations on a cultural exchange program between U.S. and Qatari servicemembers. She also has completed service work in Viet Nam, Mongolia, Papua New Guinea, and the Galapagos Islands.

Future Faculty

UNITED STATES MILITARY ACADEMY
WEST POINT

CDT Jesse Palmer, ’19
Chemical Engineering



- **Won Stamps Scholarship**
- **Won Goldwater Scholarship**
- **Tau Beta Pi Honor Society**
- **Phi Kappa Phi Honor Society**
- **Phi Sigma Iota Society**
- **Won Churchill Scholarship**

Co-Authored Publications

1. Cellulose Nanofiber Biotemplated Palladium Composite Aerogels. *Molecules,* 23(6)
2. Gelatin biotemplated platinum aerogels. *MRS Advances*, 1-6.
3. A Rapid Synthesis Method for Au, Pd, Aerogels Via direct Solution-Based Reduction. *Journal of visualized experiments: JoVE*, (136).
4. Direct solution-based reduction synthesis of Au, Pd, and Pt Aerogels. *Journal of Materials Research*, 32(22).

Australia; Renewable Energy Lab
Sweden: Water NEXUS conference

Harvard AIAD; Disease biophysics groups

Fourth Class | **Third Class** | **Second Class** | **First Class** | **Beyond**

CH290 | **CH389/CH390** | **CH489/CH490**

USMA Independent Research

Jesse has collaborated with the Army Research Labs (ARL) in Adelphi, MD to produce biosensors and has developed novel Kevlar-cellulose composites with Harvard’s Disease Biophysics group. As a recipient of Goldwater and Stamps Scholarships Jesse has used his academic funding to attend World Water Week in Stockholm, Sweden and visit the University of New South Wales in Sydney, Australia to pursue his interest in water desalination. Jesse is also completing a minor in Eurasian Studies. He plans on attending graduate school to develop batteries to enhance prosthetic limbs serving wounded veterans.

Field Artillery Officer

Future Faculty

Alumni Highlight: 2LT Ellie Milanesa

-**Class of 2020, Chemical Engineer**
-**GPA:** 3.87
-**Branch:** Armor
-AIAD at Sandia National Lab
-Distinguished Cadet Award recipient
-Sandhurst Team
-**Research:** Development of materials to be used for batteries and hydrogen fuel cells. Familiarity with material synthesis as well as scanning electron microscopy (SEM), preparing electrodes, and running cyclic voltammetry and charge, discharge testing.

Academic Excellence

The Princeton Review

#1 Most Accessible Professors

#2 Best College Library

U.S.News & WORLD REPORT

#2 Top Public Schools (Liberal Arts)

#3 Best Undergrad Engineering Program

#4 Civil Engineering Program

#7 Mechanical Engineering Program

#19 National Liberal Arts College

Forbes.com

#1 Public College in the country

#6 Liberal Arts Universities

#11 In the Northeast

#14 Overall College in the country

Strategic Influence

Governmental Strategic Guidance
- President
- Congress
- Department of Defense
- Government Agencies
  (e.g., NSA, FBI, CIA, …)

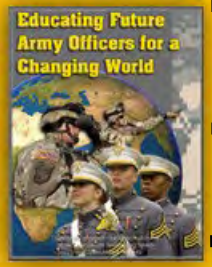
Department of the Army
- Army Goals and Priorities
- Army Regulations
- Army Doctrine

Higher Education Communities
- Professional Societies
- Accreditation Agencies
- Best Practices
- Peer Institutions

West Point Mission and Strategic Plan

Academic Program Vision and Strategic Plan

Academic Program Goals



- Core Courses
- Academic Majors
- Enrichment Experiences

PROGRAM ASSESSMENT DATA AY2023

UNITED STATES MILITARY ACADEMY
DEPARTMENT OF CHEMISTRY AND LIFE SCIENCE
CHEMICAL ENGINEERING PROGRAM
August 28, 2023

Note: When complete, the results are summarized in the "Evaluations" section. The evaluation section is a working draft as of 28 August 2023. Faculty data will be added when complete. Advisory board assessment is not available until spring 2024 after the advisory board meeting.

Working Draft – Last updated on 28 August 2023

- Transcript analysis added 24 May 2023.
- End-of-Semester Student Surveys added 12 June 2023.
- Chemical & Mech. Eng. Coursework Embedded Indicators added 5 July 2023.
- Course grades in CH402 and CH459 added on 25 May 2023.
- FEE data added 11 July 2023.
- Advisory Board data to be added April 2024 on completion of the board meeting.
- Lifelong learning skills rubric for Outcome 7 were added on 25 May 2023.
- Program exit survey added 23 May 2023.
- Contemporary issues added on 25 May 2023.
- Teamwork Skills Rubric (Peers) from CH459 added on 23 August 2023.
- Faculty Survey data was added on 28 August 2023.

Level of Achievement of Student Outcome 1:

On completion of the chemical engineering program, our graduates will be able to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

Assessment Instruments and Frequency:

1. Chemical & Mechanical Engineering Coursework Embedded Indicators, once/yr.
2. Fundamentals of Engineering Examination, once/yr.
3. End-of-Semester Student Surveys, once/semester.
4. Chemical Engineering Program Exit Survey, once/yr.

Assessment Results:

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

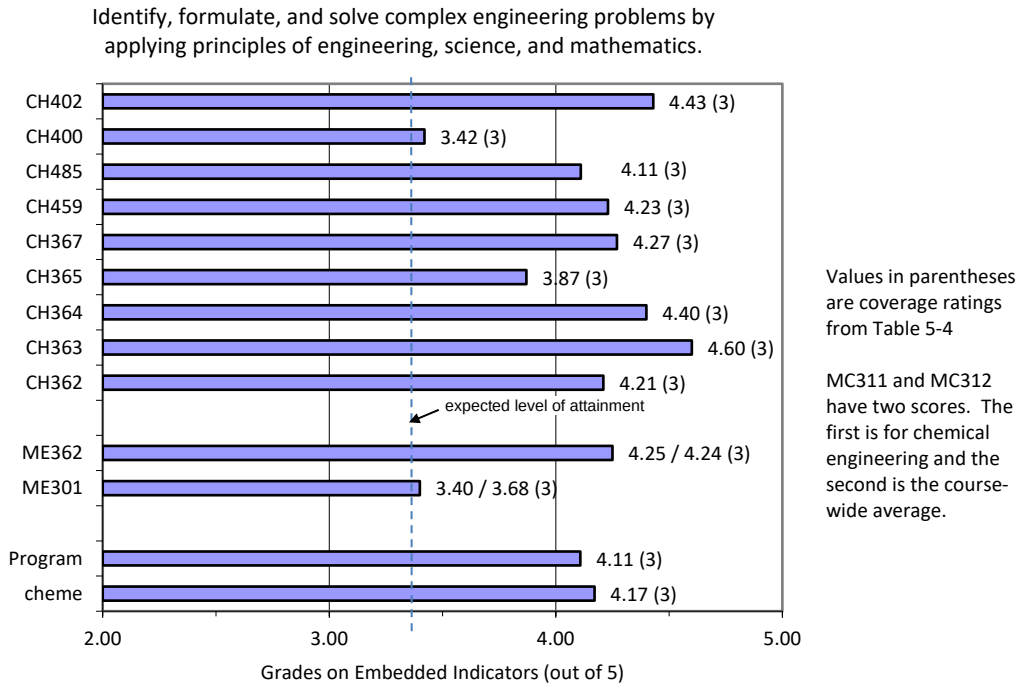


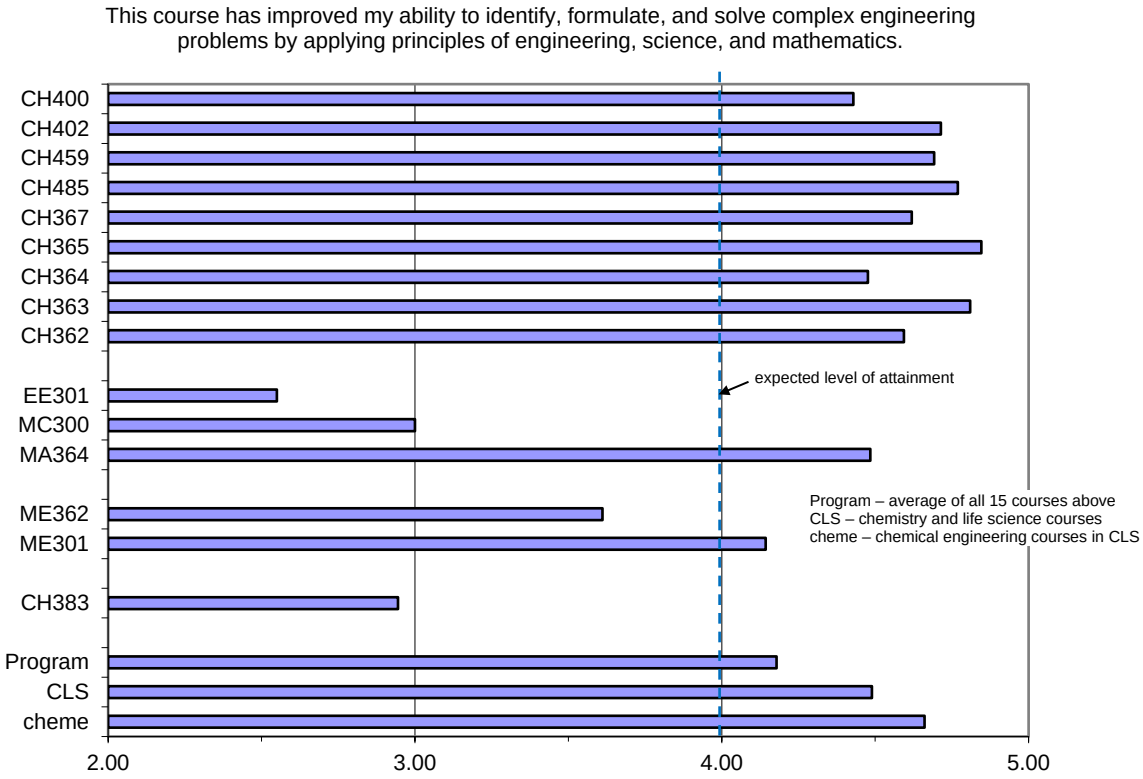
Figure 1-1. Coursework Embedded Indicator results for Student Outcome 1.

2. Fundamentals of Engineering Examination (FEE). According to the 2023 report from NCEES, 8 out of 14 cadets in the Class of 2023 took and passed the Fem exam. After one separation and two successful re-takes, our program is at 10 out of 13, or 76.9%. The national average passing in 2023 was 70.2%, and this is our expected level of attainment. In the previous five years, the pass rates were 91.3% in 2022, 85.0% in 2021, 77.8% in 2020, 100% in 2019, and 85.7% in 2018. Our running average over those previous five years is 88.0% ± 8.3% (versus 74.4% ± 2.2% for the national average).

Note: We are **above** the national average for the pass rate for the past six years even including the one separated cadet, and we assess our program against the national average, which is our expected level of attainment.

3. End of Semester Student Surveys

Figure 1-2. End-of-Semester Student Survey responses for Student Outcome 1.



4. Chemical Engineering Program Exit Survey. This survey is issued to Firsties at the end of their last semester. In this question, they were asked whether they agree with the statement "The program has prepared me to Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics." 14 out of 14 cadets completed the survey (one cadet was later separated, so there were 13 graduates). Of the 14 cadets, 13 said that they strongly agreed (score = 5/5), with one cadet replying that they were neutral (score = 3/5). This equates to a mean score of 4.88/5.00 ± 0.54 for the 14 cadets participating in the survey. The expected level of attainment on this survey is 4.00/5.00.

Level of Achievement of Student Outcome 2:

On completion of the chemical engineering program, our graduates will be able to 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.

Assessment Instruments and Frequency:

1. Chemical & Mechanical Engineering Coursework Embedded Indicators, once/yr.
2. End of Semester Student Surveys, once/semester.
3. Course Grades in CH402 Chemical Engineering Process Design, once/yr.
4. Chemical Engineering Program Exit Survey, once/yr.

Assessment Results:

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

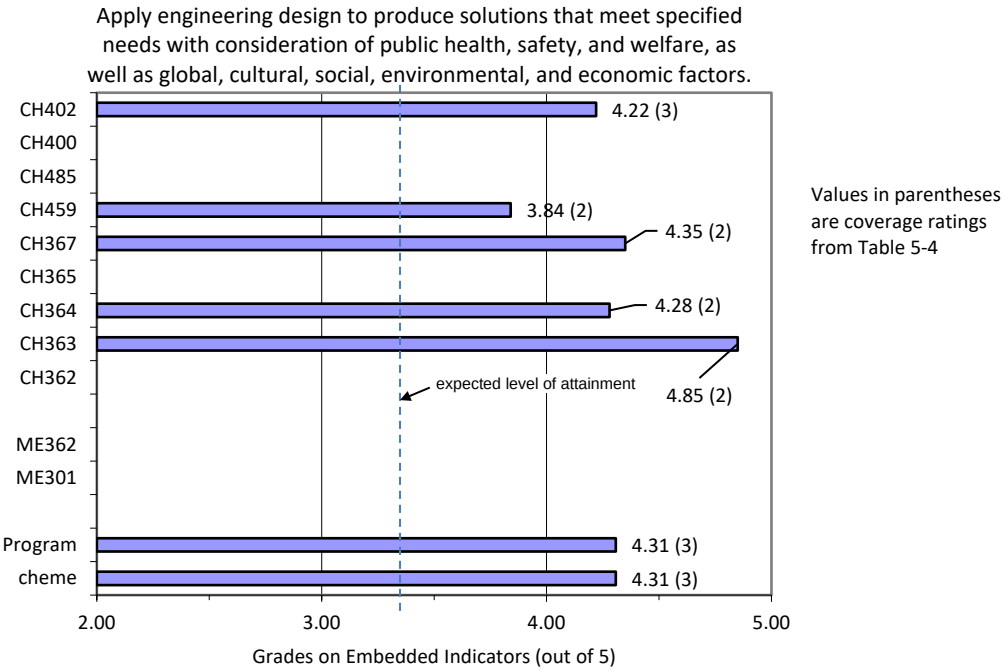


Figure 2-1. Coursework Embedded Indicator results for Student Outcome 2.

2. End of Semester Student Surveys

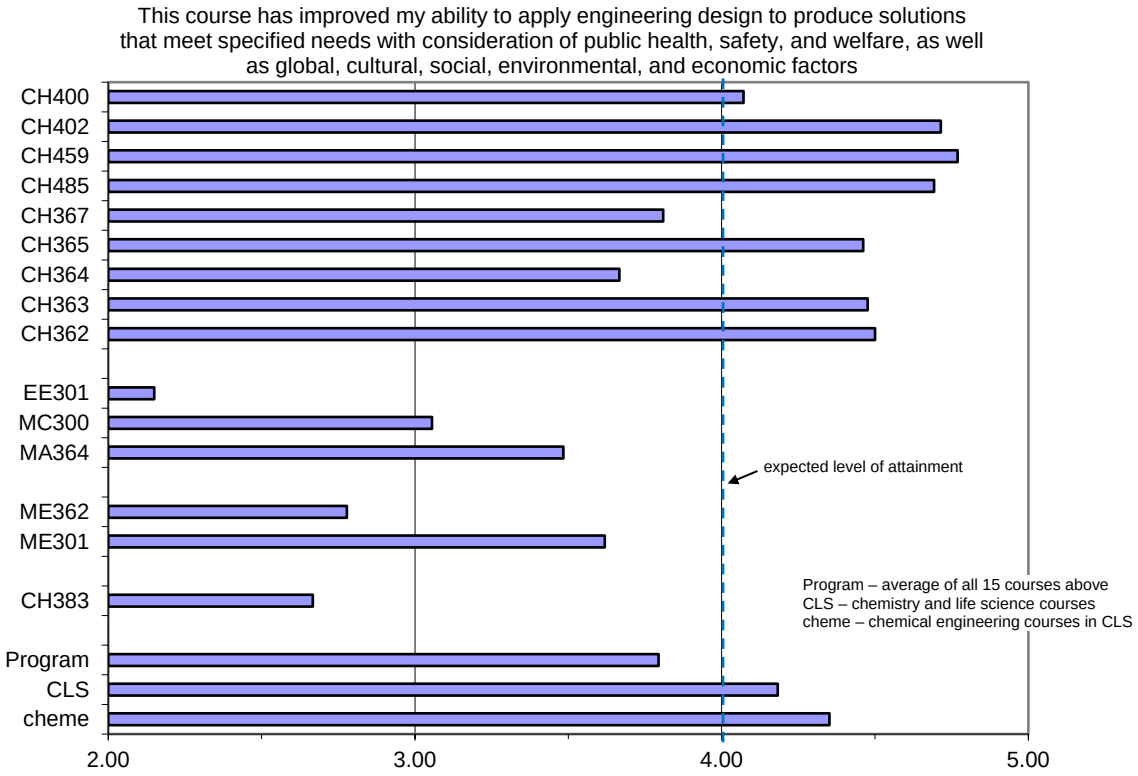


Figure 2-2. End-of-Semester Student Survey responses for Student Outcome 2.

3. The average course grade in CH402 Chemical Engineering Process Design was 3.44±0.55 (n=13) in AY23, compared to 3.33±0.50 (n=23) in AY22, 3.46±0.68 (n=20) in AY21, 3.26±0.70 (n=29) in AY20, 3.27±0.92 (n=21) in AY19, and 3.37±0.66 (n=19) in AY18. The 5-year running average for the previous five years is 3.34, and this is our expected level of attainment. This year's score was *above* the 5-year running average.

4. Chemical Engineering Program Exit Survey. As stated earlier, this survey is given to Firsties at the end of their last semester. In this question, they were asked whether or not they agree with the statement "The program has prepared me to 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." 14 out of 14 cadets completed the survey (one cadet was later separated, so there were 13 graduates). Of these, 13 out of 14 cadets said that they either agreed or strongly agreed (score = 5/5 or 4/5), with 9/14 replying that they strongly agreed (score = 5/5), 4/14 replying that they agreed (score = 4/5), and 1/14 that they were neutral (score = 3/5). This equates to a mean score of 4.57/5.00 ± 0.65 for the 14 cadets. The expected level of attainment on this survey is 4.00/5.00.

Level of Achievement of Student Outcome 3:

On completion of the chemical engineering program, our graduates will be able to communicate effectively with a range of audiences.

Assessment Instruments and Frequency:

1. Chemical & Mechanical Engineering Coursework Embedded Indicators, once/yr.
2. End of Semester Student Surveys, once/semester.
3. Course Grades in CH459 Unit Operations Laboratory, once/yr.
4. Chemical Engineering Program Exit Survey, once/yr.

Assessment Results:

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

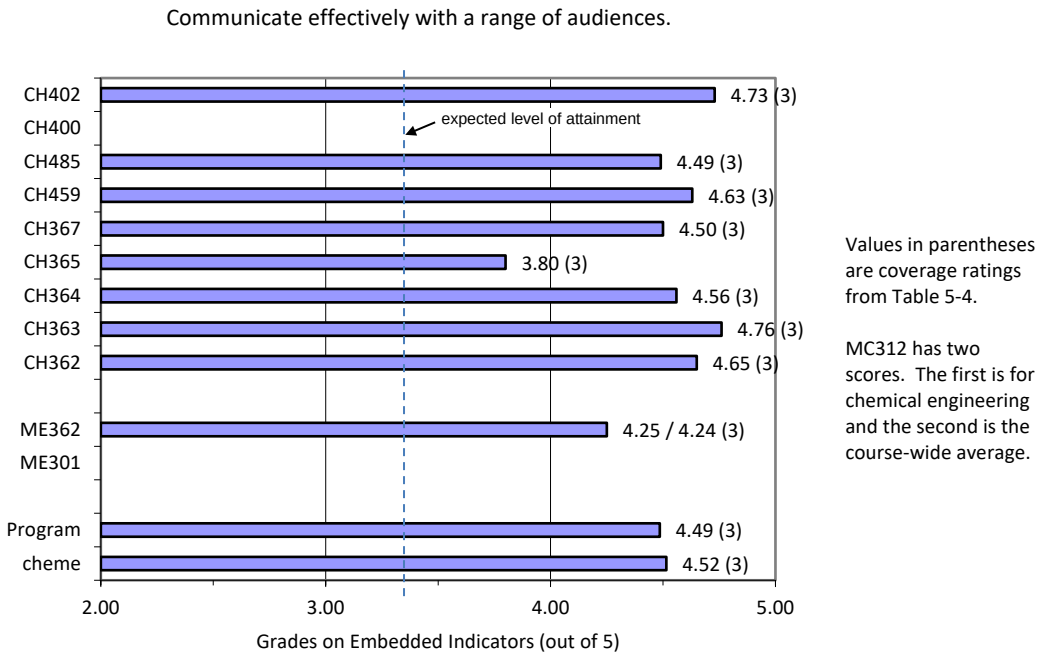


Figure 3-1. Coursework Embedded Indicator results for Student Outcome 3.

2. End of Semester Student Surveys

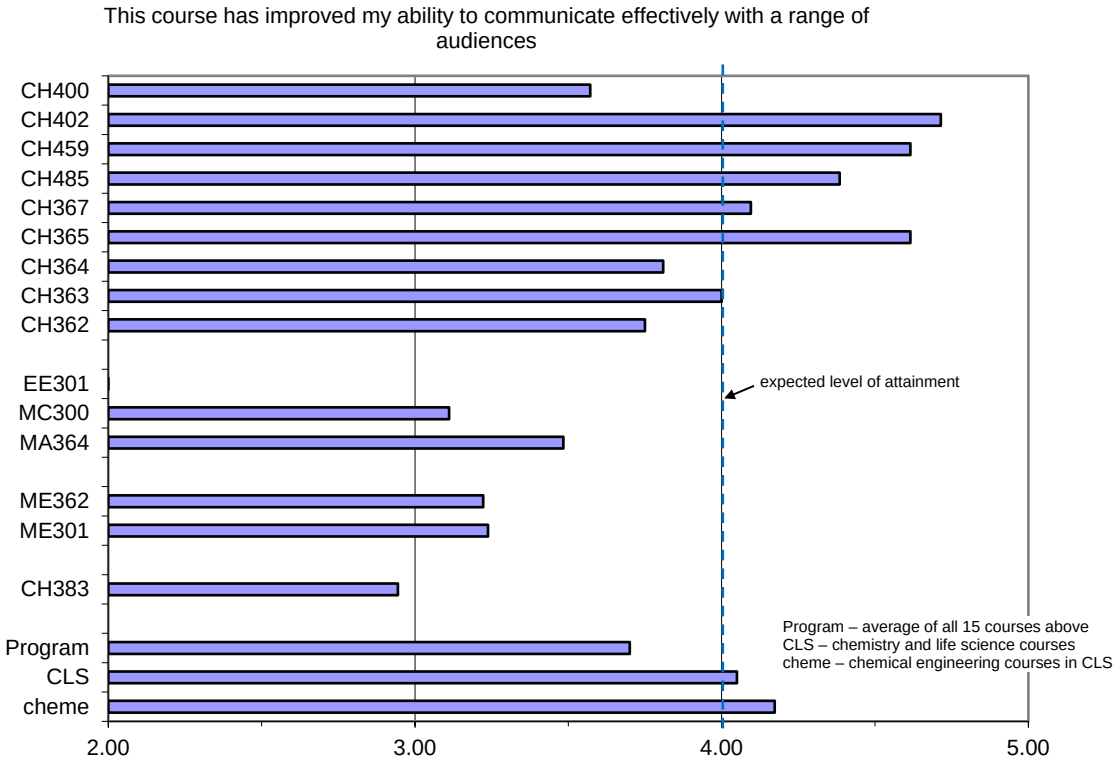


Figure 3-2. End-of-Semester Student Survey responses for Student Outcome 3.

3. The average course grade in CH459 Chemical Engineering Laboratory was 3.41±0.53 (n=13) in AY23, compared to 3.80±0.50 (n=23) in AY22, 3.67±0.75 (n=20) in AY21, 3.53±0.48 (n=29) in AY20, 3.52±0.44 (n=21) in AY19, and 3.42±0.64 (n=19) in AY18. The 5-year running average is 3.59, and this is our expected level of attainment. This year's score was slightly below the 5-year running average but *well within the standard deviation.*

4. Chemical Engineering Program Exit Survey. As stated earlier, this survey is given to Firsties at the end of their last semester. In this question, they were asked whether they agree with the statement "The program has prepared me to communicate effectively with a range of audiences." 14 out of 14 cadets completed the survey (one cadet was later separated, so there were 13 graduates). Of these, 14 out of 14 cadets said that they either agreed or strongly agreed (score = 5/5 or 4/5), with 10/14 replying that they strongly agreed (score = 5/5), and 4/14 replying that they agreed (score = 4/5). This equates to a mean score of 4.71/5.00 ± 0.47 for the 14 cadets. The expected level of attainment on this survey is 4.00/5.00.

Level of Achievement of Student Outcome 4:

On completion of the chemical engineering program, our graduates will be able to 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.

Assessment Instruments and Frequency:

1. Chemical & Mechanical Engineering Coursework Embedded Indicators, once/yr.
2. Fundamentals of Engineering Examination Performance Index, once/yr.
3. End of Semester Student Surveys, once/semester.
4. Chemical Engineering Program Exit Survey, once/yr.
5. Completion of Cadet Character Education Program, once/yr.

Assessment Results:

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

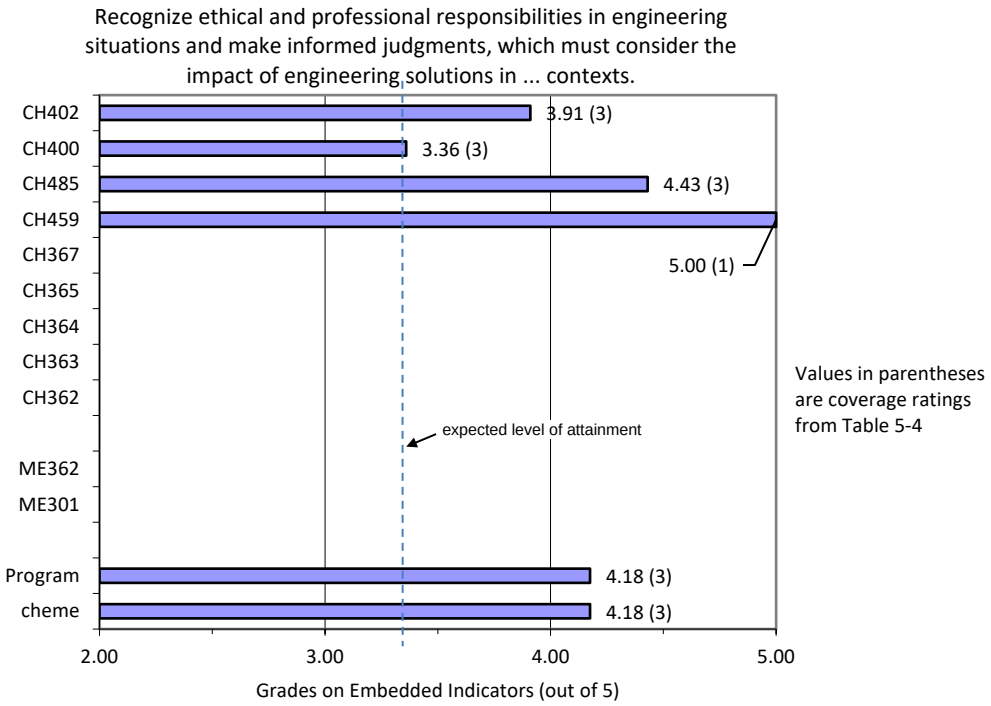


Figure 4-1. Coursework Embedded Indicator results for Student Outcome 4.

2. Fundamentals of Engineering Examination Performance, Self-Study Table 4-2.

Subject	**Outcome**	**Questions**	**USMA**	**National** (Expected level of attainment)
Ethics and Professional Practice	4	3	12.9	11.1 ± 4.4
Economics	4	4	7.6	9.7 ± 3.4

Note: the national average is our expected level of attainment, and we are within the standard deviation reported by NCEES.

3. End of Semester Student Surveys

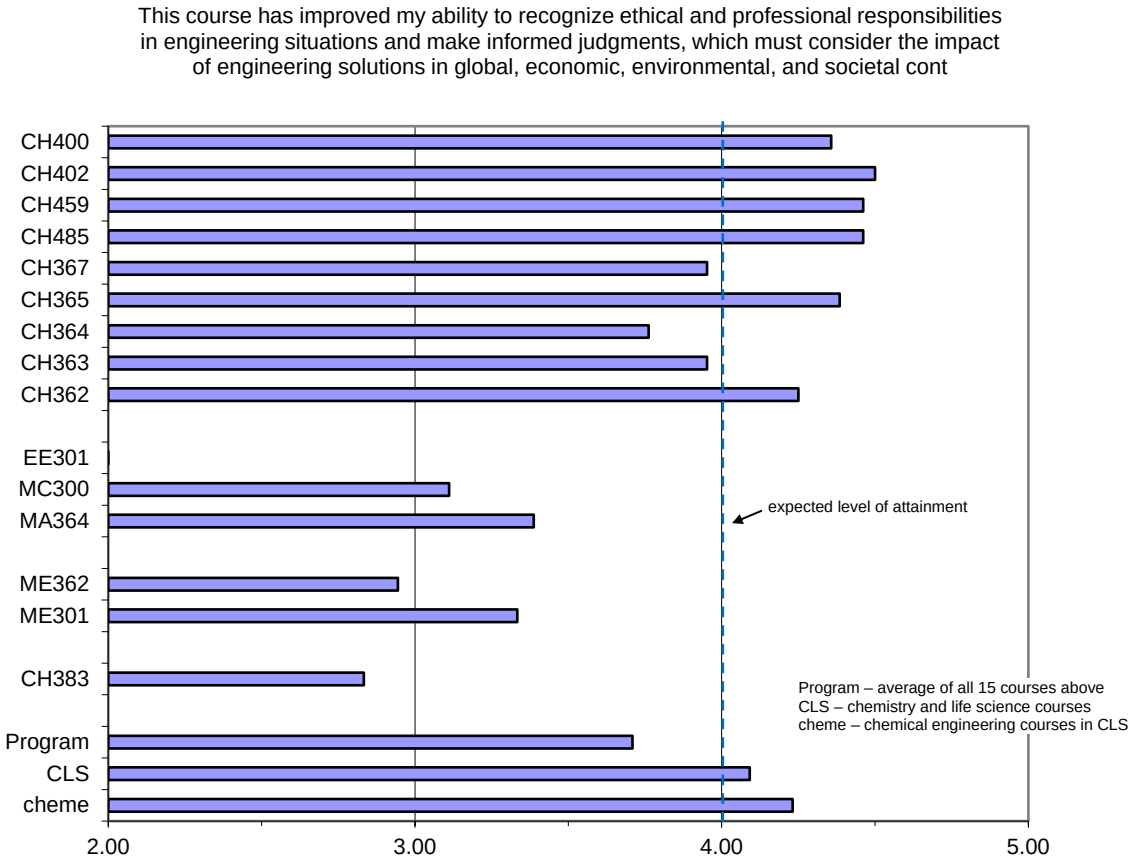


Figure 4-2. End-of-Semester Student Survey responses for Student Outcome 4.

4. Chemical Engineering Program Exit Survey. This survey is given to the Firsties at the end of their last semester. Cadets were asked to respond to the statement "The program has prepared me to 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." 14 out of 14 cadets completed the survey (one cadet was later separated, so there were 13 graduates). Of these, 13 out of 14 cadets said that they either agreed or strongly agreed (score = 5/5 or 4/5), with 6/14 replying that they strongly agreed (score = 5/5), 7/14 replying that they agreed (score = 4/5), and 1/14 replying that they were neutral (score = 3/5). This equates to a mean score of 4.36/5.00 ± 0.63 for the 14 cadets. The expected level of attainment is 4.00/5.00.

5. Training in honor and ethics takes place in the Cadet Character Education Program (CCEP) during the academic year and summer terms. The program is overseen by the Commandant of Cadets through the Simon Center for the Professional Military Ethic. CCEP customizes instruction to each of the four year-groups of cadets, who interact with faculty volunteers who share their perspectives and experience in the Armed Forces, with industry, and at other civilian institutions. All 23 chemical engineering cadets successfully completed the 4-year CCEP program.

Level of Achievement of Student Outcome 5:

On completion of the chemical engineering program, our graduates will be able to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

Assessment Instruments and Frequency:

1. Chemical & Mechanical Engineering Coursework Embedded Indicators, once/yr.
2. End of Semester Student Surveys, once/semester.
3. Chemical Engineering Program Exit Survey, once/yr.
4. Multidisciplinary Skills Rubric, once/yr.

Assessment Results:

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

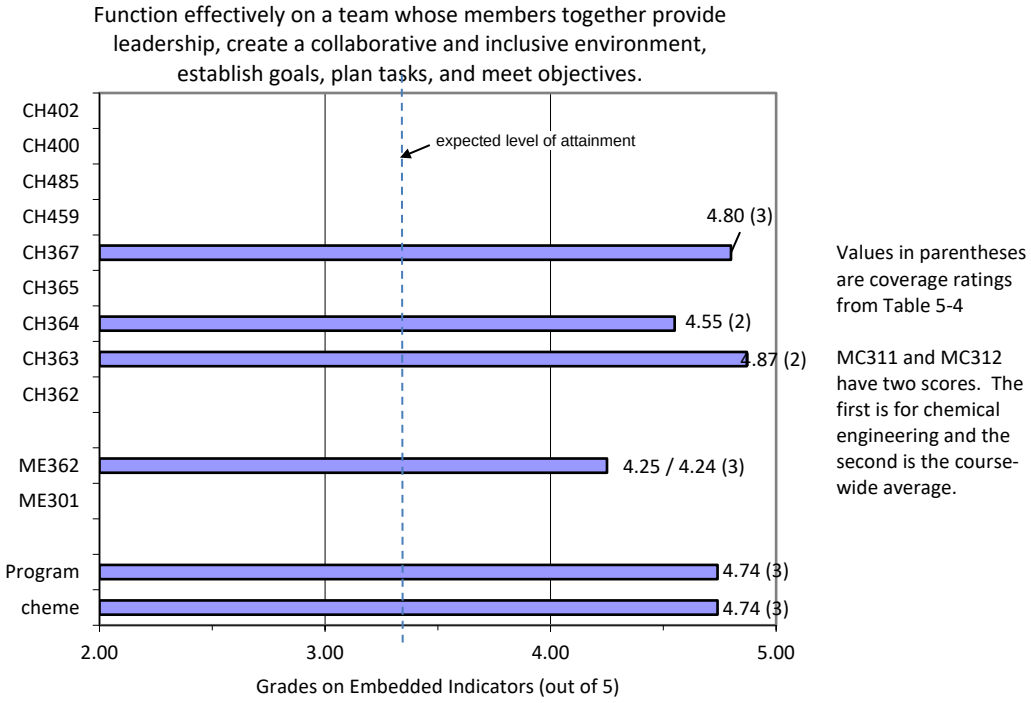


Figure 5-1. Coursework Embedded Indicator results for Student Outcome 5.

2. End of Semester Student Surveys

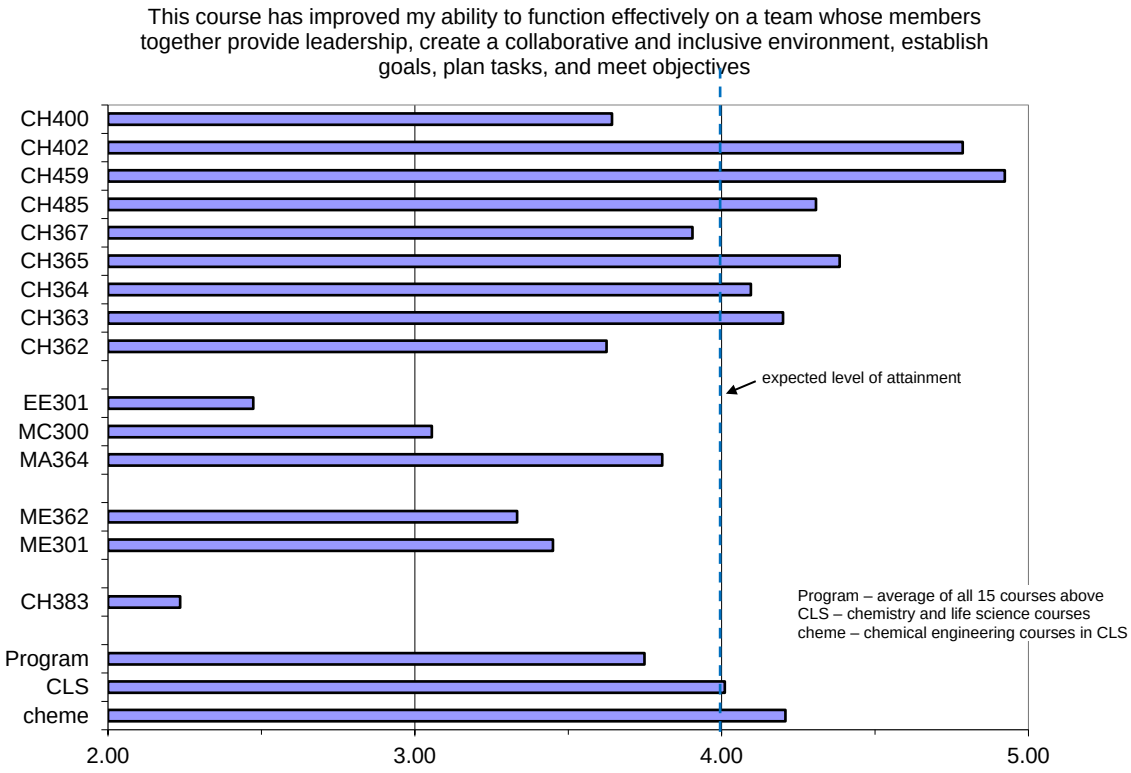


Figure 5-2. End-of-Semester Student Survey responses for Student Outcome 5.

3. Chemical Engineering Program Exit Survey. As stated earlier, this survey is given to the Firsties at the end of their last semester. In this question, they were asked whether or not they agree with the statement "The program has prepared me to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives." 14 out of 14 cadets completed the survey (one cadet was later separated, so there were 13 graduates). Of these, 13 out of 14 cadets said that they either agreed or strongly agreed (score = 5/5 or 4/5), with 10/14 replying that they strongly agreed (score = 5/5), 3/14 replying that they agreed (score = 4/5), and 1/14 replying that they were neutral (score = 3/5). This equates to a mean score of $4.64/5.00 \pm 0.63$ for the 14 cadets. The expected level of attainment on this survey is 4.00/5.00.

4. Teamwork Skills Rubric. The rubric is used to assess performance in four skills associated with the ability to function on effectively on a team, namely technical competence, communication, organization, and teamwork. The rubrics are completed by the cadets after each laboratory exercise in CH459. The results were averaged over each round-robin and reported below using the actual rubric for formatting. The superscript "a" next to the averages are for team assessment of the group leader (TAL) and "b" designates group leader assessment of the team

(GLAT). The expected level of attainment is 4.0. The color shading indicates the relationship of the averages to the expected level of attainment. Red shading indicates when improvement is needed.

Your Name: Dr. Enoch Nagelli				Person Assessed: **Cadets in CH459**					
Your Position: CH459 CD				Major of Person Assessed: **Chemical Engineering**					
	1 – Needs Improvement	1	2	3 – Meets Expectations	3	4	5 – Exceeds Expectations	5	N/A
Technical Competence	**Some misunderstandings of the technical content.**			Demonstrated knowledge of the technical content.			Exceptional knowledge of technical content.	**4.7[a] ±.17[c]** **4.6[b] ±.21[c]**	
Communication	**Lacked sensitivity and/or did not provide specific suggestions for improvement.**			Effectively communicated important points.			Exceptional ability to explain important points. Very effectively communicated ideas for improvement.	**4.6[a] ±.12[c]** **4.6[b] ±.32[c]**	
Organization	**Was not prepared or did not give sufficient time to prepare.**			Demonstrated effective organization during class.			Was exceptionally efficient, timely and responsive throughout the entire process.	**4.6[a] ±.09[c]** **4.6[b] ±.3[c]**	
Teamwork	**Demonstrated limited ability to see other perspectives or find common ground.**			Worked collaboratively with team members to reach consensus.			Exceptional ability to help group find common ground or resolve conflict in order to ultimately reach consensus.	**4.6[a] ±.09[c]** **4.5[b] ±.19[c]**	
Are the cadets capable of functioning on multidisciplinary teams? **Yes**	**Comments: Each cadet was group leader twice. Footnote "a" designates the average of all Team Assessments of Leader (TAL) scores, while "b" designates average of all Group Leader Assessment (GLAT) scores. Footnote "c" designates standard deviations.**						Assignment used for assessment: **AY23, Round Robin 1**		

Your Name: Dr. Enoch Nagelli				Person Assessed: **Cadets in CH459**					
Your Position: CH459 CD				Major of Person Assessed: **Chemical Engineering**					
	1 – Needs Improvement	1	2	3 – Meets Expectations	3	4	5 – Exceeds Expectations	5	N/A
Technical Competence	**Some misunderstandings of the technical content.**			Demonstrated knowledge of the technical content.			Exceptional knowledge of technical content.	**4.9[a] ±.02[c]** **5.0[b] ±0.0[c]**	
Communication	**Lacked sensitivity and/or did not provide specific suggestions for improvement.**			Effectively communicated important points.			Exceptional ability to explain important points. Very effectively communicated ideas for improvement.	**4.9[a] ±.05[c]** **5.0[b] ±0.0[c]**	
Organization	**Was not prepared or did not give sufficient time to prepare.**			Demonstrated effective organization during class.			Was exceptionally efficient, timely and responsive throughout the entire process.	**4.9[a] ±.02[c]** **5.0[b] ±0.0[c]**	
Teamwork	**Demonstrated limited ability to see other perspectives or find common ground.**			Worked collaboratively with team members to reach consensus.			Exceptional ability to help group find common ground or resolve conflict in order to ultimately reach consensus.	**4.9[a] ±.05[c]** **5.0[b] ±0.0[c]**	
Are the cadets capable of functioning on multidisciplinary teams? **Yes**	**Comments: Each cadet was group leader twice. Footnote "a" designates the average of all Team Assessments of Leader (TAL) scores, while "b" designates average of all Group Leader Assessment (GLAT) scores. Footnote "c" designates standard deviations.**						Assignment used for assessment: **AY22, Round Robin 2**		

Level of Achievement of Student Outcome 6:

On completion of the chemical engineering program, our graduates will be able to develop and conduct appropriate experimentation, analyze, and interpret data, and use engineering judgment to draw conclusions.

Assessment Instruments and Frequency:

1. Chemical & Mechanical Engineering Coursework Embedded Indicators, once/yr.
2. End-of-Semester Student Surveys, once/semester.
3. Chemical Engineering Program Exit Survey, once/yr.
4. Course Grades in CH459 Unit Operations Laboratory, once/yr.

Assessment Results:

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

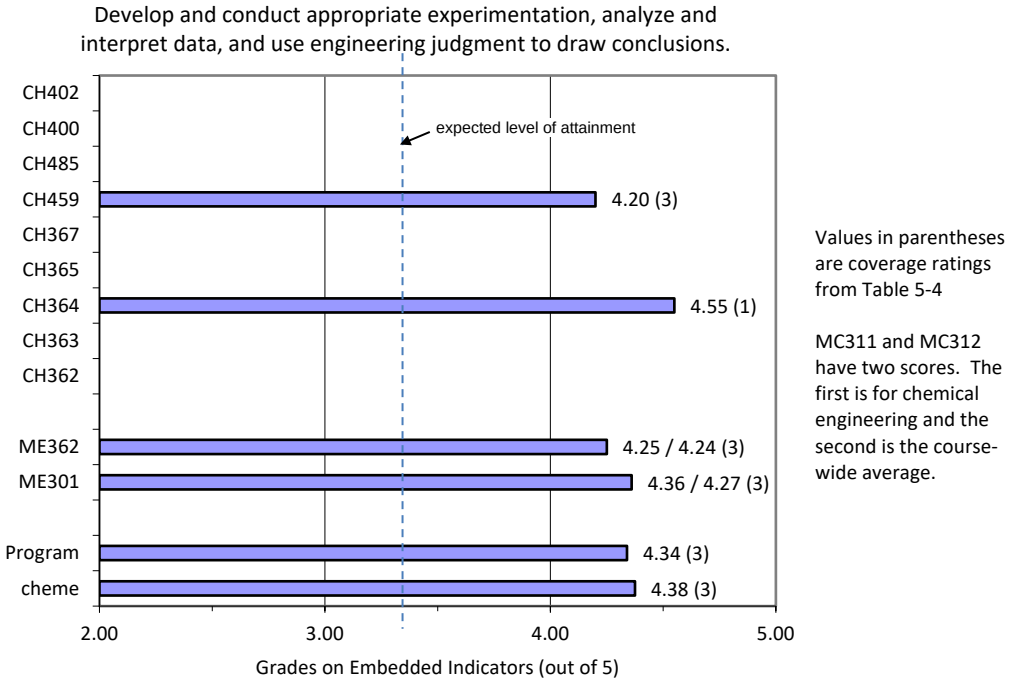


Figure 6-1. Coursework Embedded Indicator results for Student Outcome 6.

2. End of Semester Student Surveys

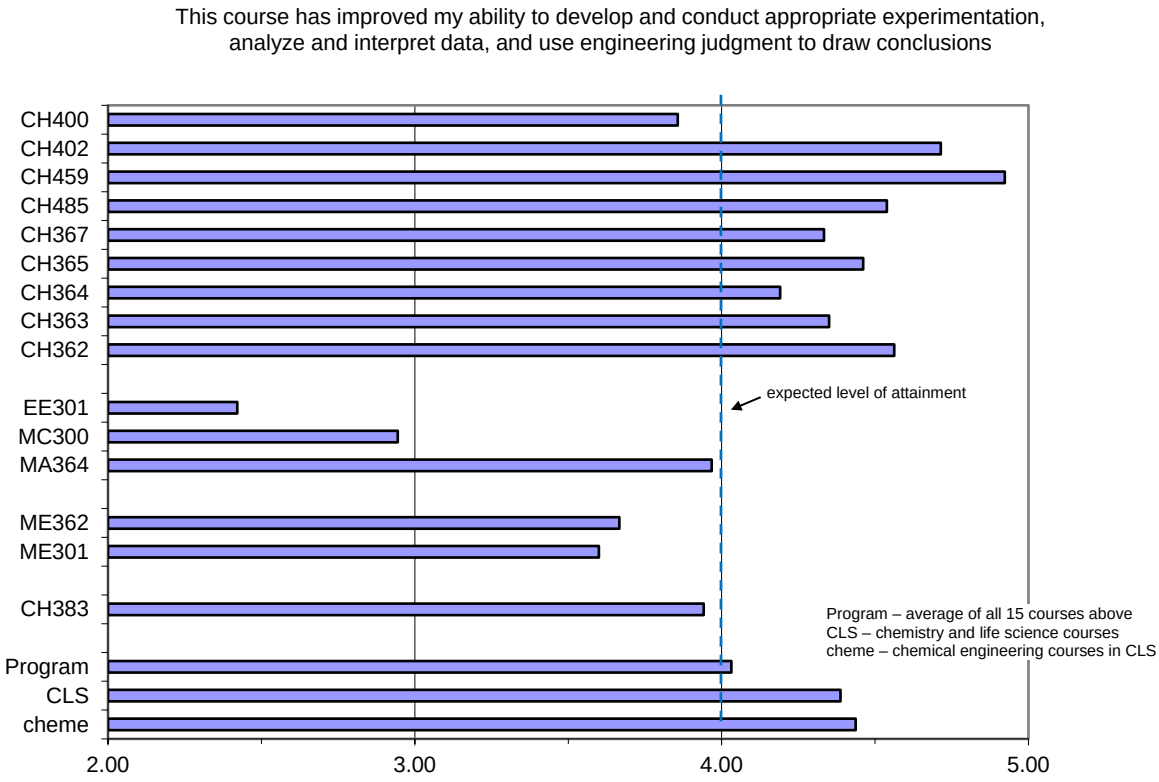


Figure 6-2. End-of-Semester Student Survey responses for Student Outcome 6.

3. Chemical Engineering Program Exit Survey. As stated earlier, this survey is given to the Firsties at the end of their last semester. In this question, they were asked whether they agree with the statement "The program has prepared me to Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions." 14 out of 14 cadets completed the survey (one cadet was later separated, so there were 13 graduates). Of these, 14 out of 14 cadets said that they either agreed or strongly agreed (score = 5/5 or 4/5), with 11/14 replying that they strongly agreed (score = 5/5) and 3/14 replying that they agreed (score = 4/5). This equates to a mean score of 4.79/5.00 ± 0.43 for the 14 cadets. The expected level of attainment on this survey is 4.00/5.00.

4. The average course grade in CH459 Chemical Engineering Laboratory was 3.41±0.53 (n=13) in AY23, compared to 3.80±0.50 (n=23) in AY22, 3.67±0.75 (n=20) in AY21, 3.53±0.48 (n=29) in AY20, 3.52±0.44 (n=21) in AY19, and 3.42±0.64 (n=19) in AY18. The 5-year running average is 3.59, and this is our expected level of attainment. This year's score was slightly below the 5-year running average but *well within the standard deviation.*

Level of Achievement of Student Outcome 7:

On completion of the chemical engineering program, our graduates will be able to acquire and apply new knowledge as needed, using appropriate learning strategies.

Assessment Instruments and Frequency:

1. Chemical & Mechanical Engineering Coursework Embedded Indicators, once/yr.
2. Percent of eligible students taking the Fundamentals of Engineering Examination (FEE), once/yr.
3. End of Semester Student Surveys, once/semester.
4. Chemical Engineering Program Exit Survey, once/yr.
5. Lifelong Learning Skills Rubric, twice per year.
6. Contemporary Issues Rubric, multiple times per year.

Assessment Results:

1. Chemical & Mechanical Engineering Coursework Embedded Indicators

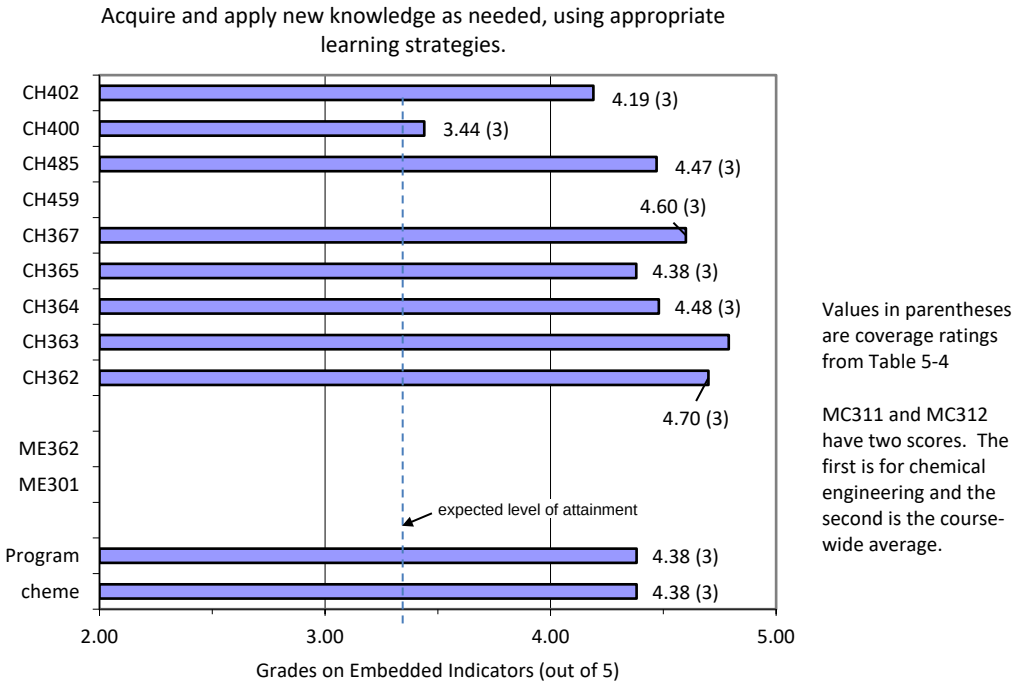


Figure 7-1. Coursework Embedded Indicator results for Student Outcome 7.

2. Percent of Eligible Cadets taking the Fundamentals of Engineering Examination (FEE). For the Class of 2023, 13 of 13 chemical engineering cadets (100% of eligible cadets) prepared for and took the FEE. This compares to 100% in years 2018 and 2019, with 31% in 2020 (9 of 29), and 100% in 2021 and 2022. The decline in participation in 2020 was due to closure of NCEES test centers nationwide in addition to restrictions on cadet movement during the COVID-19 crisis. NCEES reported a decline from 1047 participants in 2019 to 480 in 2020, which recovered somewhat to 668 in 2021, 600 in 2022, and 521 in 2023. We also recognize that five first-time takers that failed the exam on their first attempt

decided to re-take the exam at their own expense. Note: The participation rate is EXCELLENT.

3. End of Semester Student Surveys

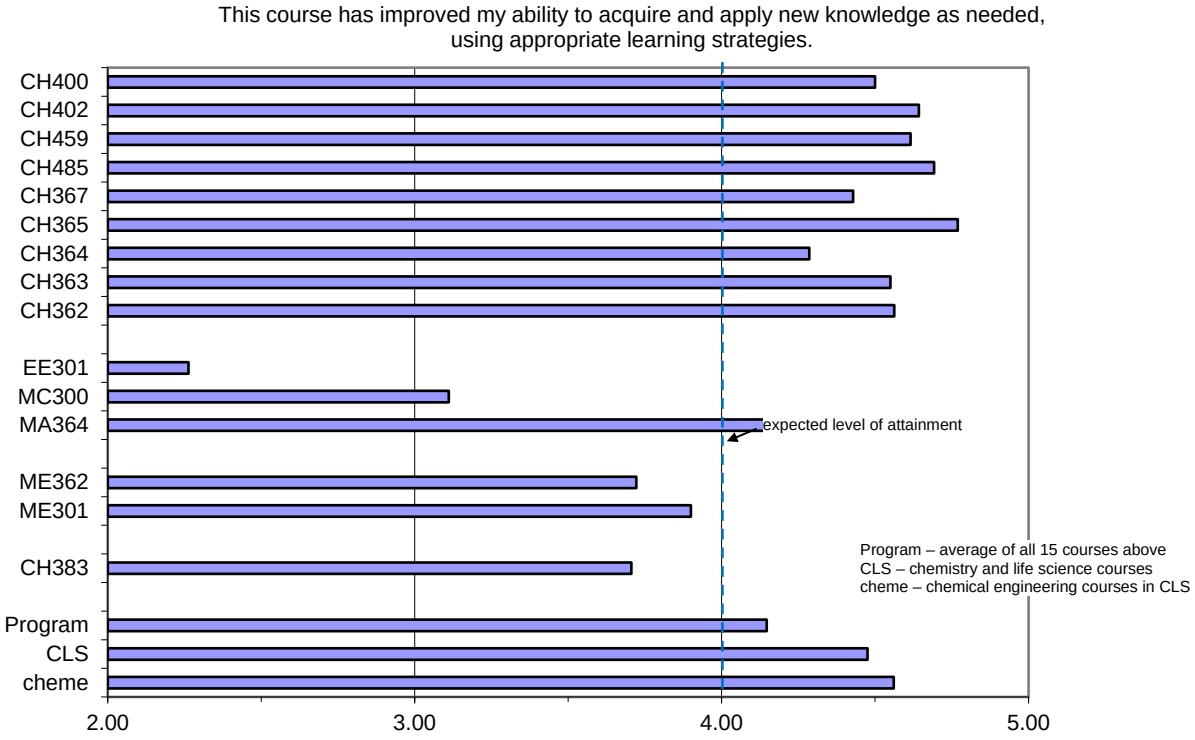


Figure 7-2. End-of-Semester Student Survey responses for Student Outcome 7.

4. Chemical Engineering Program Exit Survey. As stated earlier, this survey is given to the Firsties at the end of their last semester. In this question, they were asked whether they agree with the statement "The program has prepared me to Acquire and apply new knowledge as needed, using appropriate learning strategies." 14 out of 14 cadets completed the survey (one cadet was later separated, so there were 13 graduates). Of these, 14 out of 14 cadets said that they either agreed or strongly agreed (score = 5/5 or 4/5), with 13/14 replying that they strongly agreed (score = 5/5) and 1/14 replying that they agreed (score = 4/5). This equates to a mean score of 4.93/5.00 ± 0.27 for the 14 cadets. The expected level of attainment on this survey is 4.00/5.00.

5. Lifelong Learning Skills Rubric. This rubric, when used in tandem with the resume writing assignment in CH365, is designed to assess performance in four skills associated with the ability to acquire new knowledge, namely: rubric row 1 - engagement (in professional activities), rubric row 2 - recognition (of skills learned in the program), rubric row 3 – intellectual growth (recognition of new skills), and rubric row 4 – communication (in resume format). Resumes were written at the beginning of the semester (assignment 1.1), then revised at the end of the semester (assignment 2.0). One rubric is shown for each assignment below, along with cadet averages and standard deviations. The expected levels of attainment are color-

coded, with red indicating a need for improvement, yellow indicating acceptable performance, and green indicating that expectations are met or exceeded. Instructor comments are in the rubrics.

Instructor's Name: **Biaglow**				Cadet Assessed: **Summary, all cadets in CH365**				
Your Position: **Instructor, CH365** (e.g., CD CH365)				Cadet Major: **Chemical Engineering** (e.g., Chem. Eng.)				
	1 – Needs Improvement	**1**	**2**	**3 – Meets Expectations**	**3**	**4**	**5 – Exceeds Expectations**	**5**
Engagement Outcome 7	No evidence of pre-professional activities.			References to pre-professional activities are lacking or connections to chemical engineering are weak or implied.		4.4 ± 0.9	Uses examples of pre-professional chemical engineering activities.	
Recognition Outcome 7	Skills learned in chemical engineering courses taken in previous semesters are not listed.			Skills are listed, but the skills are vaguely described, or connection to chemical engineering concepts is not clear.	3.6 ± 0.8		Identifies specific skills learned in chemical engineering courses.	
Intellectual Growth Outcome 7	Unable to identify new concepts learned this semester.			Changes are apparent in document, but connections to recent activities in chemical engineering are weak or implied.	3.2 ± 1.3		Addition of multiple skills acquired this semester.	
Communication Outcome 3	Resume lacks organization or cohesion. Numerous grammatical errors that may interfere with meaning. Target audience unclear.			Occasional grammar errors that do not impede meaning. Demonstrates ability to write a basic resume, but document is uninteresting and flat.	3.7 ± 1.2		Demonstrates an ability to effectively communicate in the resume format. Clear, concise content. Resume is interesting.	

Has this cadet demonstrated SO7 (acquiring knowledge)? **(Y/N)** Y	Comments: **Cadet scores were good overall but some grades were held down because some cadets did not read the assignment carefully and ignored the guidance and wrote about ideas that did not meet rubric requirements.** Final Grade: **4.2 ± 1.1 / 5.0**	Assignment used for assessment: (e.g., resume draft 1.1 in CH365) **resume draft 1.1 in CH365**

Instructor's Name: **Biaglow**				Cadet Assessed: **Summary, all cadets in CH365**				
Your Position: **Instructor, CH365** (e.g., CD CH365)				Cadet Major: **Chemical Engineering** (e.g., Chem. Eng.)				
	1 – Needs Improvement	**1**	**2**	**3 – Meets Expectations**	**3**	**4**	**5 – Exceeds Expectations**	**5**
Engagement Outcome 7	No evidence of pre-professional activities.			References to pre-professional activities are lacking or connections to chemical engineering are weak or implied.			Uses examples of pre-professional chemical engineering activities.	4.9 ± 0.3
Recognition Outcome 7	Skills learned in chemical engineering courses taken in previous semesters are not listed.			Skills are listed, but the skills are vaguely described, or connection to chemical engineering concepts is not clear.		4.2 ± 0.7	Identifies specific skills learned in chemical engineering courses.	
Intellectual Growth Outcome 7	Unable to identify new concepts learned this semester.			Changes are apparent in document, but connections to recent activities in chemical engineering are weak or implied.		4.1 ± 1.0	Addition of multiple skills acquired this semester.	
Communication Outcome 3	Resume lacks organization or cohesion. Numerous grammatical errors that may interfere with meaning. Target audience unclear.			Occasional grammar errors that do not impede meaning. Demonstrates ability to write a basic resume, but document is uninteresting and flat.		4.5 ± 0.5	Demonstrates an ability to effectively communicate in the resume format. Clear, concise content. Resume is interesting.	
Has this cadet demonstrated SO7 (acquiring knowledge)? **(Y/N)** Y	Comments: **Scores increased with respect to the first draft, especially in intellectual growth. Instructor was able to provide mentoring and cadets were more introspective regarding previous experiences in chemical engineering courses.** Final Grade: 4.4 ± 0.7 / 5.0						Assignment used for assessment: (e.g., resume draft 1.1 in CH365) **resume draft 2.1 in CH365**	

There is normally improvement in scores in draft 2.1 as cadets incorporate instructor comments to improve and polish their documents. Version 2.1, though, requires articulation of new skills acquired during the semester. Scores can go down if cadets do not show new activities and skills learned during the current semester, and in some individual cases the scores did drop, and intellectual growth (row3) did increase. Overall and on average, the program scores are solidly in the green in all four categories by the end of the semester.

6. Contemporary Issues Rubric (follows on page 19).

Instructor's Name: LTC Cowart				Cadet Assessed: All Cadets in CH485 (AY23-1)				
Your Position: CD, CH485 (e.g., CD CH485)				Cadet Major: Chemical Engineering (e.g., Chem. Eng.)				
	1 – Needs Improvement	1	2	3 – Meets Expectations	3	4	5 – Exceeds Expectations	5
Acquiring Knowledge Outcome 7	Cites references but they are not substantive or do not address assignment. Context is weak or implied. Uses generic arguments or lacks specificity.			Cites at least two references relevant to the assignment. References have been adequately studied and re-worded to support a thesis.		4.1 +/- 1.0	Uses multiple substantive examples or scholarly articles in an integrative fashion to support a thesis.	
Technical Competence Outcomes 8	Demonstrates poor or incomplete understanding of technical content.			Demonstrates some knowledge of the technical content, but explanation lacks adequate depth.		3.7 +/- 0.8	Demonstrates exceptional knowledge of technical content.	
Impact of Contemporary Issues Outcome 4	Does not have a premise or does not connect issues in essay to concepts in chemical engineering.			Makes connections to chemical engineering concepts, but the connections are weak or implied or premise is weak.		4.1 +/- 0.8	Makes very clear connections between premise and chemical engineering concepts.	
Communication Outcome 3	Writing lacks organization or cohesion. Numerous grammatical errors or errors interfere with meaning. Thesis lacking or implied.			Occasional grammar errors that do not impede meaning. Demonstrates ability to write an essay but lacks cohesion or completeness. Thesis not fully supported.		3.5 +/- 1.0	Demonstrates an ability to effectively communicate in the essay format. Fully supported, clear, concise thesis. Writing style was exceptionally clear and articulate.	
Has this cadet demonstrated SO7 (acquiring knowledge)? **(Y/N)** Y	Comments: **Cadets met expectations on the draft writing assignment. Cadets demonstrated acquisition of new knowledge and generally wrote in an acceptable format. Technical content with respect to heat & mass transfer can be improved, as well as writing organization.** Final Grade: 3.8 +/- 0.9						Assignment used for assessment: (e.g., draft 1 writing assignment 1 in CH485) CH485 Writing DRAFT	

Instructor's Name: LTC Cowart				Cadet Assessed: All Cadets in CH485 (AY23-1)				
Your Position: CD, CH485 (e.g., CD CH485)				Cadet Major: Chemical Engineering (e.g., Chem. Eng.)				
	1 – Needs Improvement	1	2	3 – Meets Expectations	3	4	5 – Exceeds Expectations	5
Acquiring Knowledge Outcome 7	Cites references but they are not substantive or do not address assignment. Context is weak or implied. Uses generic arguments or lacks specificity.			Cites at least two references relevant to the assignment. References have been adequately studied and re-worded to support a thesis.			Uses multiple substantive examples or scholarly articles in an integrative fashion to support a thesis.	4.8 +/- 0.4
Technical Competence Outcomes 8	Demonstrates poor or incomplete understanding of technical content.			Demonstrates some knowledge of the technical content, but explanation lacks adequate depth.			Demonstrates exceptional knowledge of technical content.	4.7 +/- 0.5
Impact of Contemporary Issues Outcome 4	Does not have a premise or does not connect issues in essay to concepts in chemical engineering.			Makes connections to chemical engineering concepts, but the connections are weak or implied or premise is weak.			Makes very clear connections between premise and chemical engineering concepts.	4.8 +/- 0.6
Communication Outcome 3	Writing lacks organization or cohesion. Numerous grammatical errors or errors interfere with meaning. Thesis lacking or implied.			Occasional grammar errors that do not impede meaning. Demonstrates ability to write an essay but lacks cohesion or completeness. Thesis not fully supported.			Demonstrates an ability to effectively communicate in the essay format. Fully supported, clear, concise thesis. Writing style was exceptionally clear and articulate.	4.8 +/- 0.4
Has this cadet demonstrated SO7 (acquiring knowledge)? **(Y/N)** Y	Comments: **Significant improvement from the draft version of the contemporary issues essay. Technical improvement, coupled with extensive discussion of contemporary issues regarding the chosen topic resulted in interesting, thoughtful papers.** Final Grade: 4.8 +/- 0.5						Assignment used for assessment: (e.g., draft 1 writing assignment 1 in CH485) CH485 Writing FINAL	

The contemporary issues rubric is designed to assess performance in four skills associated with the ability to acquire new knowledge, namely: rubric row 1 - acquiring knowledge (through development and use of references), rubric row 2 - technical competence of the cadet (as demonstrated with writing skills), rubric row 3 – impact of contemporary issues (ability to link contemporary issues to relevant chemical engineering concepts), and rubric row 4 - grammar and structure. Each of these skills, taken independently, are associated with written communication (Student Outcome 3). However, the development and blending of these skills into a coherent and well-crafted essay are a measure of acquisition of new knowledge and are thus used by our program to assess Student Outcome 8. Admittedly, this is not a complete measure of a student's ability to acquire new knowledge, only that ability as expressed in an essay. Therefore, we combine this exercise with the other embedded indicators in this section of the report.

Operationally, the contemporary issues rubric is completed by the instructor to award grades to cadets for the writing assignments in this course. In this case, LTC Cowart used one writing assignment in CH485, completed in two drafts. In AY23 (this year), the average for the draft was 3.8 ± 0.9 and the average on the final was 4.8 ± 0.5, so they achieved a better average on the final than on the draft submission, compared to 3.7 ± 0.8 and 4.7 ± 0.5 in AY22, respectively. The draft and final submissions were graded against the rubric, with the total average score and average scores per outcome shown in the screenshots above. Cadets achieved each of the graded rubric rows with proficiency, and instructor comments are included in the screenshots.

Level of Achievement of Student Outcome 8:

The program provides the graduate with a thorough grounding and working knowledge of the chemical sciences, including:

- (8.1) Chemistry.
- (8.2) Material and energy balances
- (8.3) Safety and environmental factors.
- (8.4) Thermodynamics of physical and chemical equilibria.
- (8.5) Heat, mass, and momentum transfer.
- (8.6) Chemical reaction engineering.
- (8.7) Continuous and staged separation operations.
- (8.8) Process dynamics and control.
- (8.9) Modern experimental and computing techniques.
- (8.10) Process design.

Assessment Instruments and Frequency:

1. Fundamentals of Engineering Examination, once/yr.
2. Average Course Grades for Chemical Engineering Students, once/yr.

Assessment Results:

1. Fundamentals of Engineering Examination, Table 4-14. For the Class of 2021, the breakdown by topic is shown in comparison to the national averages.

Subject	**Outcome**	**Questions**	**USMA ChE**	**National** (expected level of attainment)
Chemistry & Biology	8.1	7	9.5	9.6±2.7
Material & Energy Balances	8.2	10	8.9	9.3±2.2
Safety, Health, & Environmental	8.3	5	9.5	9.9±3.4
Thermodynamics	8.4	8	8.9	9.1±2.2
Heat Transfer	8.5	8	9.4	9.6±2.5
Fluid Mechanics/Dynamics	8.5	8	9.1	9.4±2.6
Chemical Reaction Engineering	8.6	7	9.1	9.4±2.6
Mass Transfer & Separations	8.7	8	9.4	9.3±2.1
Process Control	8.8	4	8.8	9.4±23.2
Computational Tools	8.9	0	---	---
Economics	8.10	4	7.6	9.7±3.4
Process Design	8.10	7	8.6	9.9±3.4

2. Course grades for the last six years are shown below, Table 4-4 (from Self Study).

		Chemical Engineering Student Outcome 8								
Course ↓		Advanced Chemistry	Mater. & Energy Bal.	Thermodynamics	Transport	Reaction Engineering	Separations	Dynamics & Control	Experiment & Compute	Process Design
		8.1	**8.2**	**8.4**	**8.5**	**8.6**	**8.7**	**8.8**	**8.9**	**8.10**
CH383	Organic Chemistry I	2.64								
CH365	Chem. Eng. Thermo.			3.54						
CH362	Mass & Energy Balances		3.17							
CH363	Separation Processes						3.59			
CH364	Chem. Reaction Eng.					3.38				
CH459	Chem. Eng. Laboratory								3.41	
CH485	Heat and Mass Transfer				3.13					
CH400	Chemical Engineering Sem.									
CH402	Chem. Eng. Process Des.									3.44
MA366	Vector Calculus									
ME311	Thermal-Fluid Systems I			3.33	3.33					
ME312	Thermal-Fluid Systems II			3.18	3.18					
CE300	Fund. Eng. Mech. & Des.									
EE301	Intro. To Elec. Engineering									
CH367	Intr. Auto. Process Control							3.51		
Average Grade 2023		2.64	3.17	3.35	3.21	3.38	3.59	3.51	3.41	3.44
Average Grade 2022		3.15	3.64	3.59	3.47	3.33	3.69	3.42	3.80	3.33
Average Grade 2021		2.78	3.54	3.33	3.23	3.31	3.37	3.35	3.67	3.46
Average Grade 2020		3.06	3.53	3.27	3.20	3.38	3.64	3.36	3.53	3.26
Average Grade 2019		3.14	3.63	3.69	3.39	3.67	3.92	3.51	3.52	3.26
Average Grade 2018		2.87	3.72	3.51	3.20	3.66	3.67	3.53	3.42	3.37
Average Grade 2017		3.15	3.21	3.65	3.25	3.66	3.67	3.31	3.54	2.73
Previous 5-year Running Average *(Expected level of attainment)*		*3.00*	*3.61*	*3.48*	*3.30*	*3.47*	*3.66*	*3.43*	*3.59*	*3.34*
Standard Deviation 2022		0.79	0.59	0.67	0.62	0.53	0.56	0.65	0.53	0.55

Table 4-2. Faculty Evaluation of Chemical Engineering Student Outcomes

Chemical Engineering Student Outcomes	**Faculty Evaluation**
On completion of the chemical engineering program, our graduates are able to:	
1. Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	4.91 ± 0.30
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.	4.82 ± 0.40
3. Communicate effectively with a range of audiences.	4.55 ± 0.52
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.	4.91 ± 0.30
5. Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.	4.91 ± 0.30
6. Develop and conduct appropriate experimentation, analyze, and interpret data, and use engineering judgment to draw conclusions.	4.64 ± 0.50
7. Acquire and apply new knowledge as needed, using appropriate learning strategies.	4.82 ± 0.40
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.	5.91 ± 0.30
5- Excellent; **4** – Very Good; **3** – Acceptable; **2** – Weak ; **1** – Poor	

Table 4-3. Advisory Board Evaluation of Chemical Engineering Student Outcomes

Chemical Engineering Student Outcomes	**Advisory Board's Evaluation**
On completion of the chemical engineering program, our graduates are able to:	
1. Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	**N/A**
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.	**N/A**
3. Communicate effectively with a range of audiences.	**N/A**
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.	**N/A**
5. Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.	**N/A**
6. Develop and conduct appropriate experimentation, analyze, and interpret data, and use engineering judgment to draw conclusions.	**N/A**
7. Acquire and apply new knowledge as needed, using appropriate learning strategies.	**N/A**
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.	**N/A**
5- Excellent; **4** – Very Good; **3** – Acceptable; **2** – Weak ; **1** – Poor	

Note: Data for Table 4-3 is not available (N/A) until after the next advisory board meeting in April of 2024. Table 4-3 will be completed at that time for the AY23 EXSUM.

Table 4-4. Summary of Chemical Engineering Student Outcomes Performance.

Chemical Engineering Student Outcomes	**Program Director's Summary**
On completion of the chemical engineering program, our graduates are able to:	
1. Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	5
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.	5
3. Communicate effectively with a range of audiences.	5
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
5. Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.	5
6. Develop and conduct appropriate experimentation, analyze, and interpret data, and use engineering judgment to draw conclusions.	5
7. Acquire and apply new knowledge as needed, using appropriate learning strategies.	5
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.	4
5- Excellent; **4** – Very Good; **3** – Acceptable; **2** – Weak ; **1** – Poor	

Note: These Program Director entries are preliminary and will be updated after the next advisory board meeting in April of 2024. Table 4-4 will be finalized at that time for the AY23 EXSUM.

Name:_____ Date:_____

2024 Advisory Board Surveys

Welcome to our annual advisory board meeting. As you know, we consider each of you to be valued shareholders in our program and the meeting is our annual shareholder's meeting, where we show you our performance report and discuss methods of improving the program. This document is your official advisory board survey, and it is *extremely important to our program.* It is designed to do two things. First, the completed surveys provide *documentation* that you have been briefed on the performance of our cadets and the relevance of the program objectives, helping us maintain our accreditation. Second, it allows us to use your collective knowledge and experience to *identify areas* where we might need improvement. The surveys are based in part on the data that we present to you during this meeting, and your responses are your "thumbs up or down" to the various performance indicators we are tracking. This survey is part of the assessment for *Academic Year 2023* (cadets who graduated in May 2023).

Instructions

- The survey pertains to student outcomes (Part I), program educational objectives (Part II), and program improvement (Part III). You will be given time during the day to answer the questions.
- For Part I, use the data to evaluate the attainment of our student outcomes. You will also meet with cadets, and the opinions you form of them might also influence your ratings. It is completely appropriate to use that information in the formation of your opinions.
- Part II pertains to the relevance, consistency, and cadet awareness of the program educational objectives. Your opinions and our discussions will help shape future revisions of these objectives.
- Part III contains some free-form questions where you can comment on the quality of the curriculum, the meeting itself or any other items you would like us to address.
- The survey is electronically fillable. Use the tab key to step though the form.
- *The surveys are due by the end of the day, 12 April 2024 or as soon as possible.* If you complete the survey after you leave, please email the electronic survey or mail the physical copy to us as soon as possible.

Name:_____ Date:_____

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

- Demonstrate effective leadership and chemical engineering expertise.
- 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.

Chemical Engineering General Program Outcomes (Outcomes 1-7): On completion of the chemical engineering program, our graduates demonstrate an ability to:

- [Student Outcome 1] Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- 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.
- Communicate effectively with a range of audiences.
- 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.
- Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- Acquire and apply new knowledge as needed, using appropriate learning strategies.

Chemical Engineering Curriculum Outcomes (Outcome 8): The program provides the graduate with a thorough grounding and working knowledge of the chemical sciences, 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 operations
- Process dynamics and control
- Modern experimental and computing techniques
- Process design

Name:_____ Date:_____

Part I. Student Outcomes. Review the data and then check the box in the column that most closely represents your opinion.

The cadets in the program are able to:	Strongly Disagree		Neutral		Strongly Agree
• Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.					
• 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.					
• Communicate effectively with a range of audiences.					
• 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.					
• Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.					
• Develop and conduct appropriate experimentation, analyze, and interpret data, and use engineering judgment to draw conclusions.					
• Acquire and apply new knowledge as needed, using appropriate learning strategies.					
• Have attained a thorough grounding in and working knowledge of the chemical engineering curriculum.					

Name:_____ Date:_____

Part II. Program Objectives. Check the box that most closely represents your opinion.

	Strongly Disagree		Neutral		Strongly Agree
The program objectives are consistent with the USMA mission.					
The program objectives are consistent with the needs of the Army.					
The program curriculum supports the program objectives.					
The student outcomes are consistent with the program mission and objectives.					
The program has a process for periodically assessing the achievement of its student outcomes.					
The survey methods used by the program are effective.					
The cadets in the program are aware of the program objectives.					
The cadets are given an opportunity to provide their opinion about the program objectives.					
The cadets are satisfied with the courses in the program.					
The faculty are aware of the program objectives.					
The faculty are given an opportunity to provide their opinion about the program objectives.					

Name:_____ Date:_____

Part III. Open Questions. Answer the questions below or provide other input as desired.

Based on the assessment data or on your personal opinion, is there a course that the program should add to the curriculum? Please explain.

Do you have any suggestions to improve the advisory board meeting for next year?

Please add any addition comments that you would like to make below.