UNITED STATES MILITARY ACADEMY
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Chemical Engineering

Advisory Board Meeting

23 April 2021

United States Military Academy
Department of Chemistry and Life Science

Meeting Endstate

1. 100% surveys complete

2. Discussions with chemical engineering faculty and cadets complete

3. Tours of chemical engineering lab, work, classroom space complete

3. Travel paperwork complete

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Lunch – Subs and Wraps

Lunch:

1. Cold cut Italian mix sandwiches and wraps
2. Mixed salad
3. Chips: regular/barbeque/sour cream & onion/Cheetos/Doritos
4. Iced tea/soda/water/coffee
5. **Cookie plate**

Chemical Engineering

Advisory Board Meeting

23 April 2021

1. Introductory Remarks

United States Military Academy
Department of Chemistry and Life Science

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

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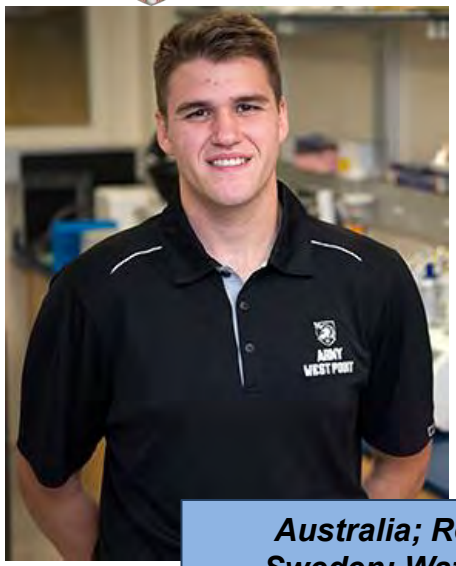
CDT Jesse Palmer, ’19
Chemical Engineering



- **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

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

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

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.

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.

ABET | Engineering Technology Accreditation Commission

Accredited **1 October 2012** to present

Next Record Year: **AY2025-2026**

ABET Visit: **Early September 2026**

Why ABET Accreditation?

- An external certification of quality
- Keeps us in touch with the engineering profession
- Helps USMA (and ChemE) recruiting (2020 – 29; 2021 - 20; 2022 - 29; 2023 -…*so far 12*)
- Provides important opportunities for graduates
- Allows USMA engineering majors to take the Fundamentals of Engineering Examination
- It is required by Army Regulations (10-87).
- Almost everything that ABET expects us to do is something we should be doing anyway.

Thoughts to Consider

- The ABET process is expensive in terms of faculty time
  - USMA is a small undergraduate college with limited human resources (faculty) and high faculty turnover
- The ABET accreditation is important to the institution and to the Army (so we tend to do it well)
- 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

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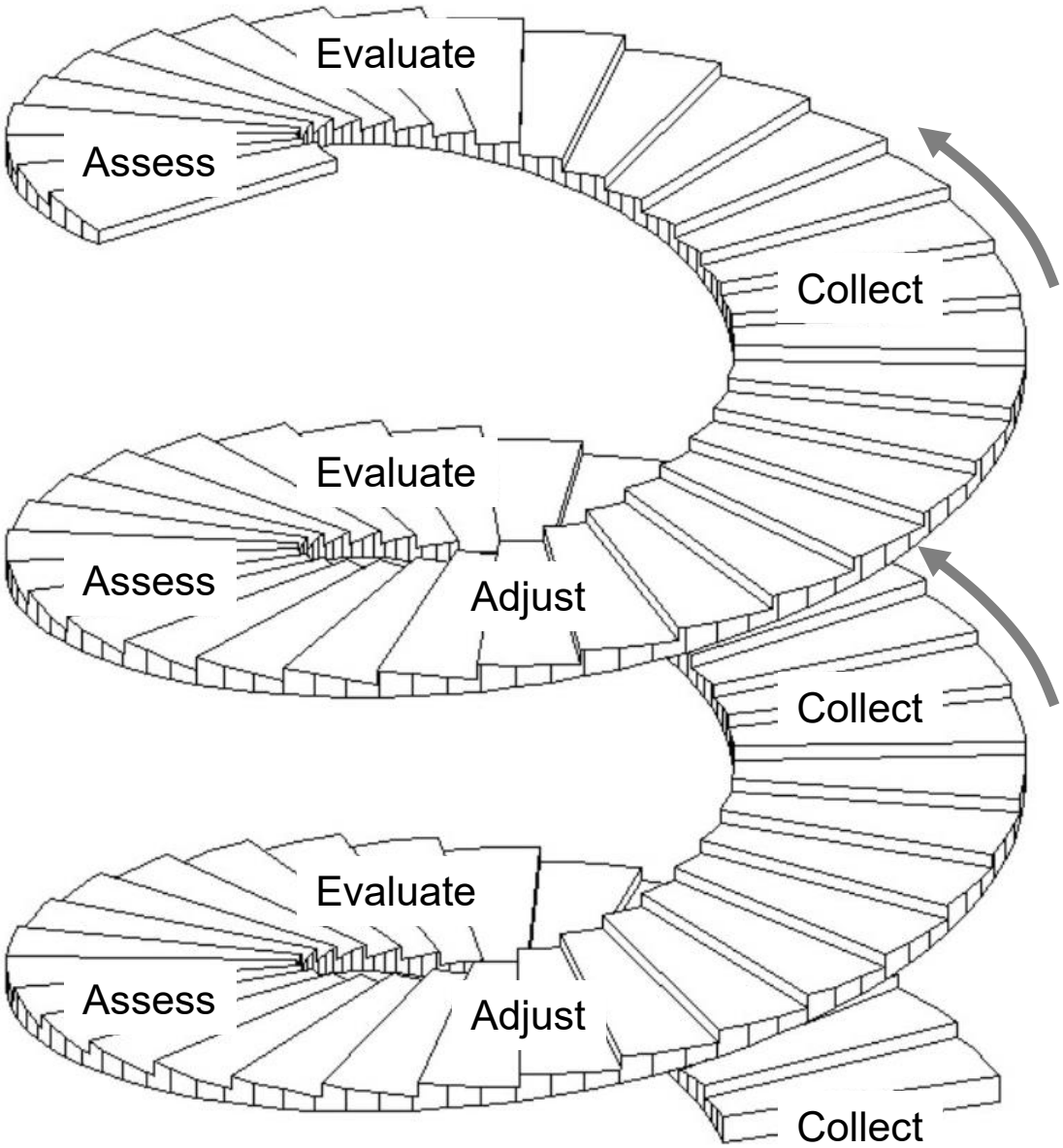
Terms You Should Know

- **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

Assessment Cycle



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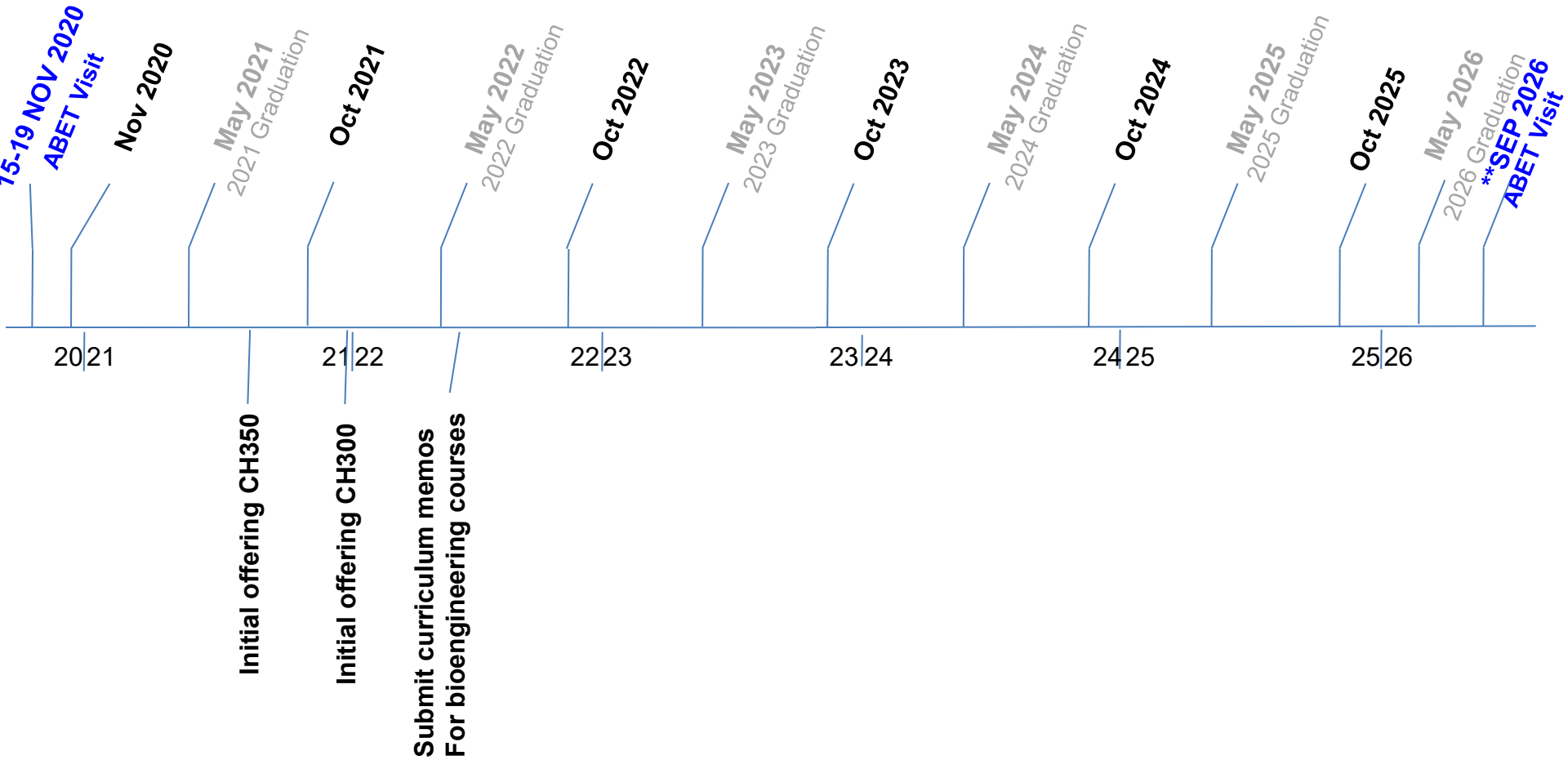
Timeline of Curricular Actions



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CH300: Introduction to Biomedical Engineering

Course Director: TBD

Course OIC: MAJ Jeffrey Chin

Credit Hours: 3.0 (BS=0, ET=3.0, MA=0)
Prerequisites: CH102, MA205
Co-requisite: None

Lessons: 30 @ 75 min This course provides a basis for understanding the application of engineering principles to problems in medicine and biology. It provides preparation for future graduate work in medical school, biomedical engineering, and chemical engineering. Specifically, the objectives of the course are: (1) to provide an introduction to the field and how it relates to other fields of engineering and science, (2) the develop the ability to apply mathematics, science, and engineering to solve problems, (3) to develop an understanding of the impact of engineering solutions on the medical field and society as a whole, and (4) to understand current topics within the field.

Assessment – Graded Events

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

TEXT: Biomedical Engineering, 2nd Edition, by W. Mark Saltzman; Cambridge University Press, 2015.

COA 1

Block I: Molecular and cellular principles
- Biomolecular principles (Ch. 2)
- Biomolecular principles: Nucleic acids (Ch. 3)
- Biomolecular principles: proteins (Ch. 4)
- Cellular principles (Ch. 5)

Block II: Physiological principles
- Communication systems in the body (Ch. 6)
- Engineering balances: respiration and digestion (Ch. 7)
- Circulation (Ch. 8)
- Removal of molecules from the body (Ch. 9)

COA 2

Block I: Molecular and cellular principles
- Biomolecular principles (Ch. 2)
- Biomolecular principles: Nucleic acids (Ch. 3)
- Biomolecular principles: proteins (Ch. 4)
- Cellular principles (Ch. 5)

Block II: Physiological principles
- Communication systems in the body (Ch. 6)
- Engineering balances: respiration and digestion (Ch. 7)
- Circulation (Ch. 8)
- Removal of molecules from the body (Ch. 9)

Block III: Biomedical Engineering
- Biomechanics (Ch. 10)
- Bioinstrumentation (Ch. 11)
- Bioimaging (Ch. 12)
- Biomolecular Engineering I: Biotechnology (Ch. 13)
- Biomolecular Engineering II: Engineering of Immunity (Ch. 14)

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CH350: Introduction to Bioengineering

Course Director: Dr. Simuck Yuk

Credit Hours: 3.0 (BS=0, ET=3.0, MA=0)
Prerequisites:
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

Bioprocess Engineering Basic Concepts, 3rd Ed., by Michael L. Shulter, Fikret Kargi, Matthew DeLisa, Prentice Hall.

Quantitative Fundamentals of Molecular and Cellular Bioengineering, by K. Dane Wittrup, Brice Tidor, Benjamin J. Hackel, and Casim A. Sarkar, The MIT Press.

- Introduction
- Enzyme Kinetics
- Central Dogma to Molecular Biology
- Cell Growth
- Bioreactor Selection
- Bioprocess Consideration

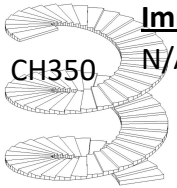
Course Assessment – Items from Section III

Sustain:

N/A at this point.

Improve:

N/A at this point.



Assessment – Graded Events

1 *Capstone Presentation	200	14%
2 *WPRs	400	28%
5 *After-class Problem Sets(20pts/ea.)	100	7%
5 *In-class Problem Sets (50pts/ea.)	250	17%
1 *Term End Exam	500	34%
Total:	1450	100.00%

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CH450: Bioengineering Modeling and Analysis

Course Director: COL John Burpo

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

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

Topics – by Chapter

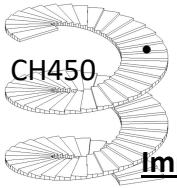
TEXT: Introduction to Biomedical Engineering, 3rd Edition, by John Enderle and Joseph Bronzino; Academic Press, 2012.

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

Course Assessment – Items from Section III

Sustain:

- Best looking Dept Head/ CD/ Prof at the academy
- 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



Improve:

Assessment – Graded Events

5 *Problem Sets@ 25 pts each	500	47.2%
6 *Quizes @ 200 pts each:	180	17.0%
1 *Paper	150	14.1%
1 *Presentation	50	4.7%
6 *Discussion	180	17.0%
Total:	1060	
*Individual Points :	1060	100%

Advisory Board Findings

Excerpts from Minutes of 26 April 2019

- CH400 professional practice was discussed at length with cadet panel; and faculty; overall stay on current azimuth
- Desire for continued program improvement; program has good balance between theory and hands-on experience
- Some members of board would like to see more flexibility
- Cadets lamented about lack of chemical engineering electives
- Cadet feedback focused on various courses
- Cadets appreciate going to other departments for some courses (CME)
- General Chemistry discussion
- CH485 tough but useful and important to curriculum

End of Section 1

Chemical Engineering

Advisory Board Meeting

23 April 2021

2. Program Assessment

United States Military Academy
Department of Chemistry and Life Science

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.

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
MC311	Thermal-Fluid Systems I
MC312	Thermal-Fluid Systems II
EE301	Fundamentals of Electrical Engineering
MC300	Fundamentals of Engineering Mechanics & Design (Statics & Dynamics)
CH365	Chemical Engineering Thermodynamics
CH383	Organic Chemistry 1

*Not including prerequisites

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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

USMA Independent Research

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

Assessment

CHEME Coursework Embedded Indicators

MECHE Coursework Embedded Indicators

Fundamentals of Engineering Exam Topics

Participation in FE Exam (not pass rate)

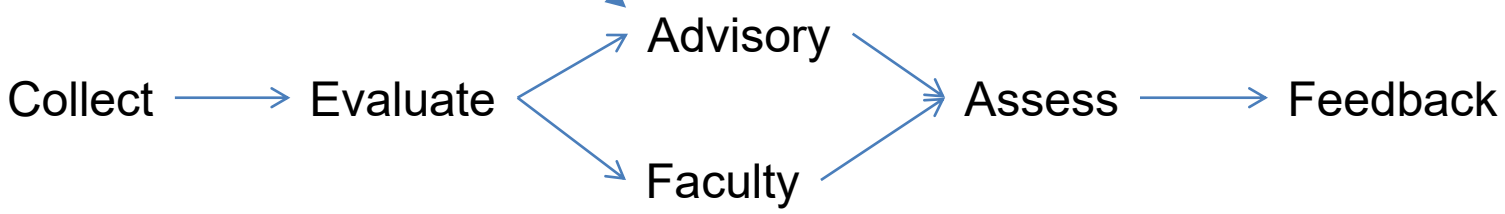
Student end of semester surveys

Student CHEME Program Exit Surveys

Course Grades

Where we are now

Process



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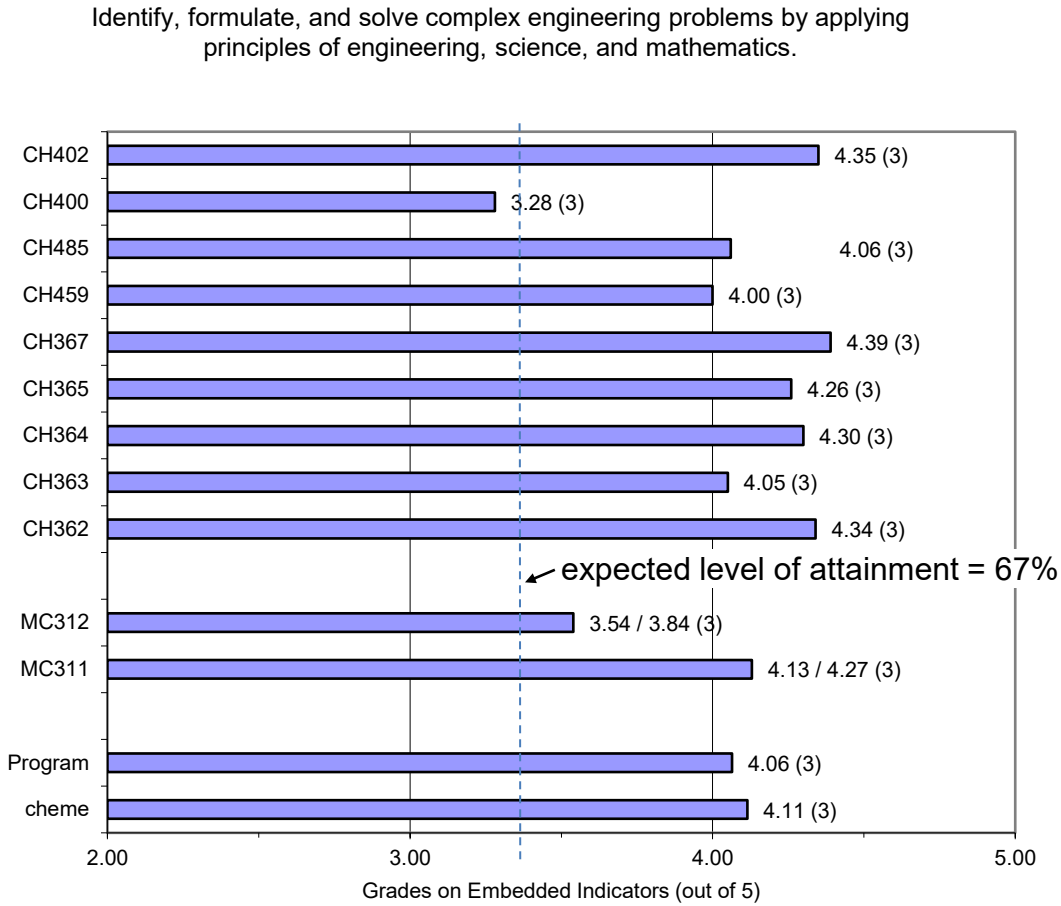
Chemical Engineering 8TAP

Example Schedule for Chemical Engineering, Classes of 2021 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
HI107	Western Civilization	3.0	HI108	Regional Studies in World History	3.0
IT105	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*	*Applied Engineering Math*	*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 1*	*3.5*	*MC312*	*Thermal-Fluid Systems 2*	*3.0*
MC311	*Thermal-Fluid Systems 1*	*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 18.5
CH459	*Chemical Engineering Laboratory*	*3.5*	*CH402*	*Chemical Engineering Process Design*	*3.5*
CH365	*Chemical Engineering Thermodynamics*	*3.0*	*CH400*	*Chemical Engineering Prof. 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

Example Data: Coursework Embedded Indicators

Student Outcome 1



Values in parentheses are coverage ratings from Table 5-3 in the 2014 Self Study, page 5-9, updated for 2019.

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 2020
Similar data is collected for all 7 ABET student outcomes
Summary of all data is shown on next slide

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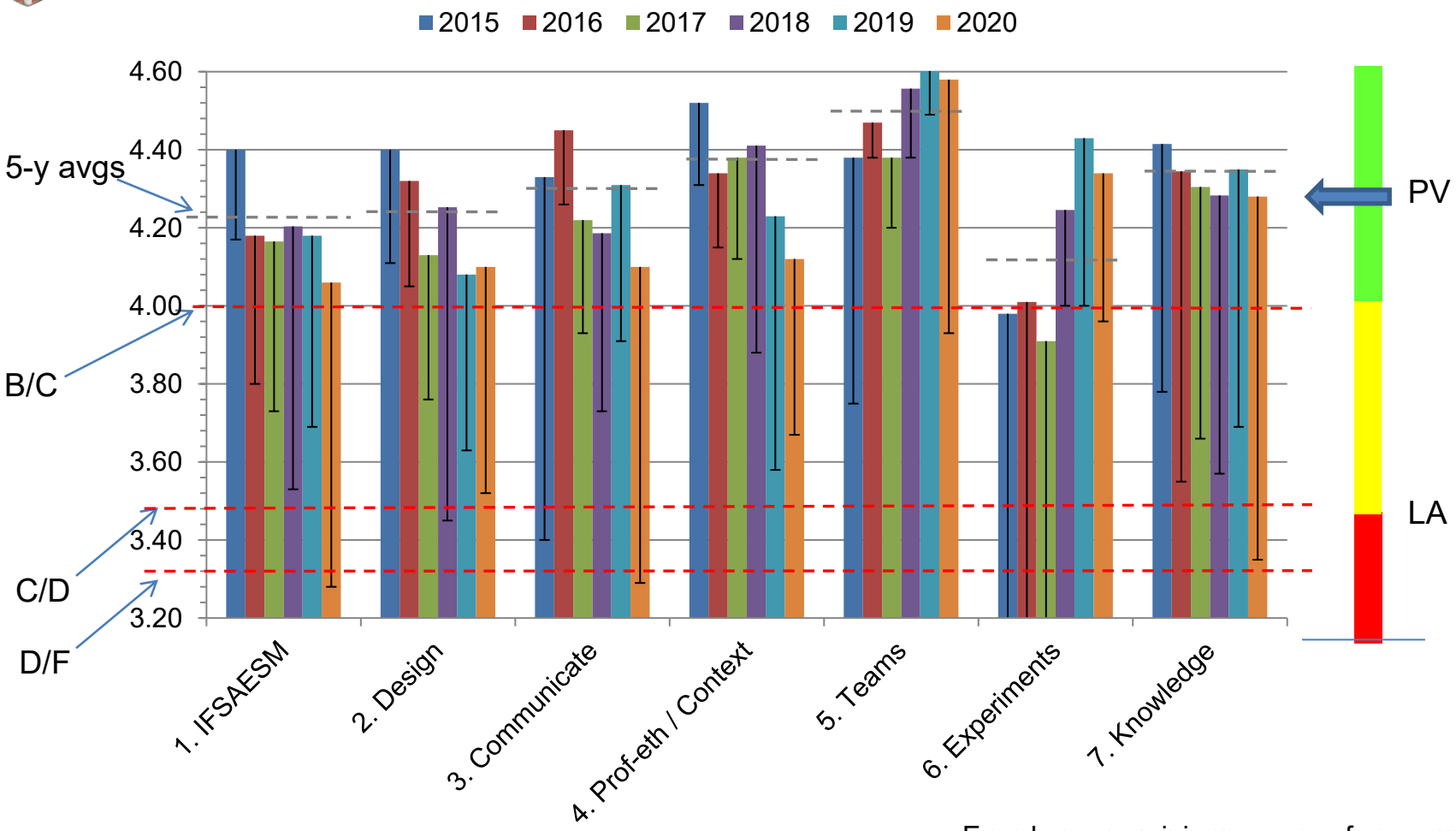
Performance on Embedded Indicators
Program Averages AY2015-20

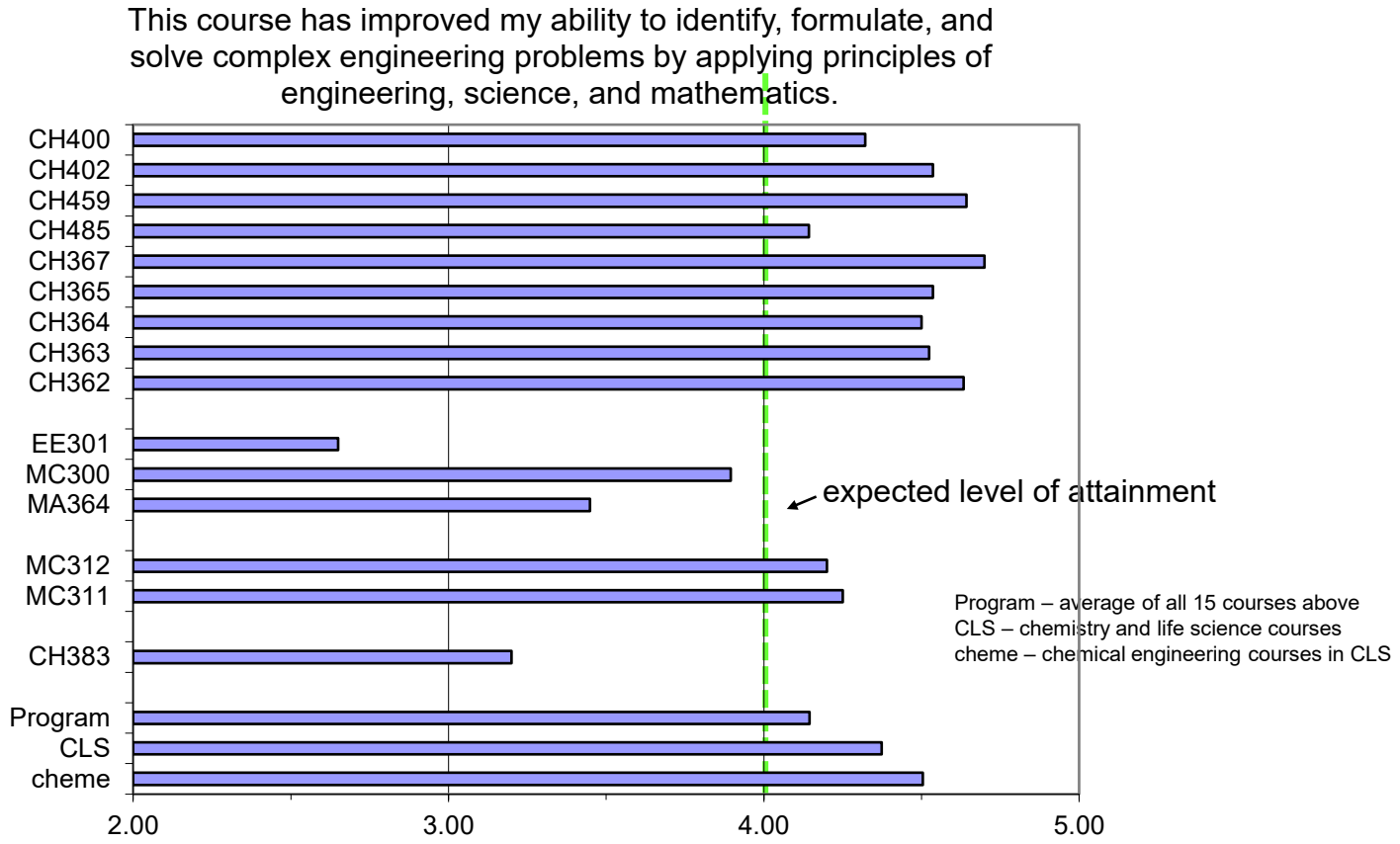


Error bars are minimum scores from courses.

Expected levels of attainment are the 5-year averages

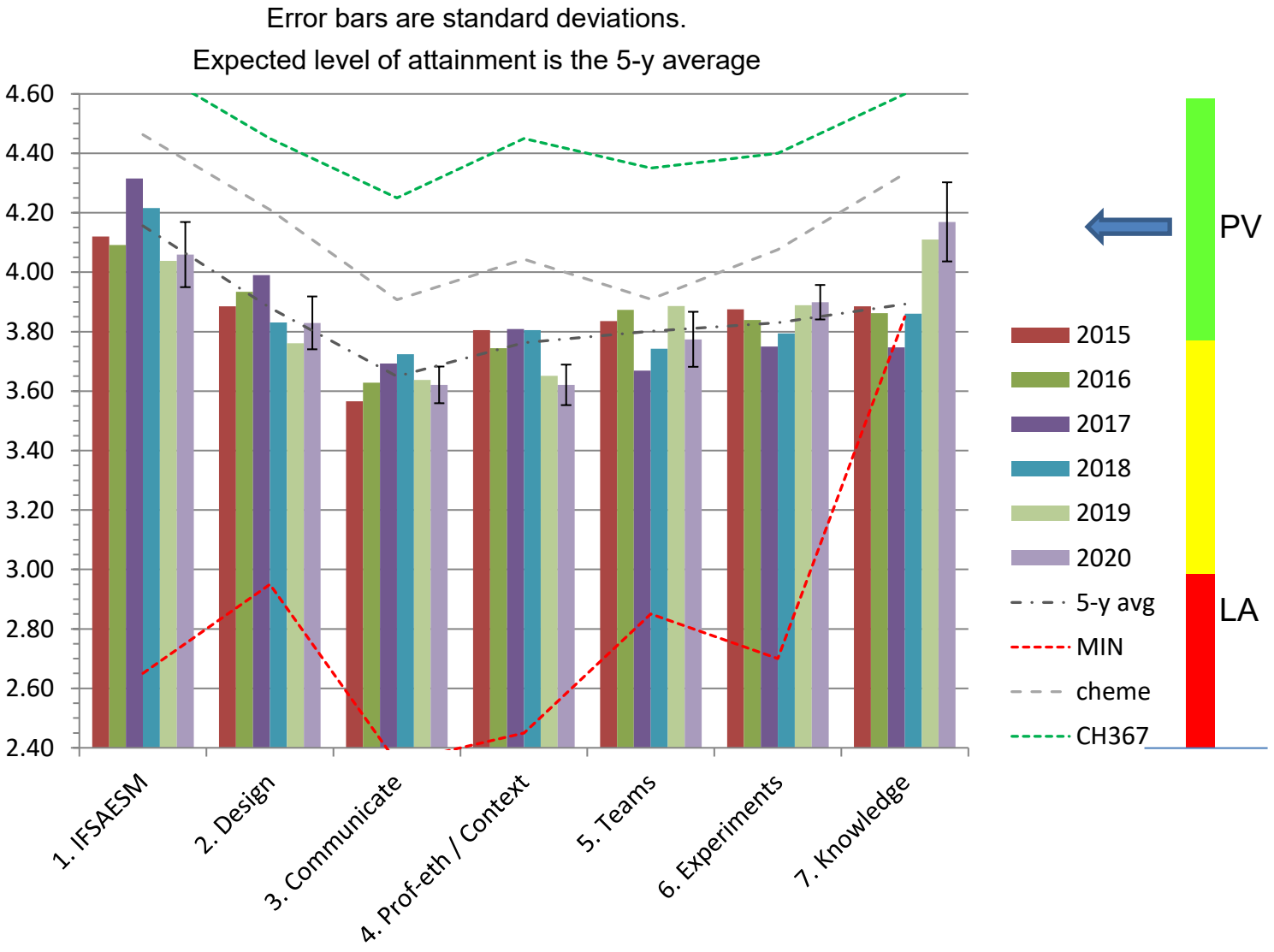
Example Data: End-of-Semester Surveys

Student Outcome 1



Data shown here is for Class of 2020
Similar data is collected for all 8 ABET student outcomes
Summary of all data is shown on next slide

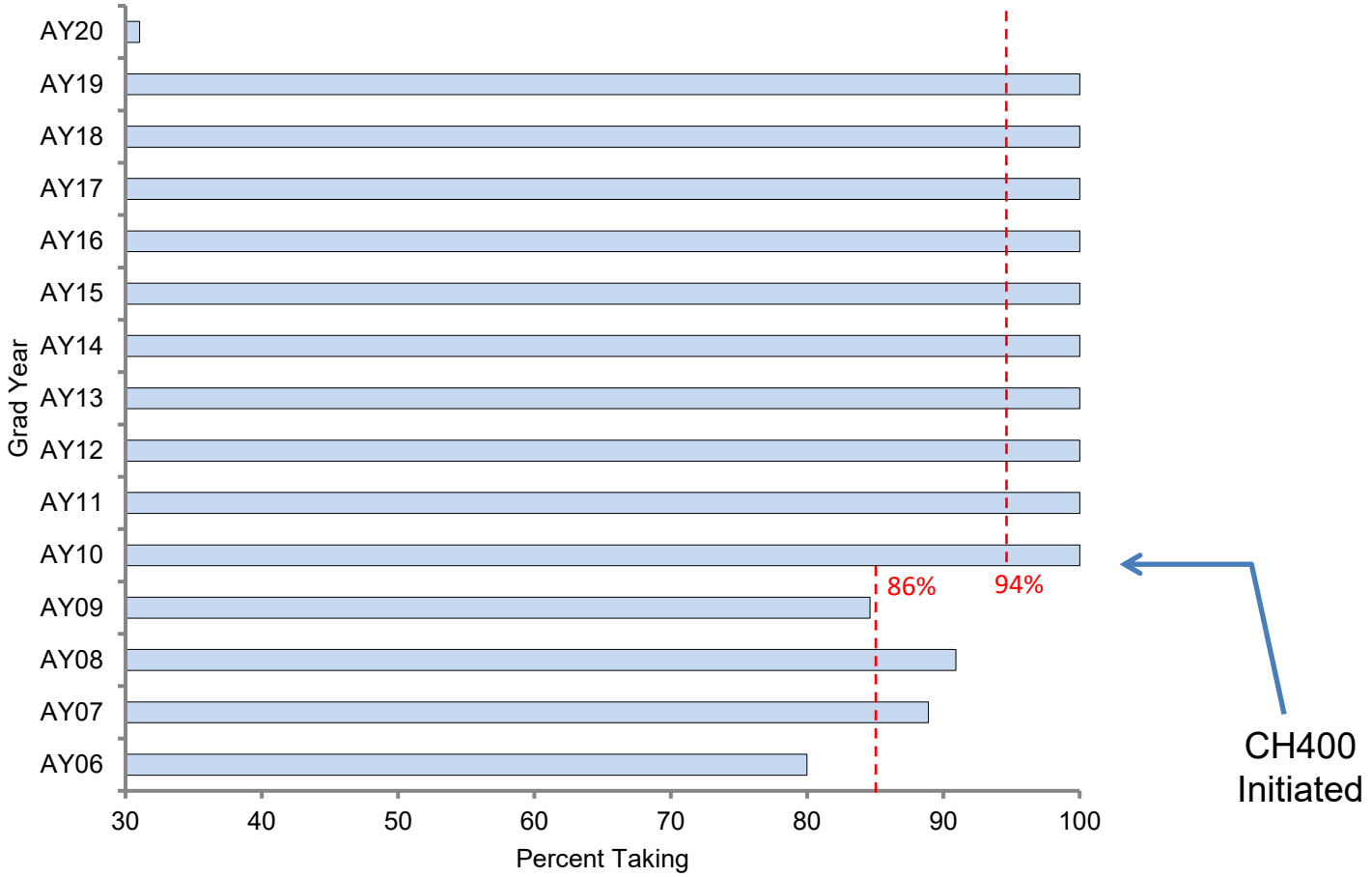
End-of-Semester Surveys Program Aves. From AY15-20



Fundamentals of Engineering Exam

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

Percent of cadets taking the FE Exam



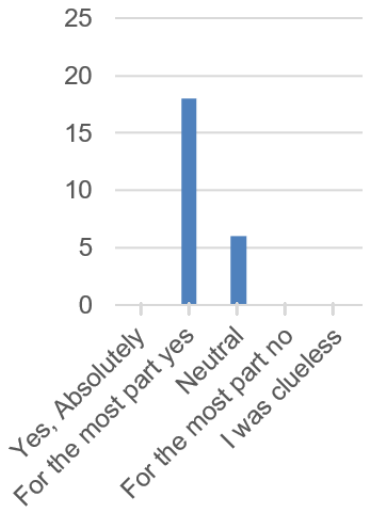
Fundamentals of Engineering Exam

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

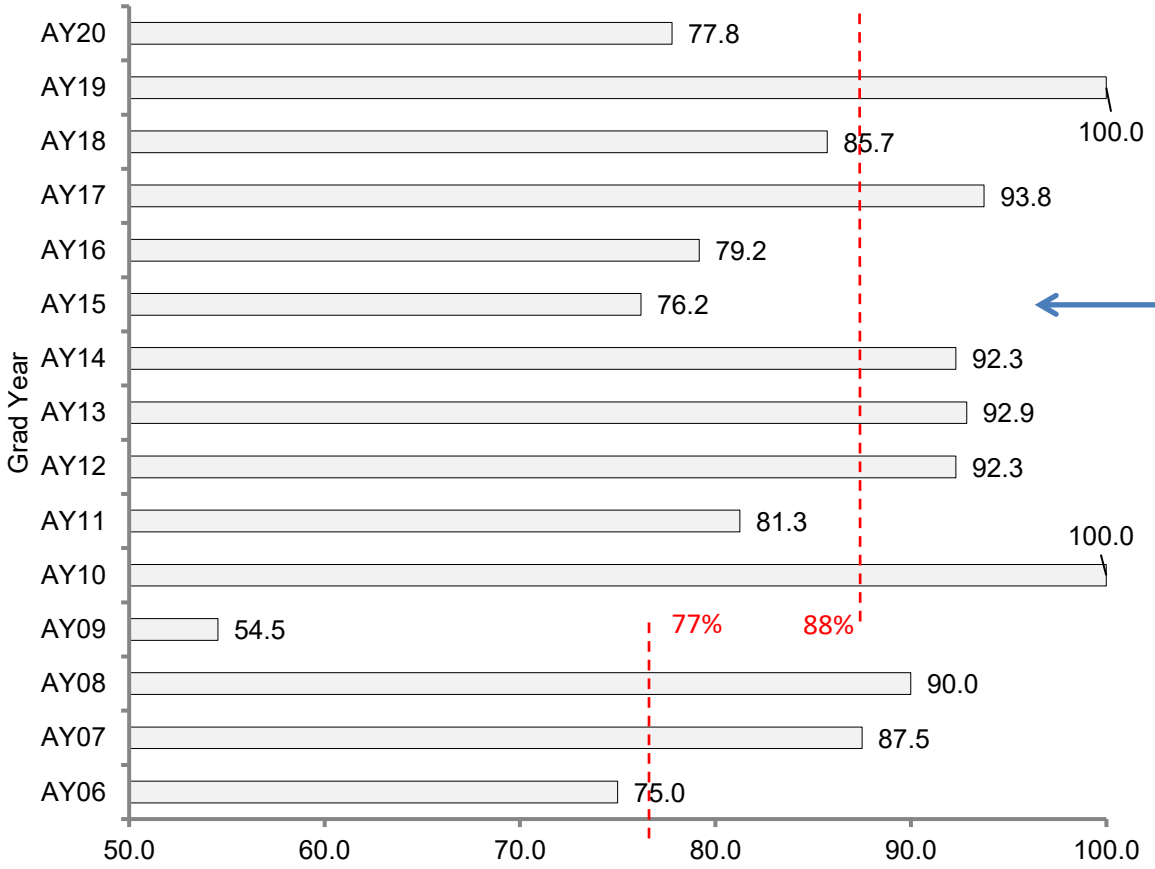
National, (+/- ~1%):

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



Percent of cadets passing the FE Exam



Electronic Testing Initiated

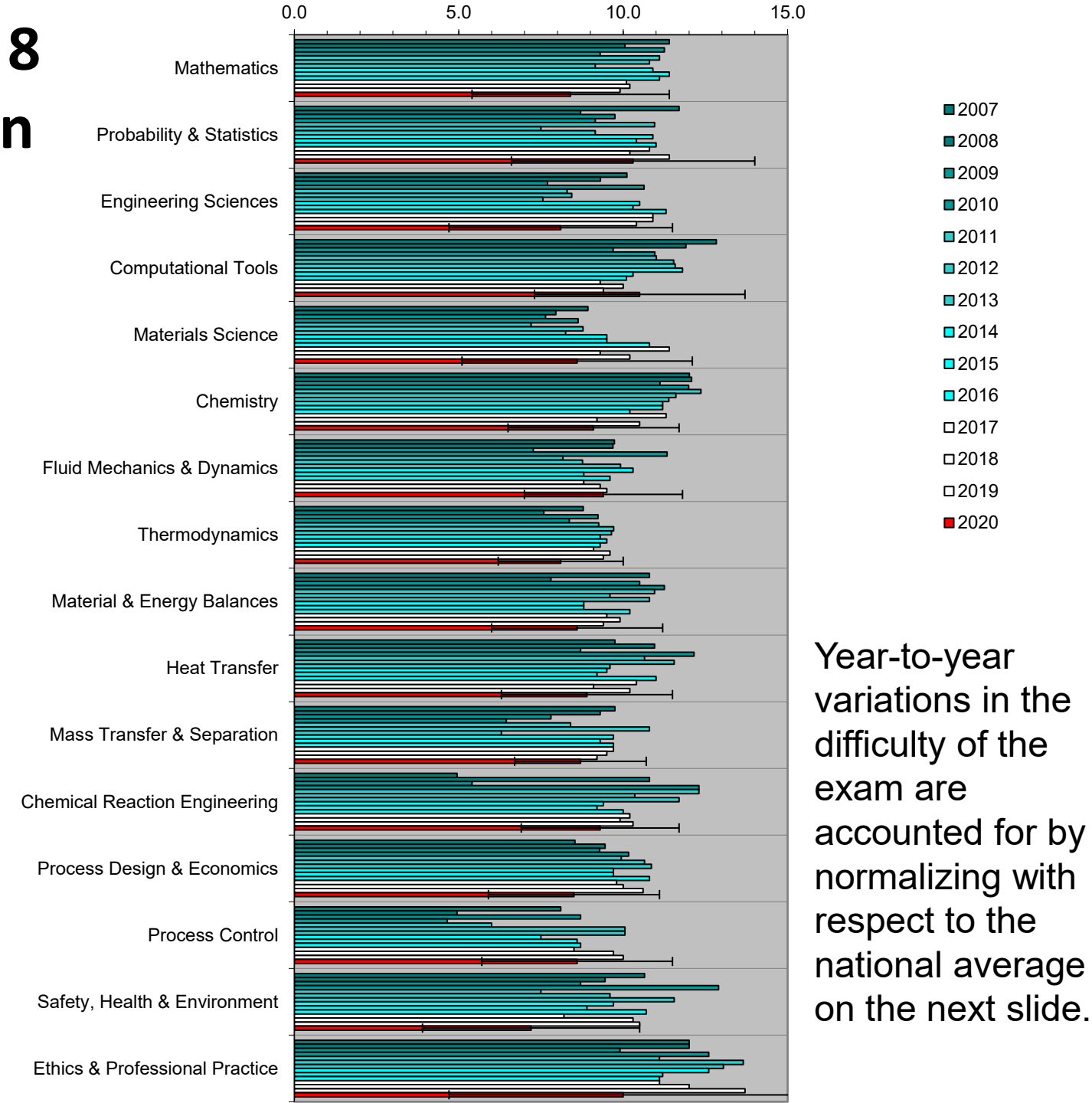
CH400 Initiated

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

Outcome 8 Evaluation

FEE Results by Topic

AY07 to AY20



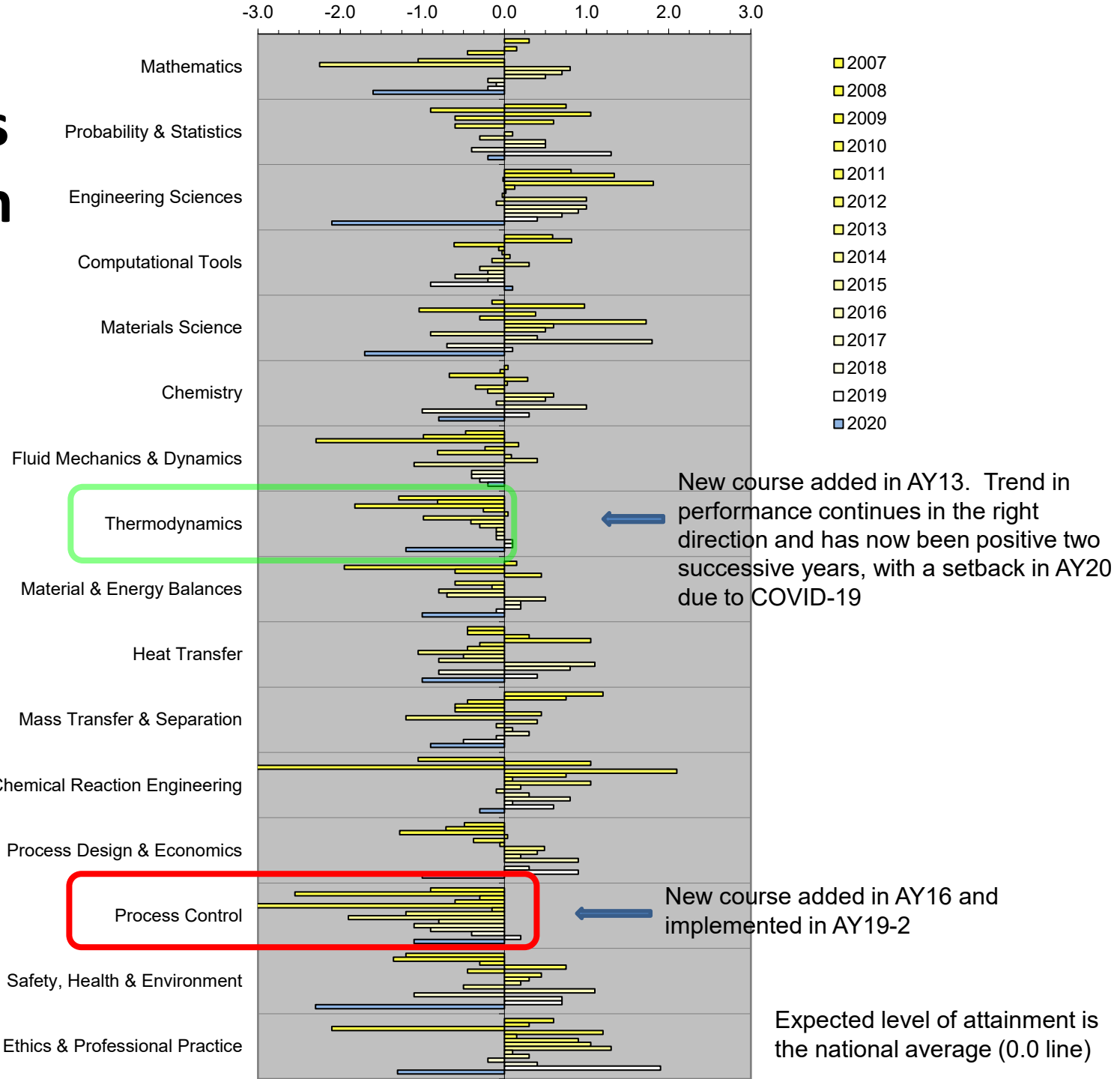
The error bars are the individual standard deviations for the AY20 data.

The average standard deviation over all data is 3.0.

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

Topical Outcomes Evaluation

Deviations from National Averages AY07 to AY20



New course added in AY13. Trend in performance continues in the right direction and has now been positive two successive years, with a setback in AY20 due to COVID-19

New course added in AY16 and implemented in AY19-2

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

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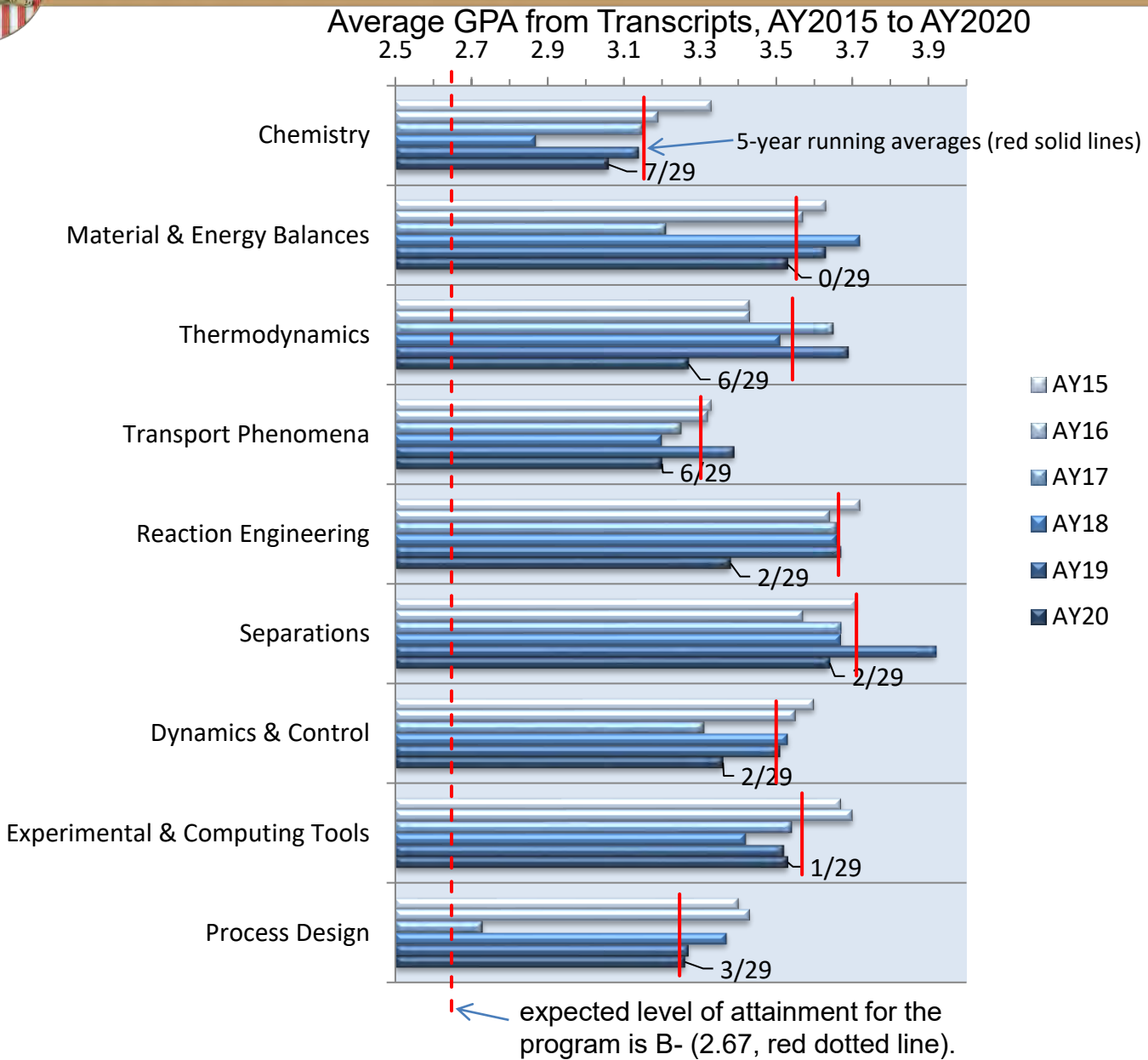
Topical Outcomes Evaluation

Student Outcome 8: Understanding of the Chemical Engineering Curriculum



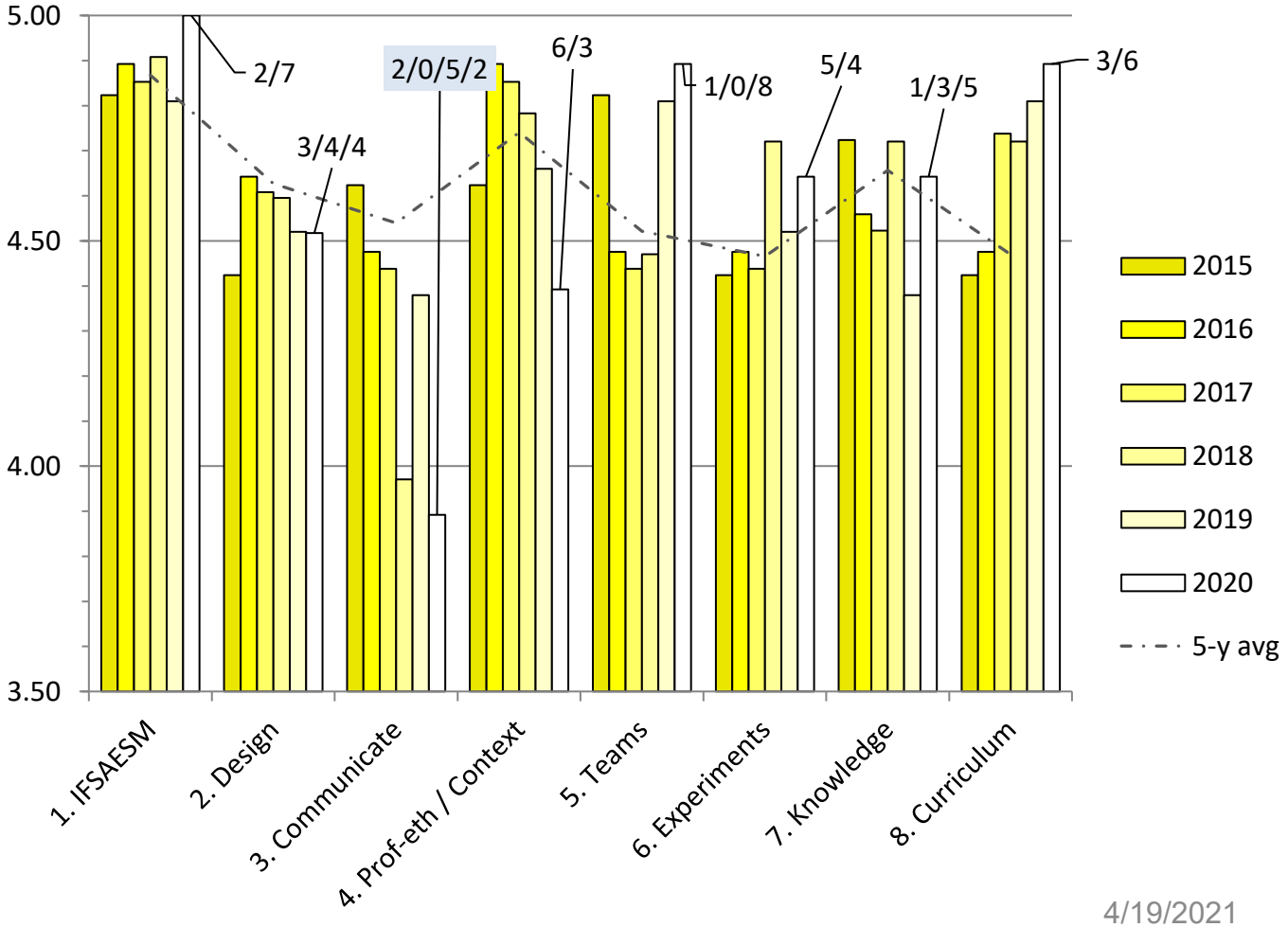
Letter Grade	Grade Point Conversion:
A+	4.33
A	4.00
A-	3.67
B+	3.33
B	3.00
B-	2.67
C+	2.33
C	2.00
C-	1.67
D	1.00
F	0.00

Faculty Student Outcomes Surveys

Student Outcomes 1-8

Program Averages from AY15-20

Data labels are response frequencies for 2-5 on the 1-5 Survey Likert Scale (# of 2 / # of 3 / # 4 / # of 5)
Standard deviations range from .08 to .23

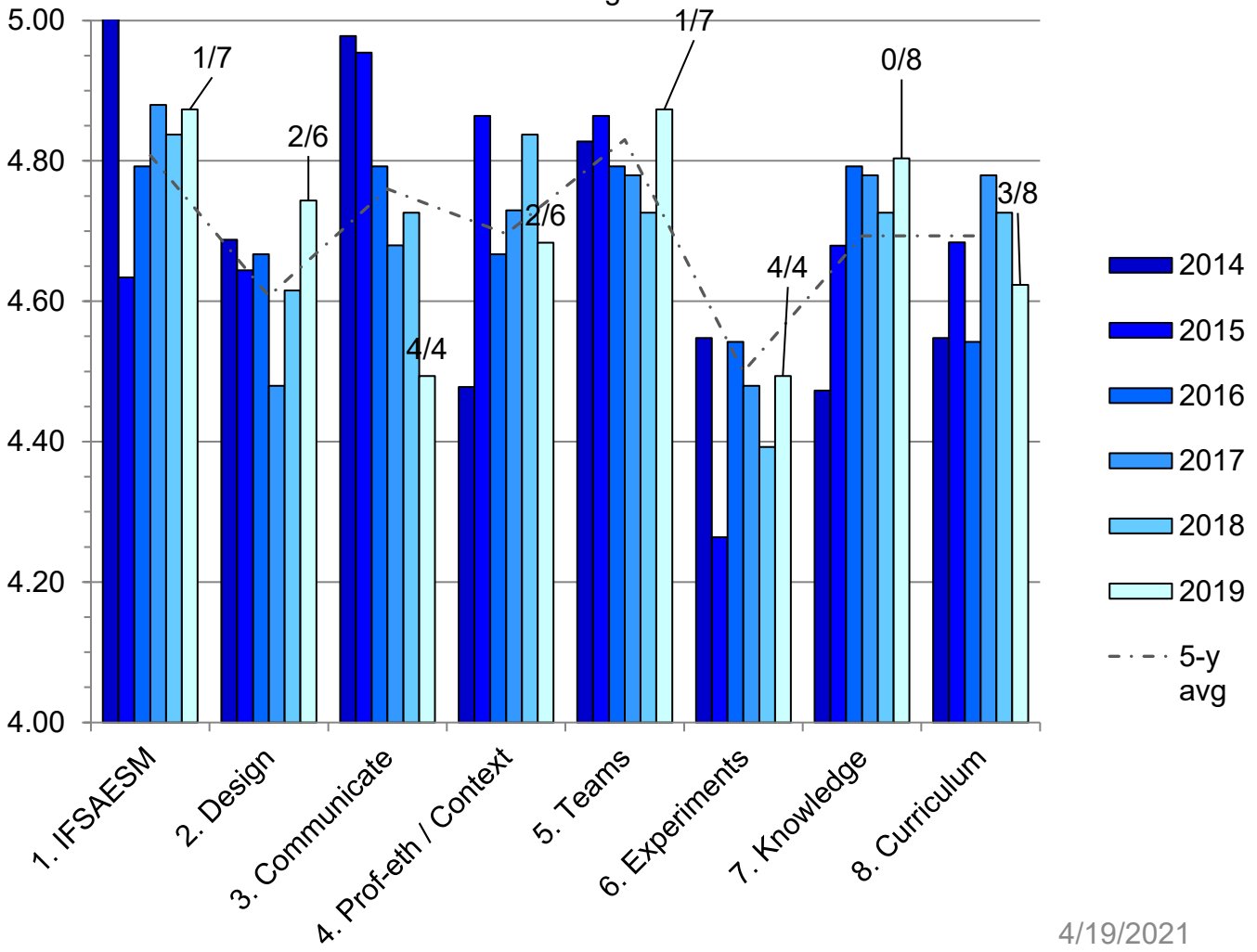


Advisory Board Student Outcomes Surveys

Student Outcomes 1-8

Program Averages from AY14-19

Data labels are response frequencies for 4 or 5 (# of 4s / # of 5s) on the 1-5 Survey Likert Scale
Standard deviations range from .26 to .53



Advisory Board Completes Survey Part 1

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

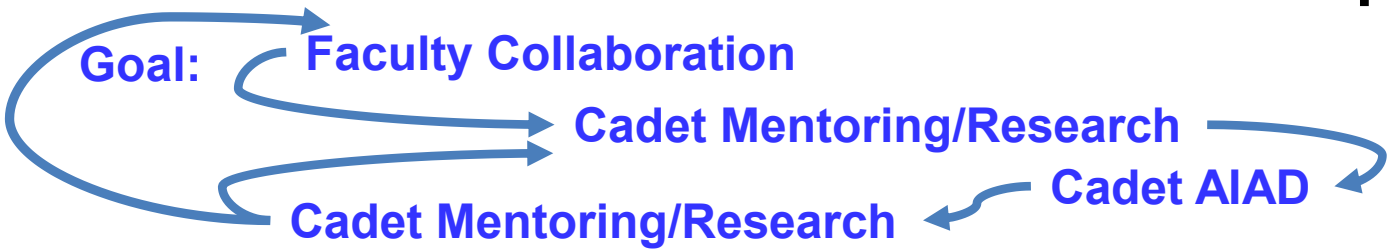
Assessment Instruments for Objectives

Program Surveys

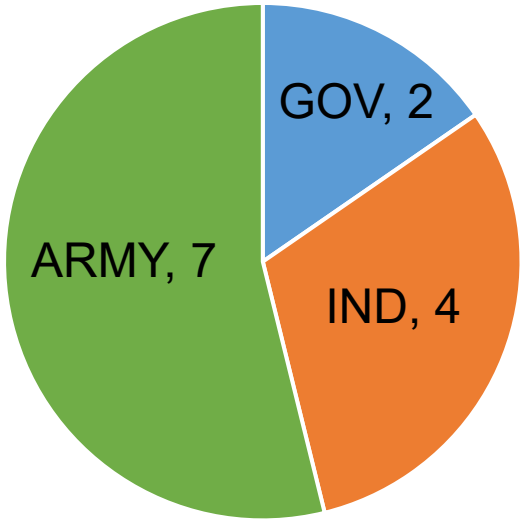
Program Advisory Board Surveys
Program Faculty Surveys
Program Cadet Surveys

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



Advisory Board Completes Survey Part 2

Board – Cadet Discussions

Concept (flexible) of discussions

~ 1000-1045 Board ask questions of cadets

Any courses in curriculum cadets are unhappy with?
Any general issues with the program they would like to discuss?

~ 1045-1115 Cadets ask questions of board

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Lunch – Subs and Wraps

Lunch:

1. Cold cut Italian mix sandwiches and wraps
2. Mixed salad
3. Chips: regular/barbeque/sour cream & onion/Cheetos/Doritos
4. Iced tea/soda/water/coffee
5. Cookie plate

Chemical Engineering

Advisory Board Meeting

23 April 2021

4. Future Challenges

United States Military Academy
Department of Chemistry and Life Science

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

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Strategic Influence

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

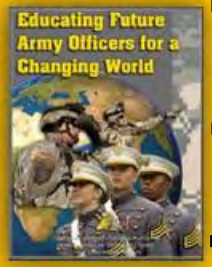
Department of the Army
- Army Goals and Priorities
- Army Regulations
- Army Doctrine

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

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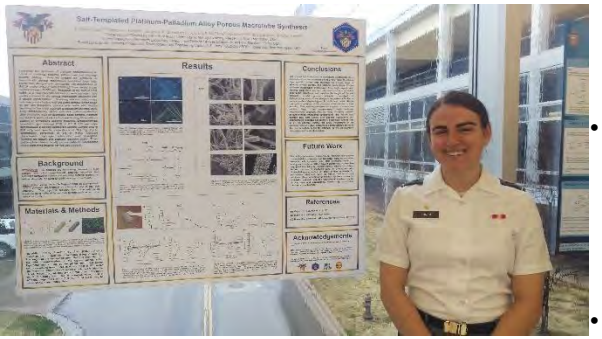
CDT Anchor Losch, ’20
Chemical Engineering



- **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

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.

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Chemical Engineering Faculty

	AY21	AY22	AY23	AY24	AY25	AY26	AY27
Burpo	X	X	X	X	X	X	X
Biaglow	X	X	X	X	X	X	
Lachance	a	?	?	?	?	?	?
Nagelli	X	X	X	X	X	X	X
James	X	X	X	X	X	X	X
Yuk	X	X	X	X	X	X	X
Corrigan	X						
Cowart	X	X	X				
Armstrong	X	X					
Chin	X	X	X				
Yi	X	X	X				
Bowers		X	X	X			
Mandes		X	X	X			
Belanger			X	X	X		
Rogers						X	X
Golonski					X	X	X
Totals	**10+**	**11+**	**11+**	**8+**	**7+**	**7+**	**6+**

a – available to teach; currently in registrar's office

? – uncertain availability

Effects of COVID: AY20/ AY21

- Spring AY20-2 transition to remote learning
- Cadets left for Spring Break 6MAR→ came back JUN20
- 10/30 Class of ’20 chemical engineers took FEE
- Fall AY21-1 was a combination of in person, fully remote and hybrid
- Fall AY21-1 no TEE in chemical engineering courses
- Spring AY21-2 first 10 days remote
- Hybrid/remote for remainder of Spring AY21-2 semester

Implementing Schedule Change

- Since AY19 the Academy's 1-day/2-day schedule has changed
  - Now 40x 1-days and 30x 2-days
  - **Some courses have shifted to a 30-lesson sequence (CH363; CH485), IOT deconflict cadet schedules**
- The additional 10 2-days are now 'Study Days'
- Biggest impact on Chemical Engineering is CH459 (ChemE Laboratory)
  - Back-to-back sections: experiment reset time?
- Major impacts to core classes, CH101/102
  - Full impact on base knowledge and understanding uncertain

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Chemical Engineering Program
10+ year vision

1. **Stabilized** at **~40** +/- (1-5) cadets per class year; if >40 establish OML; Recommended GPA: ~2.3

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

3. Curriculum:

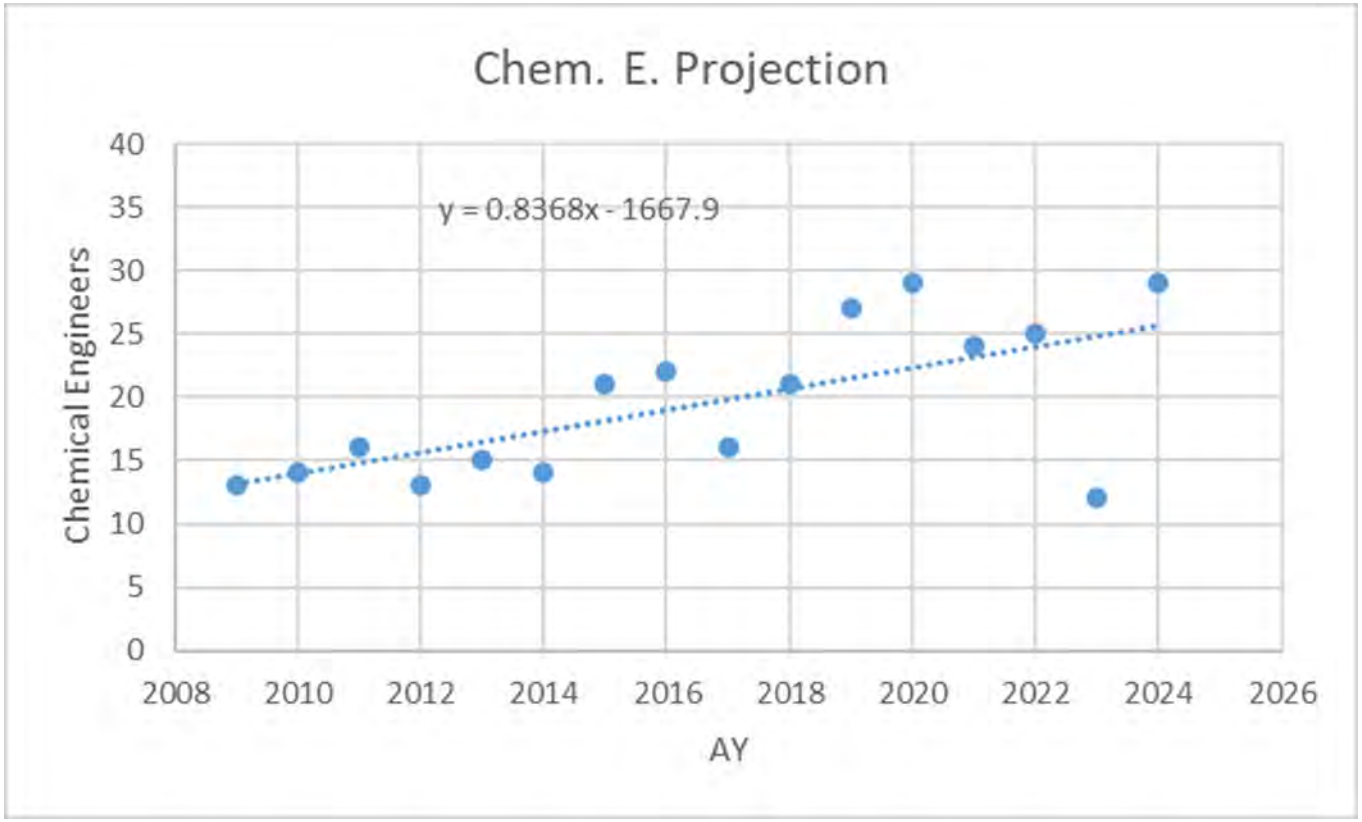
Bioengineering
   a. 3x Bio.-Eng. track: CH300, CH350, CH4; validate the ET credit
   b. Stand up bioengineering sequence
   c. Stand up bioengineering major
   d. Currently: Bio.-Eng. AP search; Ongoing Title10 hiring action

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

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

5. **Ranked** undergraduate program
   a. ABET recertifications (15-19 NOV20); maintain ABET efforts; assessment; strength use of SSI software/CHEMCAD
   b. Establish "footprint" at National level conferences: AIChE; SOR; ACS & communicate USMA Chem. E. vision to other Universities
   c. Get more Chemical Engineers PEV training here (James, Nagelli)
   d. **Maintain** BH331 computer room; chemical engineering work/research space (Applications Rm.; BH136); Network

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


Chem. E. Projection
y = 0.8368x - 1667.9
Chemical Engineers
AY
0
5
10
15
20
25
30
35
40
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026

Electives Proposals

- Cadets have expressed ongoing interest in more bioengineering electives
- Currently have 3 engineering electives in our major (to meet ABET requirements; 9 credit hours)
- ABET change lowered the required number of strictly engineering credit hours to 45
  - Options: retain engineering elective (at least in short term, will do so)? Chemistry elective? MSE at large? Others?

Other Electives / Thoughts

- **CH450** Bioengineering Modeling and Analysis added to Redbook (*more details next slide*)
- Numerical Methods for Chemical Engineering Problems
  - Enhance cadet experience with computational tools (MMA, Matlab)
  - Ready to execute
  - FEE data seems to support this
- Chemical Explosives
  - Taught before, ready to execute with instructor prep

CH300: Introduction to Biomedical Engineering

Course Director: TBD

Course OIC: MAJ Jeffrey Chin

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

Assessment – Graded Events

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

TEXT: Biomedical Engineering, 2nd Edition, by W. Mark Saltzman; Cambridge University Press, 2015.

COA 1

Block I: Molecular and cellular principles
- Biomolecular principles (Ch. 2)
- Biomolecular principles: Nucleic acids (Ch. 3)
- Biomolecular principles: proteins (Ch. 4)
- Cellular principles (Ch. 5)

Block II: Physiological principles
- Communication systems in the body (Ch. 6)
- Engineering balances: respiration and digestion (Ch. 7)
- Circulation (Ch. 8)
- Removal of molecules from the body (Ch. 9)

COA 2

Block I: Molecular and cellular principles
- Biomolecular principles (Ch. 2)
- Biomolecular principles: Nucleic acids (Ch. 3)
- Biomolecular principles: proteins (Ch. 4)
- Cellular principles (Ch. 5)

Block II: Physiological principles
- Communication systems in the body (Ch. 6)
- Engineering balances: respiration and digestion (Ch. 7)
- Circulation (Ch. 8)
- Removal of molecules from the body (Ch. 9)

Block III: Biomedical Engineering
- Biomechanics (Ch. 10)
- Bioinstrumentation (Ch. 11)
- Bioimaging (Ch. 12)
- Biomolecular Engineering I: Biotechnology (Ch. 13)
- Biomolecular Engineering II: Engineering of Immunity (Ch. 14)

CH350: Introduction to Bioengineering

Course Director: Dr. Simuck Yuk

Credit Hours: 3.0 (BS=0, ET=3.0, MA=0)
Prerequisites:
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

Bioprocess Engineering Basic Concepts, 3rd Ed., by Michael L. Shulter, Fikret Kargi, Matthew DeLisa, Prentice Hall.

Quantitative Fundamentals of Molecular and Cellular Bioengineering, by K. Dane Wittrup, Brice Tidor, Benjamin J. Hackel, and Casim A. Sarkar, The MIT Press.

- Introduction
- Enzyme Kinetics
- Central Dogma to Molecular Biology
- Cell Growth
- Bioreactor Selection
- Bioprocess Consideration

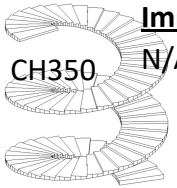
Course Assessment – Items from Section III

Sustain:

N/A at this point.

Improve:

N/A at this point.



Assessment – Graded Events

1 *Capstone Presentation	200	14%
2 *WPRs	400	28%
5 *After-class Problem Sets(20pts/ea.)	100	7%
5 *In-class Problem Sets (50pts/ea.)	250	17%
1 *Term End Exam	500	34%
Total:	1450	100.00%

CH450: Bioengineering Modeling and Analysis

Course Director: COL John Burpo

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

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

Topics – by Chapter

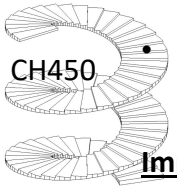
TEXT: Introduction to Biomedical Engineering, 3rd Edition, by John Enderle and Joseph Bronzino; Academic Press, 2012.

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

Course Assessment – Items from Section III

Sustain:

- Best looking Dept Head/ CD/ Prof at the academy
- 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



Improve:

Assessment – Graded Events

5 *Problem Sets@ 25 pts each	500	47.2%
6 *Quizes @ 200 pts each:	180	17.0%
1 *Paper	150	14.1%
1 *Presentation	50	4.7%
6 *Discussion	180	17.0%
Total:	1060	
*Individual Points :	1060	100%

Bioengineering Track

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

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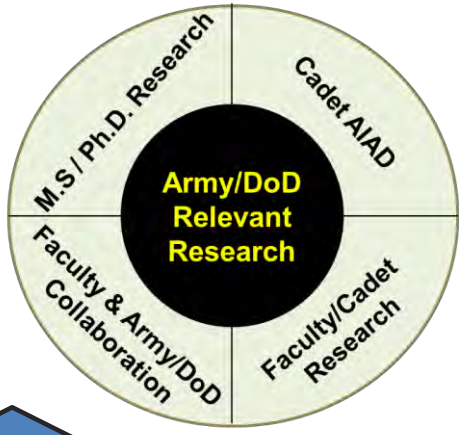
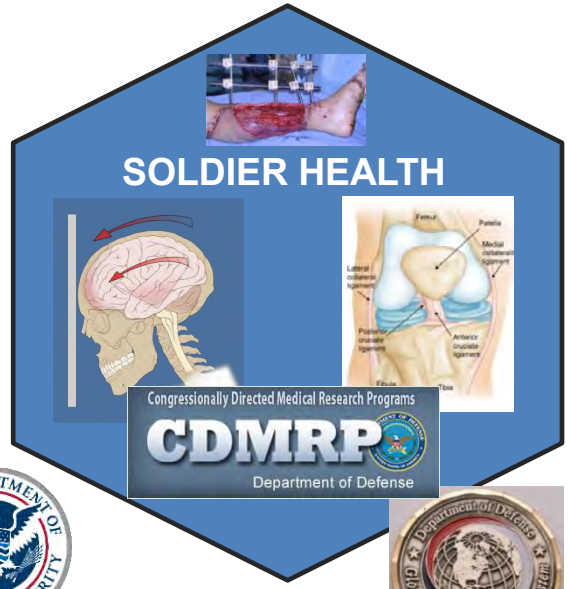
Undergraduate Research

Securing external resources through collaborations



Funded Collaborations:
UC Santa Barbara
Florida Institute of Technology
Cornell
University of Michigan



ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER
PICATINNY ARSENAL, NJ

U.S. ARMY RDECOM

ARL

DARPA

EDGEWOOD CHEMICAL BIOLOGICAL CENTER
A U.S. Army RDECOM Laboratory

DEFENSE THREAT REDUCTION AGENCY
UNITED STATES OF AMERICA

U.S. DEPARTMENT OF HOMELAND SECURITY

USU
Uniformed Services University

NCAA•DOD
Grand Alliance
CARE Consortium

Department of Defense
Global Emerging Infections System

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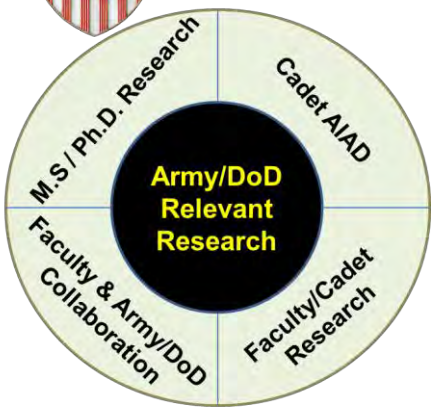
Promoting Cadet Development in Chem. E.



Faculty and Cadet Developmental Model

Principal investigators with DoD supporting projects, funding, and collaborators facilitate cadet research through a progressive series of courses – **CH290** (1 CR), **CH389/390** (1.5 CR), **CH489-492** (3 CR). This course progression allows cadets to begin research as early as their first year and participate in a multi-year project. Every effort is made to link research AIAD's with the collaborating DoD labs.

***Promoting Research and Scholarship**
- **10 Cadet co-authored papers in AY20**
- **24 Cadet conference proceedings AY20**
  - **AIChE; SOR; ACS**
  - **200/300/400 level research**

***Modeling Institutional Values**:
- Department Character development strategy
- **3 Leadership Challenge Facilitators**
- **3 PL300 Mentors (25 cadets)**
- **3 SLDP Developmental Coaches**

*Instituting **research-based instructional practices** to support APGs and WPLDS outcomes

***Engaging with Cadets**:
- **Club Affiliations: 3 Faculty/2 Clubs (1 OIC)**
- **USMA Chapters: AIChE and ACS**
- **ODIA Sport: 4 Faculty/ 4 Teams**
  - ***1 Head OR- Men's Hockey***
  - ***3 Asst. OR-Swimming & Diving***
  - ***Rifle***
  - ***Men's Basketball***
- **First-year Sponsorship Program: ~53 Cadets**
- **Unofficial Sponsor: >25**

Every interaction is a developmental event

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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

USMA Independent Research

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

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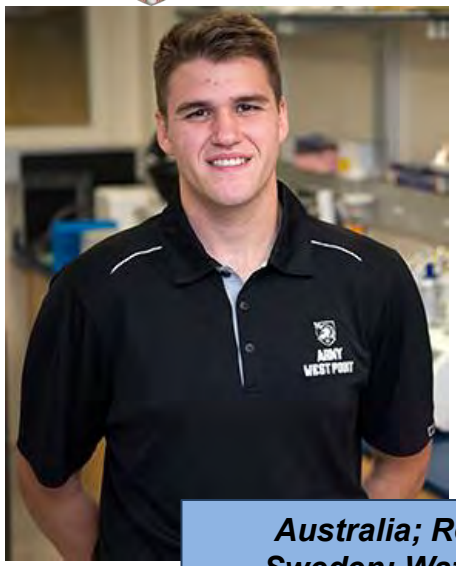
CDT Jesse Palmer, ’19
Chemical Engineering



- **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

Engineering Concentrations

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

Some Administrative

- Next Advisory Board on-site
  - Late April/Early May 2022…close out Class of ‘21
- Travel Paperwork/Dinner settle
- Tour of Unit Operations Lab…UTC

End of Section 4

Chemical Engineering

Advisory Board Meeting

23 April 2021

Thank you!

United States Military Academy
Department of Chemistry and Life Science

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