AY20-2 Chemical Engineering Course and Program Brief

LTC Matthew Armstrong
LTC(P) Geoff Bull
Dr. Enoch Nagelli
MAJ Trevor Corrigan

LTC Corey James
Dr. Andy Biaglow
LTC April Miller

7NOV19

Agenda

- Course Briefings
  - CH402
  - CH400
  - CH367
  - CH364
  - CH362
- Course/Program Assessment Highlights
- ABET Recertification Update
- Bio-Engineering “track”
- ABET Advisory Board (**9-10APR**); Attendees

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

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

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

Topics – by Chapter

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

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

Course Assessment – Items from Section III

Sustain:

- Communication efforts
- Capstone project - petroleum refinery project – expanded: standardized crude analysis method to simplify troubleshooting, required working design earlier, vastly increased process safety research, required professional P&IDs, discussion of logistics trains, requirement for profitable operation, and professional reports
- Synchronization with CH400 vis-à-vis FEE prep

Improve:

High-mileage computers – time to replace
Communication skills (written)
Add contemporary issues (bitumen, dieseline, etc.)

Assessment – Graded Events

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

CH400: Chemical Engineering Professional Practice
Course Director: LTC Matthew Armstrong

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

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

Topics – by Chapter

FEE Supplied-Reference Handbook Ed. 9.4 for Computer
FEE Chemical sample questions + solutions

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

Course Assessment – Items from Section III

Sustain:
Continue to have graded events per topic
Continue to go over all graded events before FEE
Probability and Statistics review
New WPRs with Chem E. FEE problems
Improve:
Take FEE before 1APR (100% pass AY19)
Conduct General Chemistry review
Use discipline specific FEE manual

Assessment – Graded Events

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

CH367: Intro. to Auto. Process Control
Course Director: LTC James

Credit Hours: 3.0 (BS=0, ET=3.0, MA=0)
Prerequisites: EE301, MA364/365
Co-requisite: None
Lessons: 30 @ 75 min
Special Requirements: None

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

Topics – by Chapter

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

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

Course Assessment – Items from Section III

Sustain:

*Use of SSI software for demonstrating dynamics, stability, design, and tuning

Improve:

*Spread capstone throughout the semester

*Spend more time designing valves and relating that to control

*Expand coverage in chapter 8 (~lesson 12, controllers)

*Expand stability and tuning practical exercises

Assessment – Graded Events

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

CH364: Chemical Reaction Engineering
Course Director: Dr. Enoch Nagelli

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

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

Topics – by Chapter

Elements of Chemical Reaction Engineering, Fogler, Prentice Hall, 5th Edition (2016)

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

Course Assessment – Items from Section III

Sustain:

Continue use of Fogler, Sect. 12.6 for Capstone Project

Continue open-feedback questions in end-of-course surveys

Improve:

Capstone needs refinement and introduction earlier in course

Improved feedback to cadets regarding written work quality

Transition textbook from Fogler's *Essentials* to *Elements*

Increase number of in-class problems; re-work/improve problem sets

Assessment – Graded Events

3 WPRs @ 250 pts each:	750	35.70%
9 Problem Sets @ 35-50 pts each:	330	16.00%
30 Daily Questions @ 3.33 pts each:	100	4.76%
5 Computer Labs @ 40 pts each:	200	9.50%
1 Capstone Project @ 200 pts:	200	9.50%
Instructor Points (Various)	20	1.00%
1 Term End Exam @ 500 pts	500	23.80%
Total:	2100	
Individual Submission:	1700	80.95%

CH362: Mass and Energy Balances
Course Director: MAJ Corrigan

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

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

Topics – by Chapter

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

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

Course Assessment – Items from Section III

Sustain:

Technical Writing: Written Lab Reports and Research Paper

Capstone project – open to contemporary issues in any field in science and engineering. Modeling and Oral Presentation

Modeling projects using software for analytical techniques

Improve:

More Energy Balance Lessons and Ch. 10 Transient Processes

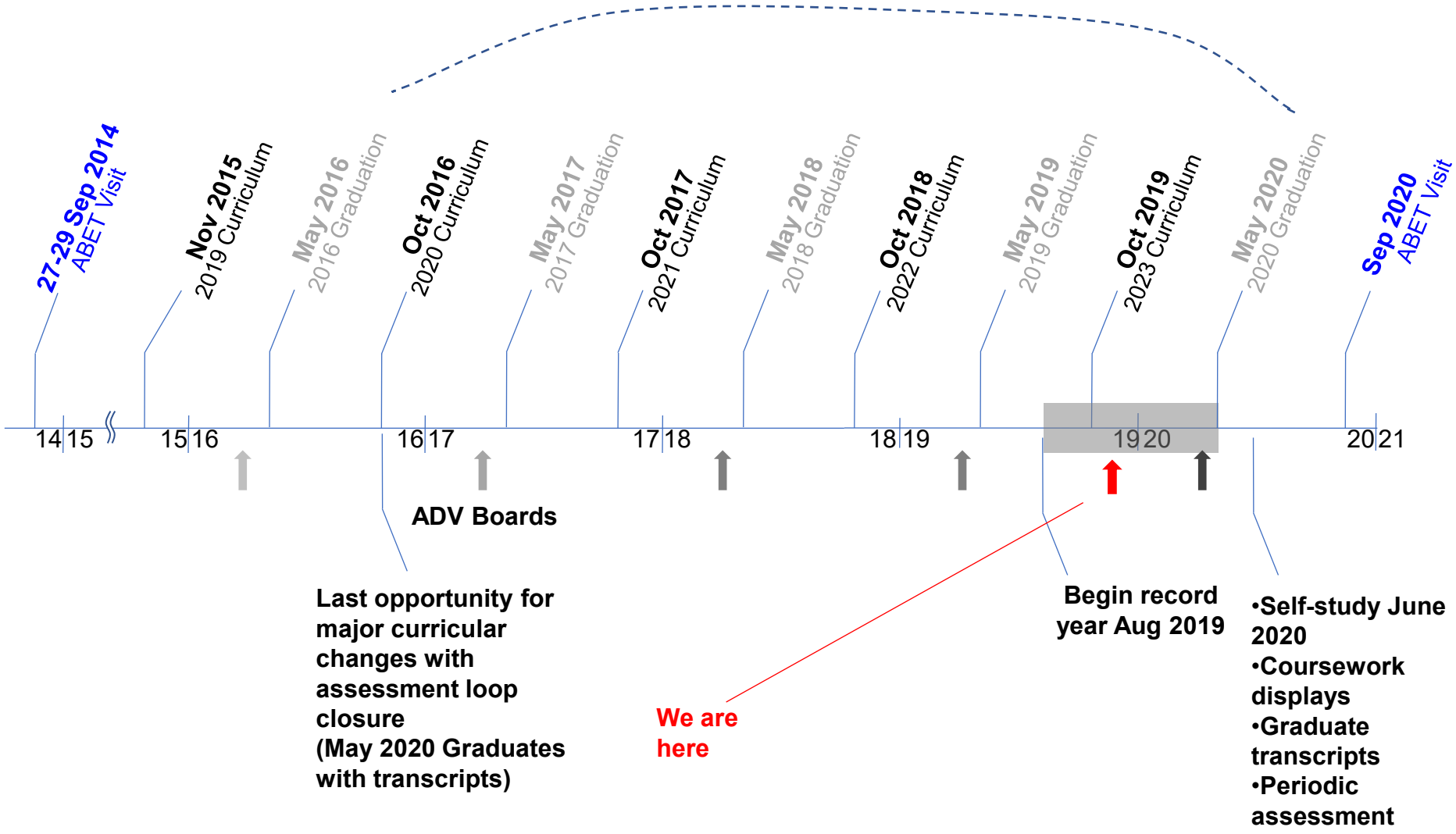
Technical Skills (navigating CHEMCAD, Mathematica)

Problem solving and basics of general chemistry

Assessment – Graded Events

8 *Problem Sets @ 25 pts each:	200	8.2%
4 *In-Class Prob. Sets @ 100 pts ea.:	400	16.43%
3 *WPRs @ 200 pts each:	600	24.64%
1 *Research Paper @ 100 pts:	100	4.11%
3 *Modeling Projects @ 75 pts each:	225	9.24%
7 *Labs @ 30 pts each:	210	8.62%
1 *Term End Exam @ 550 pts:	550	22.58%
1 Capstone	150	6.16%
Total:	2435	
*Individual Submission:	2485	**93.8%**

Timeline for Major Curricular (ABET) Actions



Fundamentals of Engineering Exam

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

National, (+/- ~1%):

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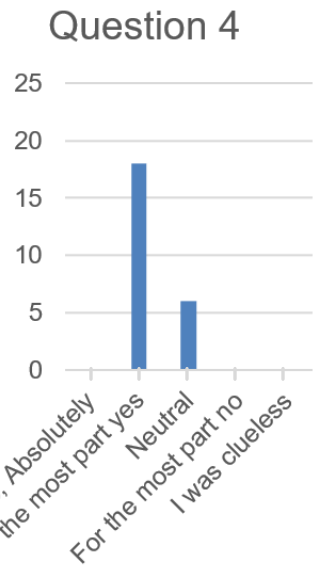
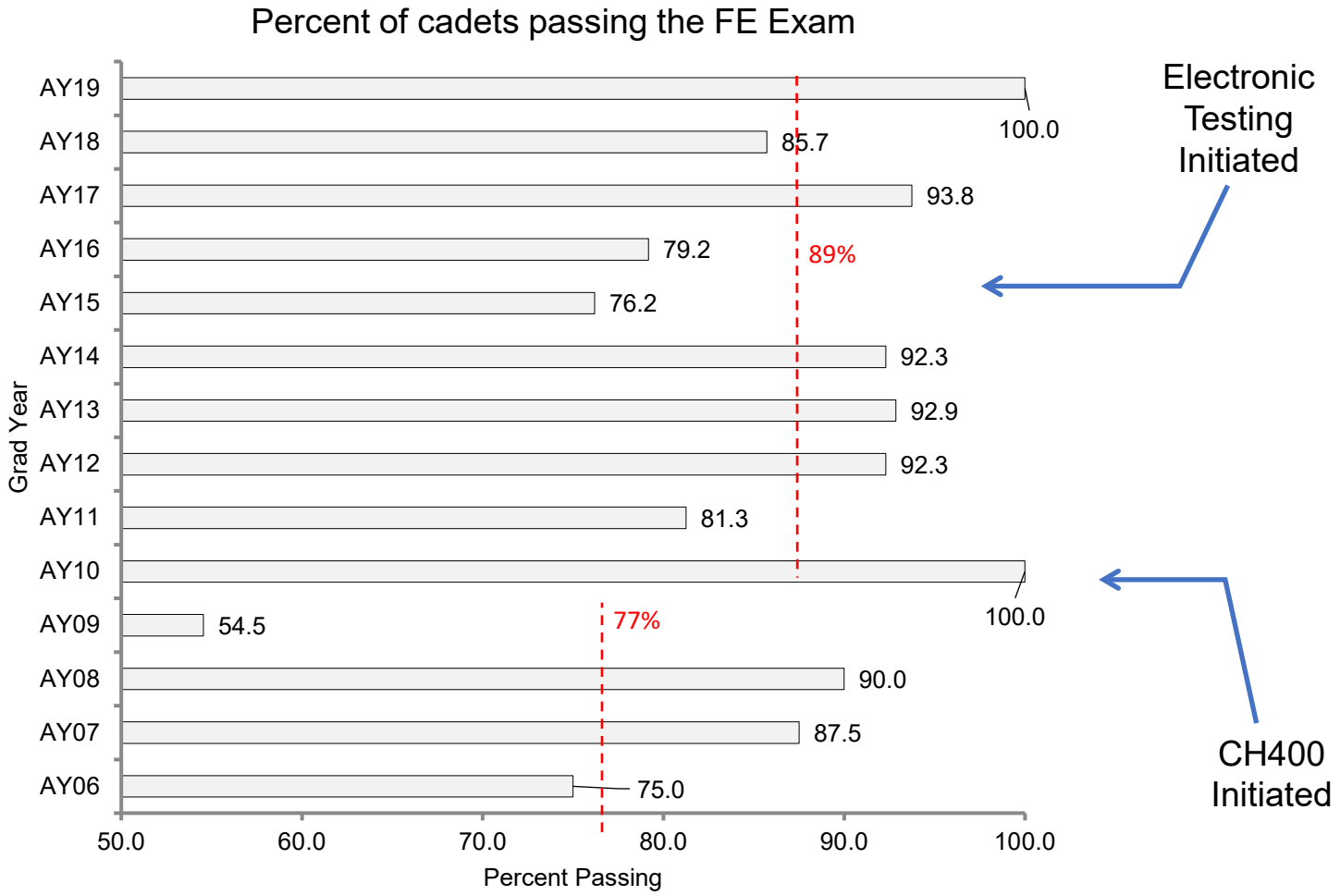
2014	89.0%
2013	86.3%
2012	85.1%
2011	87.0%
2010	87.0%
2009	84.0%
2008	87.0%
2007	87.0%
2006	87.0%

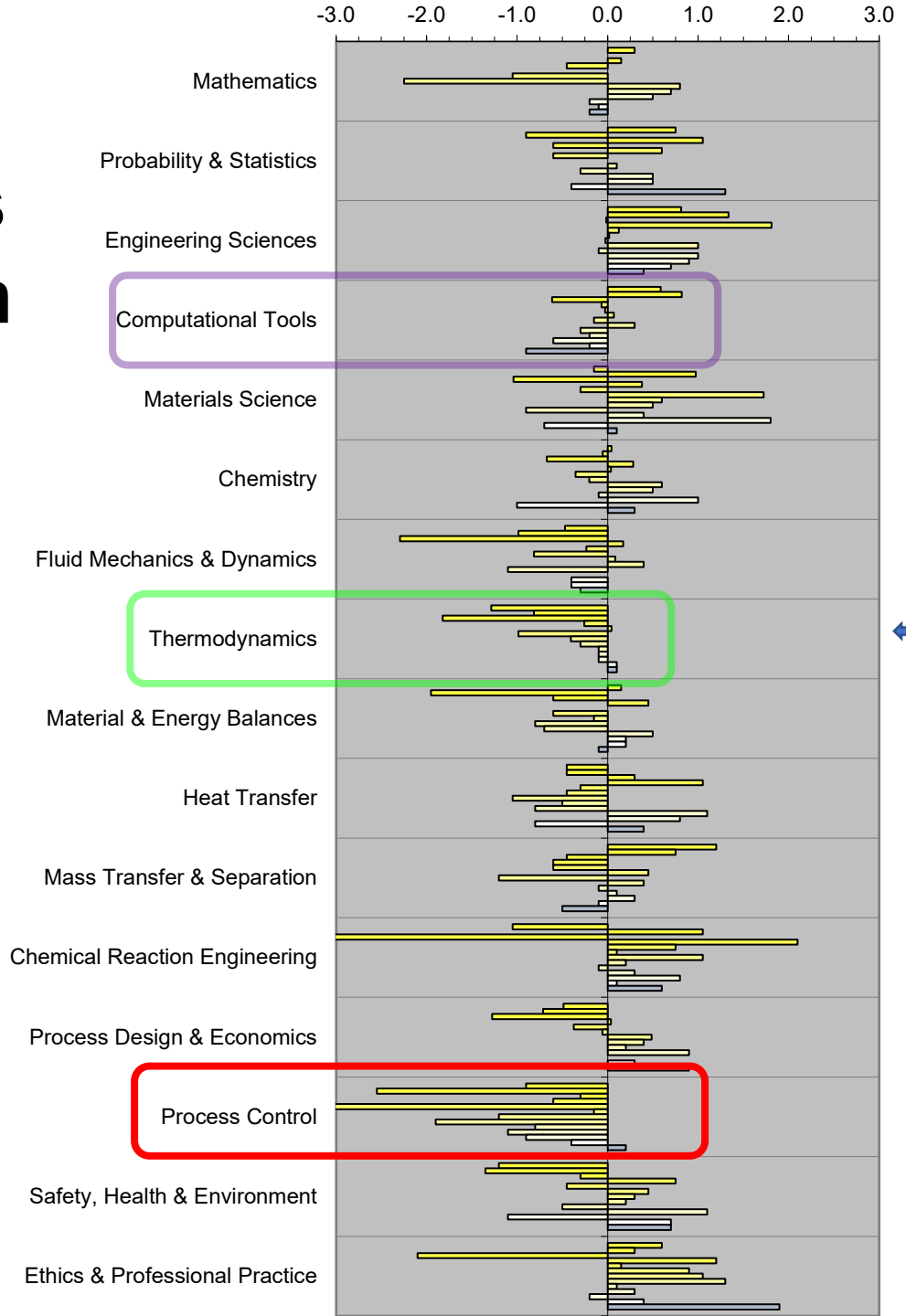




Question 4, Post FEE Survey:
For the questions on the exam that seemed new to you, were you able to learn the material on the spot?

Topical Outcomes Evaluation

Deviations from National Averages AY07 to AY19



Intervention accomplished in AY13 (new course). Trend in performance continues in the right direction and has now been positive two successive years.

Intervention accomplished in AY16 (new course added and implemented in AY19-2

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

ABET Recertification Update

(as of 31OCT19)

Go to Excel Sheet

Bio-engineering Track

COA 1	COA 2
CH362-CH364-CH450	**CH300-CH350-CH450**
Will require minimum of 2 additional faculty.	Will require additional faculty, minimum of 2. Ongoing Title10 & AP searches. Faculty allocation will be the same in either COA, so use new faculty to develop new courses.
Does not give Chem E cadets new electives.	*Chem E cadets currently have no electives in DCLS. Continuing area of concern.* Chem E cadets get 2x elective courses.
Existing course material/objectives are tied to ABET outcomes. These courses are highly optimized for chemical engineering content leading to high performance in these areas. Will require extensive re-configuring of **two** key program courses for a different audience without basis in assessment.	Courses should be designed to meet student needs. Memo constructed in AY18 was reviewed by other programs and is ready to drop now. Even if proposed courses are not optimal or we do not agree on content, get the courses in Redbook.
Less resource encumbered	
Course material/objectives tied to ABET outcomes 1-7,8	Better for the department. Opportunity for interdisciplinary collaboration and team building.
Cannot dilute or alter content	

Bio-engineering Track…Major

- Select Bioengineering AP
- Select Bioengineering T10
- Stand up new courses
- Get courses on book
- Get to curriculum committee
- Get Bioengineering sequence approved
- Fill in additional courses for major
- Get ABET accredited

Advisory Board AY20: 9 – 10APR20

No.	Name	Title	School - Company	Email	Best Dates
1	Kevin Shipe	Automation Engineer	NALCO Champion	kevin.a.shipe@gmail.com	both
2	Lucy Hair	EleCent Team Leader	LLNL	hair1@llnl.gov	
3	COL (Ret) Paul Dietrich	Chemical Officer	Chemical Officer/Industry	paul@the-dietrichs.com	9-10 APR
4	Kisondra Waters	Principal Analyst	Margin Analytics	kisondra@gmail.com	9 - 10 APR
5	Anthony Hatfield	Consultant Engineer	Eli Lilly and Company	hatfield@lilly.com	
6	Donald Glaser	President	Simulation Solutions	dglaser@simulation-solutions.com	
7	Matt Garvey	Engineer	Simulation Solutions	mgarvey@simulation-solutions.com	
8	Kelly Schutz	Assistant Professor	Lehigh University	kes513@lehigh.edu	9 - 10 or 23-24APR
9	Lynn Walker	Professor	Carnegie Mellon University	lwalker@anderw.cmu.edu	9 - 10 APR
10	Matthew Libertore	Professor	University of Toledo	matthew.liberatore@Utoledo.edu	23-24APR
11	Patrick Nonhof	Managing Partner	Provenance Consulting	Patrick.Nonhof@provenanceconsulting.com	9-10 APR
12	Dwight Springer	COL(RET)	Retired Deputy Head	dss5456@verizon.net	
13	Greg Ritch	COL(RET)/ Engineering Officer	MIL/Industry	garitch@cvzoom.net	
14	Mike Deforest	Industry, Chem E (Old Grad '07)	SMK Packaging	mike@smkpackaging.com	
15	Phil Visser	Chem Corps; COL (RET)		cell: 7572543017	
16	COL Aaron Hill	Academy Professor	USMA; CME	aaron.hill@westpoint.edu	
17	Patrick Underhill	Associate Professor	RPI	underhill@rpi.edu	23-24 APR 20
	Alternating				
	Go				
	No go for this year				
	Maybe				

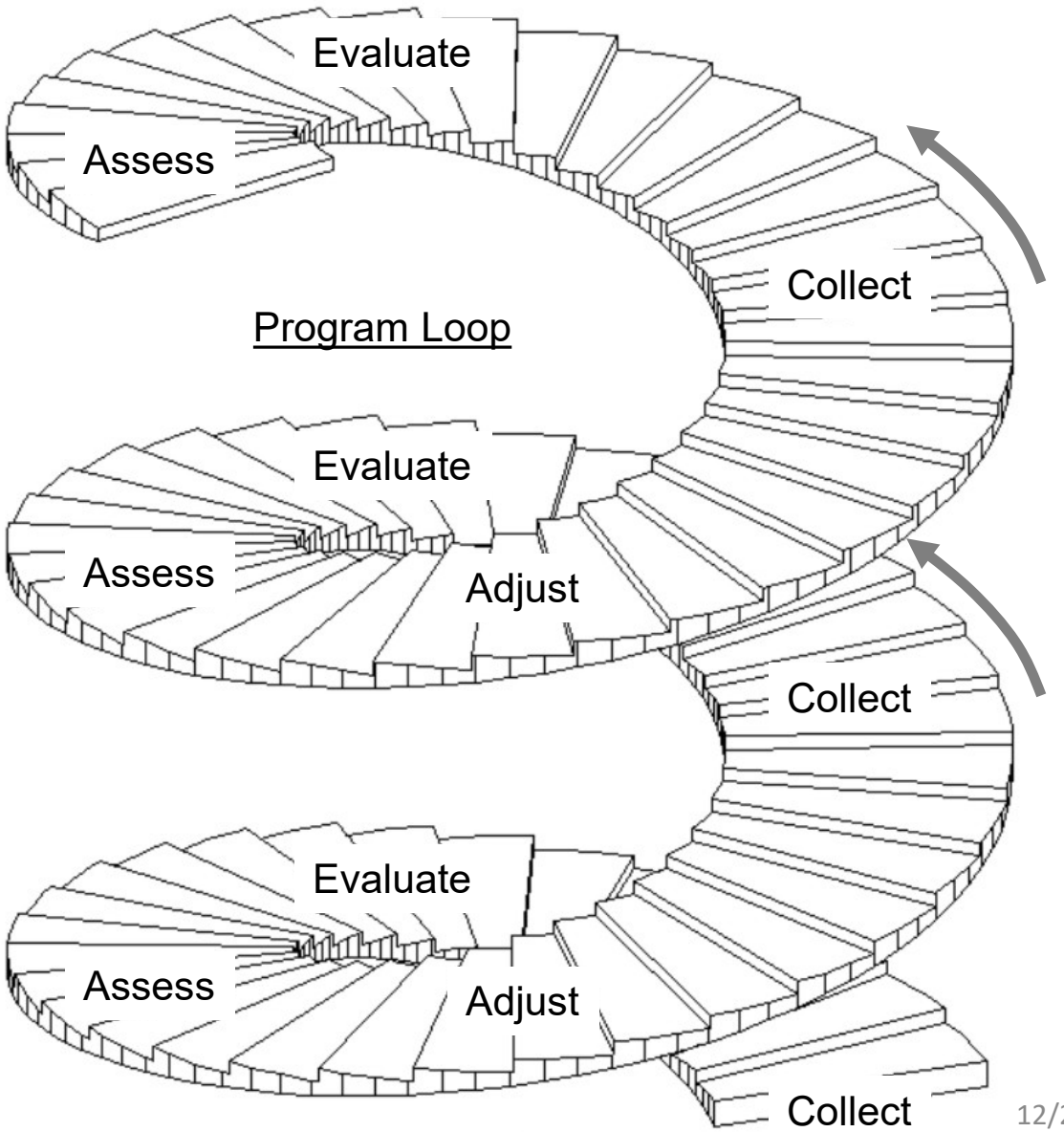
Questions

Backup Slides

ABET Advisory Board

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

Program Assessment Cycle

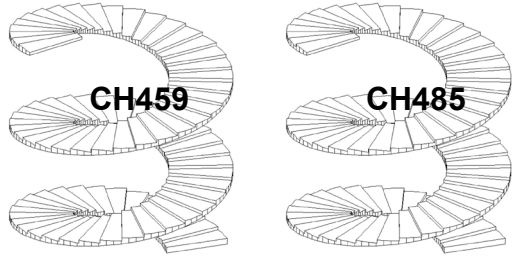


Performance Indicators:
FE Exam Results
Coursework Embedded Indicators
Surveys (Cadet, Faculty, Adv. Board)
Course Grades

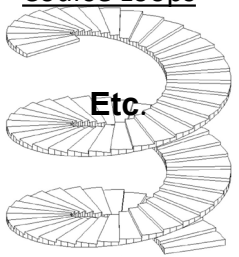
Program-level

Course-level

Course Assessments (Sect. III)
Embedded Indicators



Course Loops



CH362 Material and Energy Balance

COURSE	TITLE	EFF YEAR	EFF TERM	CREDIT HOURS
CH362	MASS & ENERGY BALANCES	2014	2	3.5 (BS=0.0, ET=3.5, MA=0.0)

SCOPE

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

LESSONS: 40 @ 55 min (2.500 Att/wk) **LABS:** 7 @ 120 min

SPECIAL REQUIREMENTS:

None

CH362 COURSE REQUISITES

TYPE	COURSE	EFF YEAR	EFF TERM	TRACK	RED BOOK FLG
PRE REQUISITE					
	CH102	2009	2	1	Y
	CH152	2009	2	2	Y

CH364 Chemical Reaction Engineering

COURSE	TITLE	EFF YEAR	EFF TERM	CREDIT HOURS
CH364	CHEMICAL REACTION ENGINEERING	2012	2	3.5 (BS=0.0, ET=3.5, MA=0.0)

SCOPE

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

LESSONS: 40 @ 55 min (2.500 Att/wk) **LABS:** 7 @ 120 min

SPECIAL REQUIREMENTS:

None

CH364 COURSE REQUISITES

TYPE	COURSE	EFF YEAR	EFF TERM	TRACK	RED BOOK FLG
PRE REQUISITE					
	CH362	2004	1	1	Y

CH450 Bioengineering Modeling and Analysis

COURSE	TITLE	EFF YEAR	EFF TERM	CREDIT HOURS
CH450	Bioengineering Modeling and Analysis	2019	2	3.0 (BS=0.0, ET=3.0, MA=0.0)

***Must be reviewed for 3.0 ET**

SCOPE

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.

LESSONS: 30 @ 75 min (2.500 Att/wk) **LABS:** 0 @ 0 min

SPECIAL REQUIREMENTS:

None

TYPE	COURSE	EFF YEAR	EFF TERM	TRACK	RED BOOK FLG
PRE REQUISITE					
	CH102	2016	1	1	Y
	PH206	2018	1	1	Y
	MA205	2017	1	1	Y

CH300 Biomedical Engineering

COURSE	TITLE	EFF YEAR	EFF TERM	CREDIT HOURS
CH300	Biomedical Engineering	2021	1	3.0 (BS=0.0, ET=3.0, MA=0.0)

SCOPE

This course is designed to develop an understanding of the field of biomedical engineering. The course covers application of engineering principles to the study of medical physiology. Topics include biomaterials and biomaterial processing, interaction of biomaterials with tissues, tissue engineering, transport modeling, and medical imaging. Mathematical modeling is an integral part of the course.

LESSONS: 40 @ 55 min (2.500 Att/wk) **LABS:** 0 @ 0 min

SPECIAL REQUIREMENTS:

None

TYPE	COURSE	EFF YEAR	EFF TERM	TRACK	RED BOOK FLG
PRE REQUISITE	CH102 or CH275	1982	2	1	Y
	MA205	1991	2	1	Y

CH350 Biochemical Engineering

COURSE	TITLE	EFF YEAR	EFF TERM	CREDIT HOURS
CH350	Biochemical Engineering	2021	1	3.0 (BS=0.0, ET=3.0, MA=0.0)

SCOPE

This course is designed to develop an understanding of the field of biochemical engineering. The course covers application of engineering principles to the study of bioprocesses and biochemical reactor design. Topics include enzymes and enzyme kinetics, cell growth and cell growth kinetics, suspension and immobilization of cultures, bioreactor design, scale-up, and control, and recovery and purification technology. Mathematical modeling is an integral part of the course.

LESSONS: 40 @ 55 min (2.500 Att/wk) **LABS:** 0 @ 0 min

SPECIAL REQUIREMENTS:

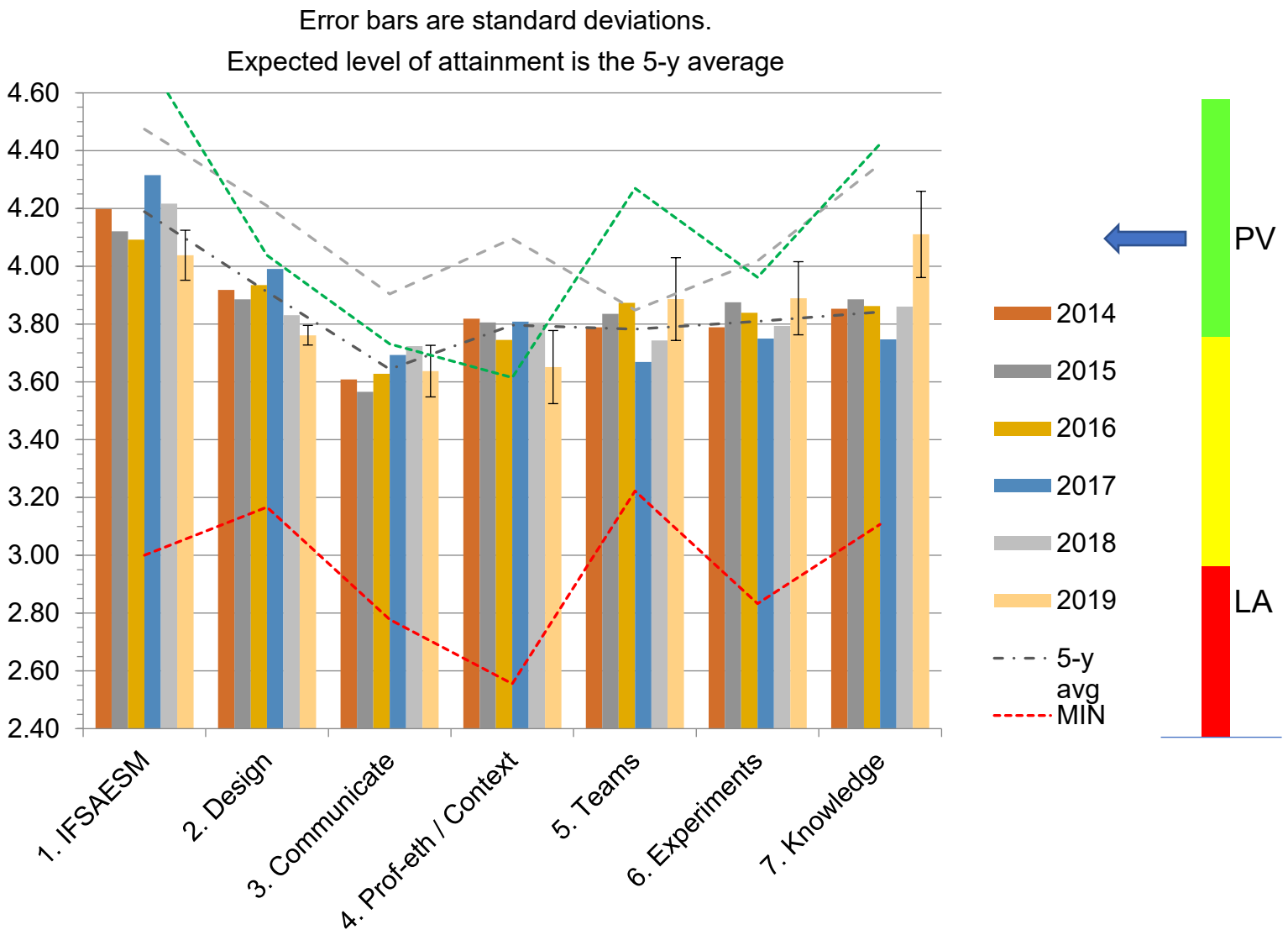
None

CH350 COURSE REQUISITES

TYPE	COURSE	EFF YEAR	EFF TERM	TRACK	RED BOOK FLG
PRE REQUISITE	CH102 or CH275	1982	2	1	Y
	MA205	1991	2	1	Y

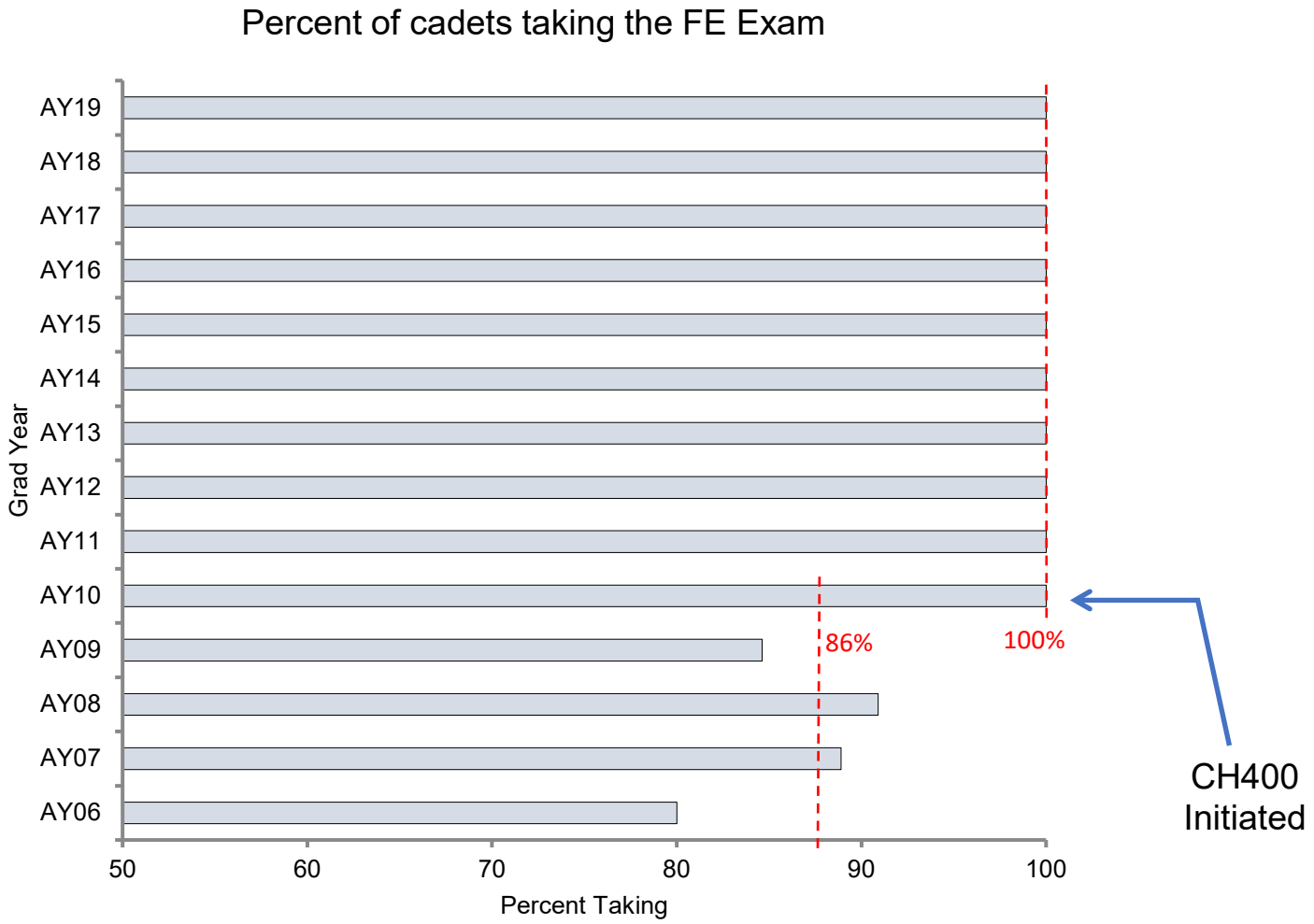
End-of-Semester Surveys

Program Averages from AY14-19



Fundamentals of Engineering Exam

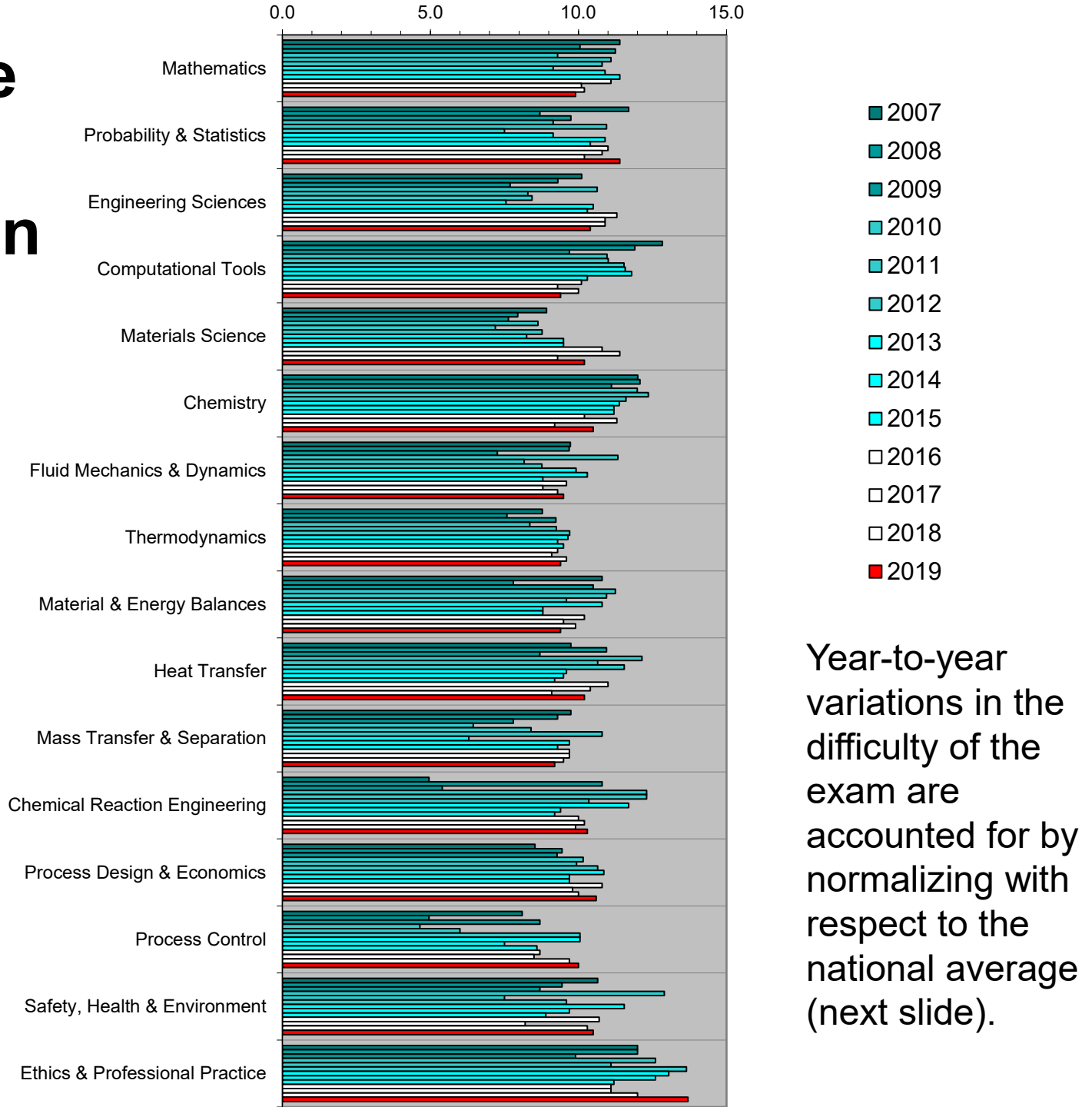
Student Outcome 7: Acquire and apply new knowledge as needed, using appropriate learning strategies



Outcome 8 Evaluation

FEE Results by Topic

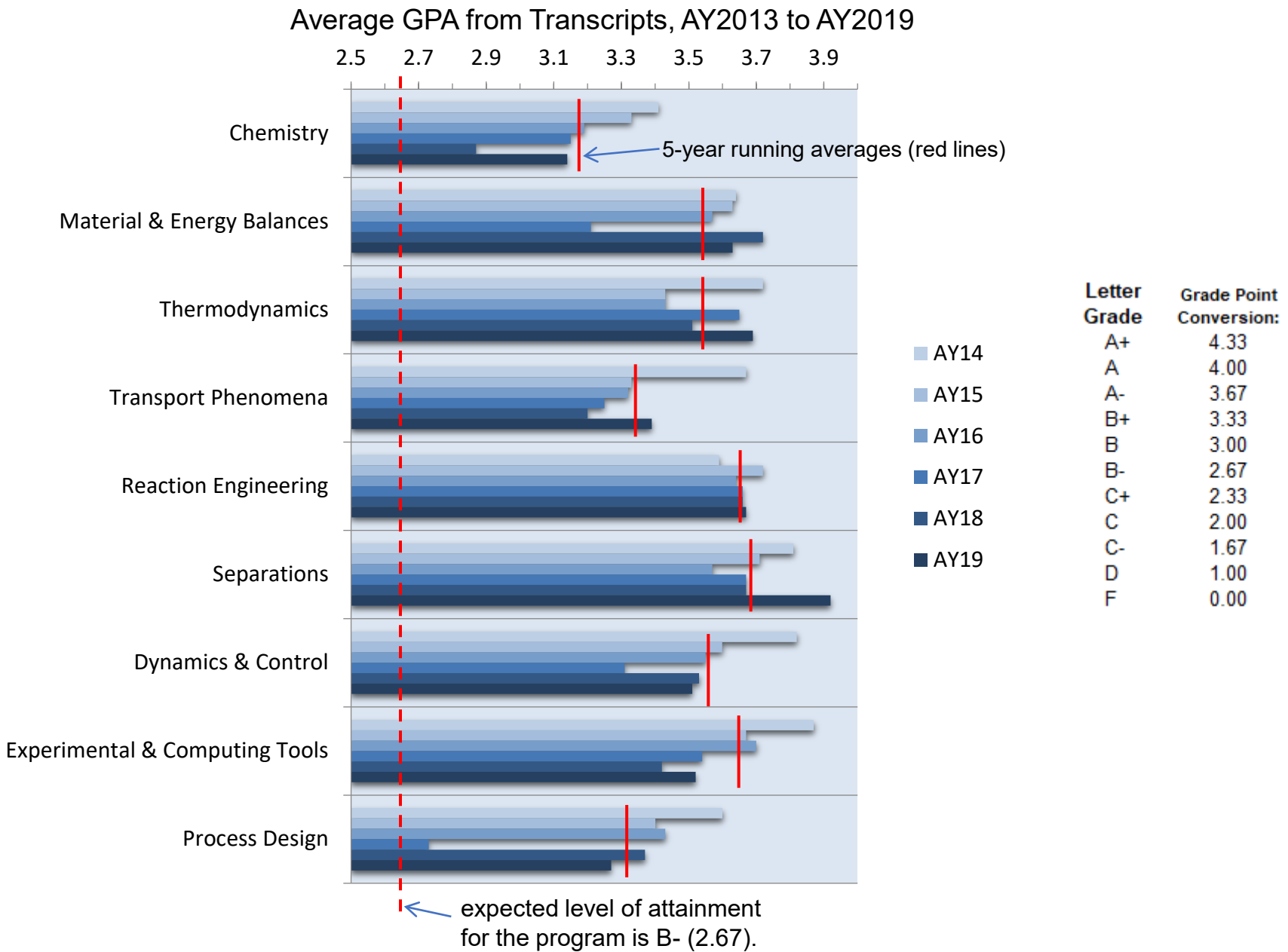
AY07 to AY19



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

Topical Outcomes Evaluation

Student Outcome 8: Understanding of the Chemical Engineering Curriculum



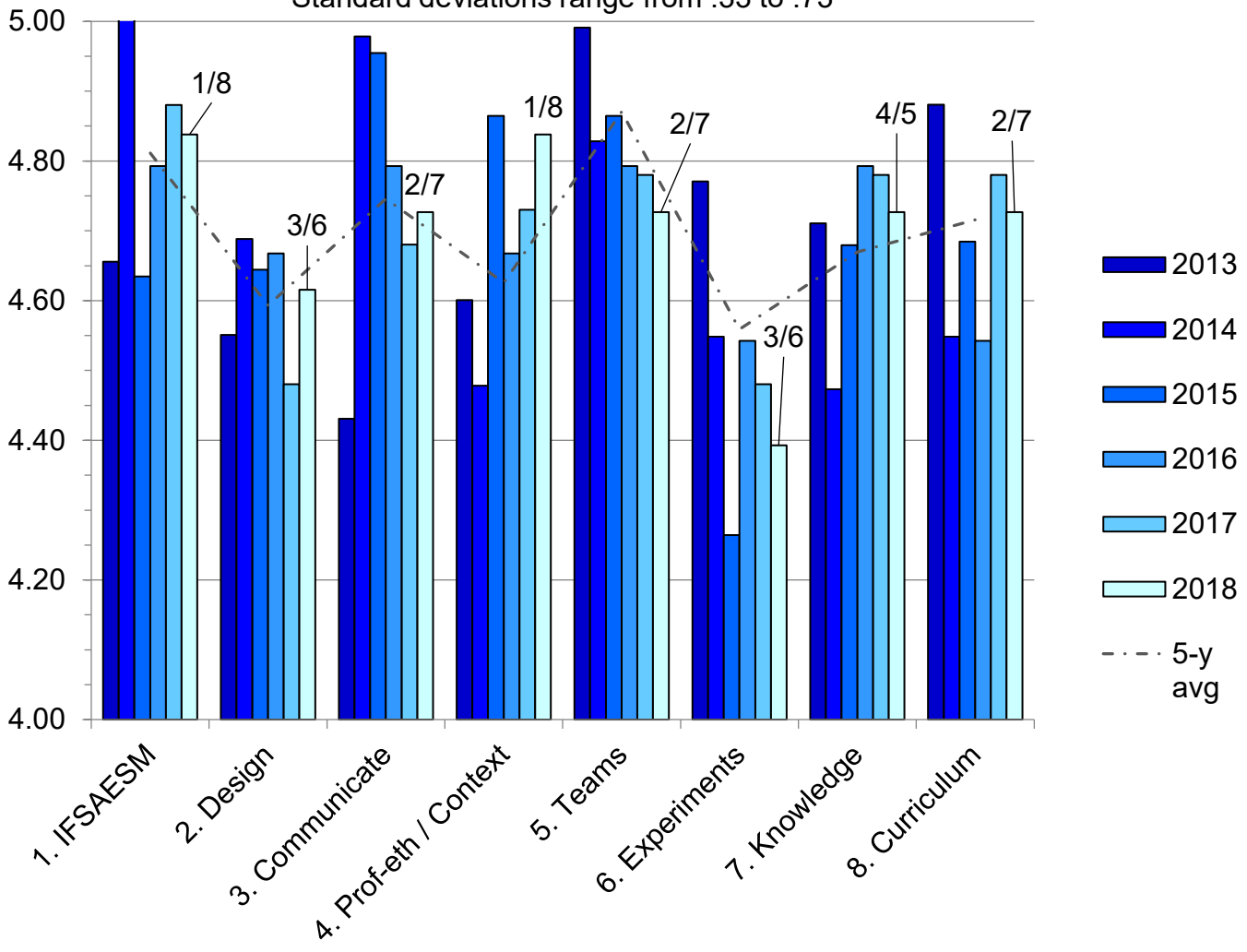
Letter Grade	Grade Point Conversion:
A+	4.33
A	4.00
A-	3.67
B+	3.33
B	3.00
B-	2.67
C+	2.33
C	2.00
C-	1.67
D	1.00
F	0.00

Advisory Board Student Outcomes Surveys

Student Outcomes 1-8

Program Averages from AY13-18

Data labels are response frequencies for 4 or 5 (# of 4s / # of 5s) on the 1-5 Survey Likert Scale
Standard deviations range from .33 to .73

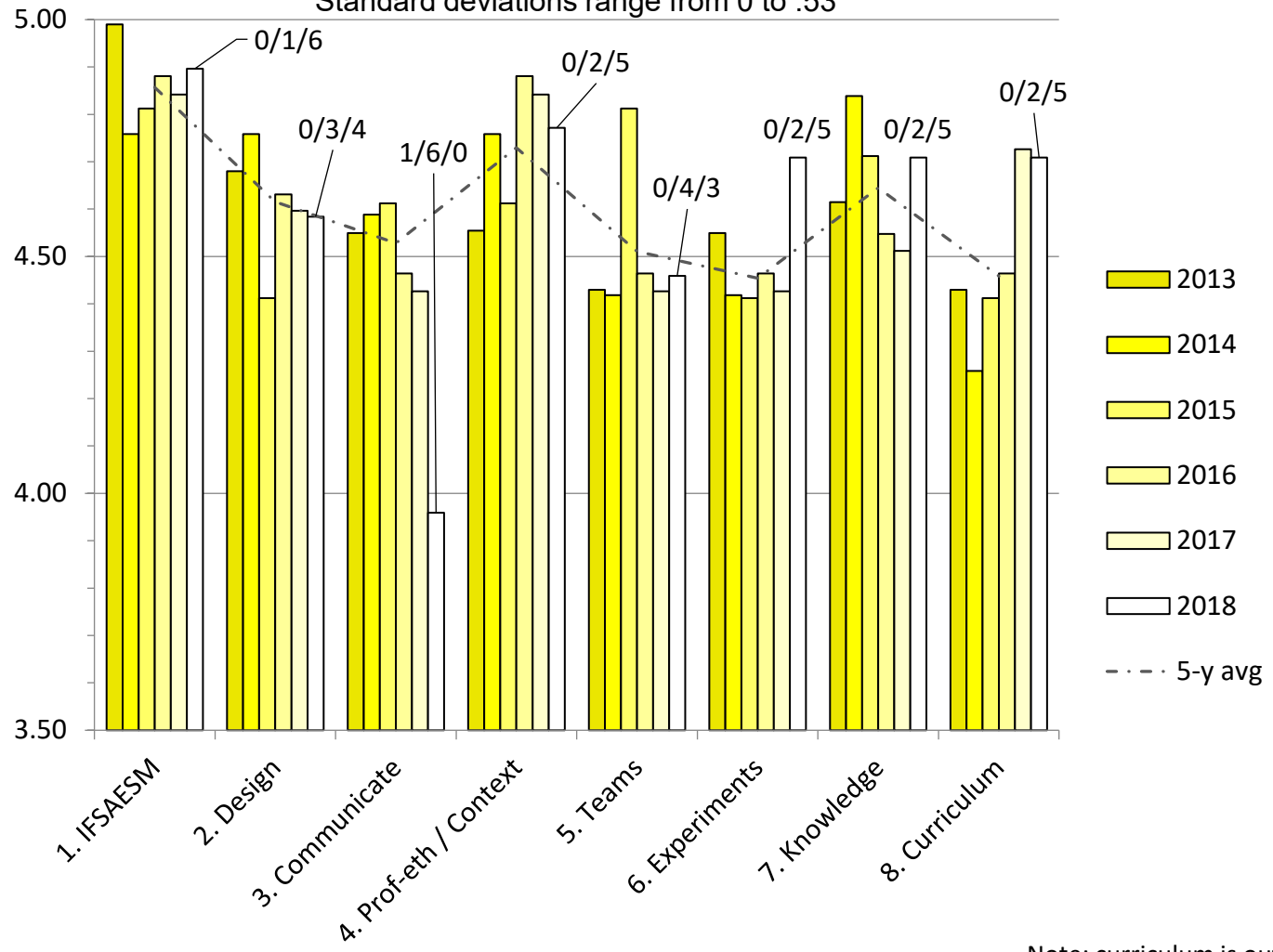


Faculty Student Outcomes Surveys

Student Outcomes 1-8

Program Averages from AY13-18

Data labels are response frequencies for 3, 4 or 5 (# of 3s / # of 4s / # of 5s) on the 1-5 Survey Likert Scale
Standard deviations range from 0 to .53



Note: curriculum is outcome 12

ABET | Engineering Technology Accreditation Commission

Accredited 1 October 2012 to present

Next Record Year: AY2019-2020

Next ABET Visit: Fall 2020

Why ABET Accreditation?

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

Thoughts to Consider

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

Terms You Should Know

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

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

Loop closure

Course Assessment Cycle

Table 4-1. Outline of the course assessment process

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

- Published guidance in CD Handbook
- Required for all chemical engineering courses used for assessment (not optional)
- Similar system for courses outside department
- Sustain and improve from last AY

Chemical Engineering Program Objectives

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

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

Course Assessment Completion Matrix

Student Outcomes

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

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

Required Courses * (for classes 2020 and beyond)	
MA364	Engineering Mathematics
CH362	Mass & Energy Balances
CH363	Separation Processes
CH364	Chemical Reaction Engineering
CH367	Introduction to Automatic Process Control (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

***Not including prerequisites**