DEPARTMENT OF THE ARMY
UNITED STATES MILITARY ACADEMY
West Point, New York 10996

REPLY TO ATTENTION OF
MADN-CLS

8 June 2020

MEMORANDUM THRU COL F. John Burpo, Department Head, Department of Chemistry and Life Science, United States Military Academy, West Point, NY 10996

FOR Dean of the Academic Board, United States Military Academy, West Point, NY 10996

SUBJECT: 2019 Executive Summary of Chemical Engineering (CEN1) Program Assessment

1. This memorandum is an executive summary, per *DPOM 5-07 Assessment of Student Learning in the Academic Program*, outlining the changes in the Chemical Engineering Program's assessment and assessment process, as well as curriculum changes, that have occurred since the last executive summary in September 2018.

a. The Chemical Engineering Program made no new recommendations for curricular changes during AY19. Of note, this is the first AY under the CEN1 program. Previous years had been the CEN0 program.

(1) The last curricular change, from AY17, to add CH367 – Introduction to Automatic Process Control, to the Chemical Engineering major, was previously approved for implementation in AY19-2. The inaugural offering of CH367 occurred in AY19-2 successfully.

(2) A curriculum change in the Department of Mathematical Sciences impacted the CEN1 curriculum. Based on external requests, the MA366 – Applied Engineering Math course was changed to reflect the needs of other departments. The Chemical Engineering faculty reviewed the proposed changed and determined that the new course content no longer met the needs of the CEN1 major. As a result, the decision was made to change the CEN1 advanced math course to MA364 – Engineering Mathematics. Execution occurred in AY19 and will for the foreseeable future. This course is taken by numerous other engineering programs and includes the advanced math needed in the CEN1 major. A related change in the math department that impacted some cadets in CEN1 was the implementation of MA365 – Advanced Math for Engineers and Scientists. This course will be taken in lieu of MA364 for CEN1 cadets that take the advanced ("Jedi") math track of MA153 – Math Modeling/Introduction to Differential Equations and MA255 – Advanced Multivariable Calculus.

(3) The new standard 8TAP that reflects these changes is shown in Appendix 1.

b. Course Student Outcomes (SO) Assessment:

(1) For AY19, the Chemical Engineering Program made the decision to implement assessment against the new Student Outcomes as required by changes in ABET Accreditation Criteria for implementation no later than AY19. The previous assessment data prior to AY19 was mapped from the old outcomes to the new outcomes to preserve the continuity of the assessment data (See Appendix 6 for mapping). These changes were made in AY19, with the new SOs updated in the Redbook and a comparison of the new outcomes (1-8) to the previous (1-12) shown in Appendix 2. All assessments for AY19 and beyond will be conducted only against the new SOs.

(2) The analysis of AY19 SOs proceeds from the chemical engineering program assessment process, which includes analysis of an extensive data pack, discussions among faculty members, advisory board members, and students, as well as survey data capturing the opinions of each of these groups. Assessment data for embedded indicators is included in Appendix 3, which references the attachments Encl 1 - exsum_CEN1_2019-09_Final. Updated assessment data and evaluation results, to include survey and Advisory Board data, will be updated when complete. The performance of cadets on the Fundamentals of Engineering Exam (FEE) during AY19 was 21/24 (88%) cadets passing first try, above this year's national chemical engineering average pass rate of 77%. Three cadets took the FEE twice and passed ultimately bringing the chemical engineering program to a 24/24 pass rate. We are very proud of our students for this excellent level of performance.

(3) Data for Student Outcome 8 (FE Exam data) show continued relative weak downward trend in performance in computational tools (See Appendix 4 for FEE data comparison to previous years).

(4) AY19 was the fourth iteration of the CH365 Chemical Engineering Thermodynamics course. This course was introduced to address continual low performance in this topic area on the FEE observed prior to AY16. For AY19, for the second time the CEN1 average was above the national average. There now appears to be an upward trend in performance over the past several years. Therefore, it appears that this historical weakness in our program's performance in chemical engineering thermodynamics has been corrected by the addition of this course. Continued assessment will need to occur in subsequent years to ascertain whether this upward trend is sustained.

(5) The remaining topical areas were generally within historical variations except for the process design and economics section in which our programs performance was well above the national average.

(6) The program also required instructors, starting in AY19-2, to include justifications for correlations in the 1/0 spread sheet. (During AY20 the program introduced the 1/0 rubrics to assist course directors in more precisely defining embedded indicators.)

c. Summary of results of Academic Program Goals and What Graduates Can Do (APG-WGCD) responsibility evaluations was conducted during the year. The APG-WGCD map was updated to reflect the changes to Student Outcomes described in Paragraph 1b(1) and Appendix 2. The new mapping is shown in Appendix 5.

d. Significant planned curricular changes. The Chemical Engineering program is not proposing any significant curricular changes moving into AY20. The program will be executing the same academic schedule as AY19, with one course, CH485 – Heat and Mass Transfer, becoming a 30-lesson, 75-minute, course.

e. During AY20, we will continue to use the new Student Outcomes for the program reflected in the new ABET Criteria. These new Student Outcomes are already reflected in the Redbook.

f. Other than the stated change to the assessment process to reflect ABET accreditation criteria, there are no planned changes to the Chemical Engineering program's assessment process.

g. Current assessment schedule. Program assessment for AY19 will be complete by 1 Sep 2020 (following our next advisory board meeting, at which time the board will evaluate the program data of AY2019) and will be added as an Appendix to this Executive Summary. The planned Advisory Board meeting for AY20 will occur in May 2020. The next ABET record year will be AY19-20 with the onsite visit during the fall of 2020.

2. Point of contact for this action is the AY19 Chemical Engineering Program Director, LTC Matthew Armstrong, at x8555.

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MATTHEW J. ARMSTRONG
LTC, FA52
Chemical Engineering Program Director (AY19)

6 Encls
1. Approved CEN1 8TAP
2. Comparison of Previous Student Outcomes to New
3. Program Assessment Data AY2018-2019
4. FEE Topical Outcomes Evaluation
5. Student Outcome to APG/WGCD Mapping
6. ABET Outcomes (a-k) to (1-7) Mapping

APPENDIX 1 to 2019 Executive Summary of Chemical Engineering Program Assessment. Approved CEN1 8TAP

CEN1 - Class of 2021

4th Class Year Fall Term	Spring Term	3rd Class Year Fall Term	Spring Term	2nd Class Year Fall Term	Spring Term	1st Class Year Fall Term	Spring Term
E **MA103** 4.0	*E* **MA104** 4.5	*E* **MA205** 4.5	*R* **CH362** 3.5	*R* **CH363** 3.5	*R* **CH364** 3.5	*D,R* **CH459** 3.5	**CH402** 3.0
EV203/ CH101 4.0	*R* **CH101/ PH205** 4.0	*R* **PH205/ PH206** 4.0	*R/* **EV203/ PH206** 4.0	*R* **EE301** 3.5	**CH367** 3.0	**CH365** 3.0	**CH400** 1.5
EN101 3.0	**EN102** 3.0	*R* **CH102** 4	**MA364/5** 3.0	*R* **CH383** 3.5	**MC312** 3.0	*R* **CH485** 3.5	**Engr Elective** 3.0
IT105 3.0	**PL100** 3.0	*E* **DFL1** 4.0	**PY201** 3.0	**MC311** 3.5	**MC300** 3.0	**Engr Elective** 3.0	**LW403** 3.5
HI105 3.0	**HI108** 3.0	*R* **SS201** 3.5	*E* **DFL2** 4.0	**PL300** 3.0	**SS307** 3.5	**Engr Elective** 3.0	*R* **HI302** 3.0
			R **SS202** 3.5	**MA206** 3.0			**MX400** 3.0

D = Double blocked course

R = RSTU lab course

E = Meet every day for 55 minutes

- Course should not be moved from that year or term
- Course may be scheduled in the fall or spring of that academic year
- Complementary Support Courses
- Core Engineering Sequence (not applicable)
- Course 3 Science Depth
- Course 9 STEM Depth
- other electives - most popular electives are templated

APPENDIX 2 TO 2018 Executive Summary of Chemical Engineering Program Assessment: Comparison of Previous Student Outcomes (ABET a-k) to New (ABET 1-8)

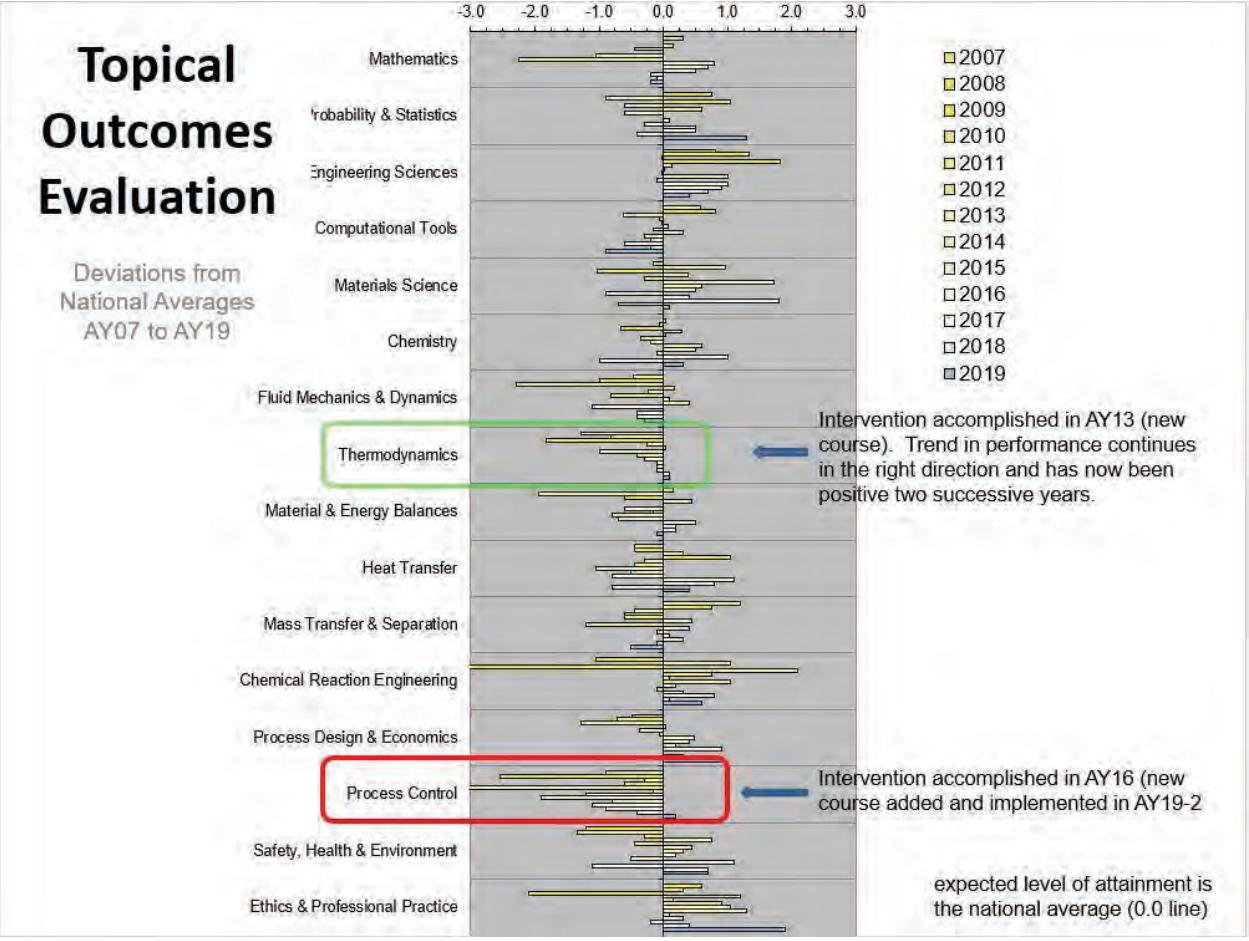
Student Outcomes AY18 & Prior to AY18 (ABET a-k)
On completion of the chemical engineering program, our graduates will be able to:
1. Apply knowledge of mathematics, science, and engineering.
2. Design and conduct experiments, as well as analyze and interpret data.
3. Design a system, component, or process to meet desired needs within economic, environmental, social, political, ethical, health and safety, manufacturing, and sustainability constraints.
4. Function on multidisciplinary teams.
5. Identify, formulate, and solve engineering problems.
6. Understand professional and ethical responsibilities.
7. Communicate effectively.
8. Understand the impact of engineering solutions in a global economic, environmental, and societal context.
9. Recognize the need and develop the skills required for life-long learning.
10. Demonstrate knowledge of contemporary issues.
11. Demonstrate an ability to use techniques, skills, and modern engineering tools necessary for engineering practice.
12. The program provides the graduate with a thorough grounding and working knowledge of the chemical sciences, including: - General, organic, and physical chemistry, - Material and energy balance on chemical processes, including 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, and - Process design.

Student Outcomes AY19 (ABET 1-7):
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 balance, - 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.

APPENDIX 3 TO 2018 Executive Summary of Chemical Engineering Program Assessment: Program Assessment Data (found in file name: Encl 1 - exsum_CEN1_2019-09_Final)

Initial data published in separate file. Updated with Advisory Board input and survey data o/a 1 September 2019.

APPENDIX 4 TO 2019 Executive Summary of Chemical Engineering Program Assessment: FEE Topical Outcomes Evaluation



APPENDIX 5 TO 2019 Executive Summary of Chemical Engineering Program Assessment: Student Outcome to APG/WGCD Mapping.

Student Outcome	Communication					Critical/Creative Thinking						Lifelong Learning				Disciplinary Depth				
	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	2.6	3.1	3.2	3.3	3.4	7.1	7.2	7.3	7.4	7.5
a																XX	XX	XX	XX	
b						XX			X							XX		X		
c						XX				XX	X					XX		X	X	
d	X		X		X	XX	XX						X					XX	XX	XX
e					X	X										XX	X	X		
f										X						X		X		
g	XX	XX	XX													X			X	X
h			X		X						X				X			X	X	X
i												XX	XX					X		
j			XX		X							XX	X			XX	X			
k							XX			X		X	X			XX	XX	X		X
Total	XX	XX	XX		X	XX	XX		X	XX	X	XX	XX		X	XX	XX	XX	XX	XX

Student Outcome	Communication					Critical/Creative Thinking						Lifelong Learning				Disciplinary Depth				
	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	2.6	3.1	3.2	3.3	3.4	7.1	7.2	7.3	7.4	7.5
1						XX										XX	XX	XX	XX	
2						XX	XX		X		X					XX		X		
3	XX	XX	XX													X			X	X
4						XX												X	X	
5	X		X		X	XX	XX						X			X	X	XX	XX	XX
6										XX					X	XX		X		
7			XX		X	XX				X		XX	XX			X			X	X
Total	XX	XX	XX		X	XX	XX		X	XX	X	XX	XX		X	XX	XX	XX	XX	XX

APPENDIX 6 TO 2019 Executive Summary of Chemical Engineering Program Assessment: ABET (a-k) to ABET (1-8) mapping

	This course has improved my ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	This course has improved my ability 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	This course has improved my ability to communicate effectively with a range of audiences	This course has improved my ability 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	This course has improved my ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	This course has improved my ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	This course has improved my ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
This course has improved my ability to apply knowledge of mathematics, science, and engineering	X						
This course has improved my ability to design and conduct experiments, as well as analyze and interpret data.						X	
This course has improved my understanding of how to design a system, a component of a system, or a process to meet desired needs		X					
This course has improved my ability to function on multidisciplinary teams.					X		
This course has improved my ability to identify, formulate, and solve engineering problems.	X						
As a result of this course, my understanding of professional and ethical responsibilities has improved.				X			
This course has helped me to communicate more effectively.			X				
understanding of the impact of engineering solutions in a global economic, environmental, and societal context.				X			
This course has helped me recognize the need and develop the skills required for life-long learning.							X
This course has increased my knowledge of contemporary chemical engineering issues.							X
This course has improved my ability to use techniques, skills, and modern engineering tools necessary for engineering practice.	N/A	N/A	N/A	N/A	N/A	N/A	N/A