



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

**REPLY TO  
ATTENTION OF  
MADN-CLS**

26 August 2021

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: 2021 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 2020, in response to program assessment.

a. The Chemical Engineering Program was able to obtain the validation of 3.0 engineering topics credit for CH450, Bioengineering Modeling and Analysis. CH450 is now permanently listed in the USMA Redbook. This addition was in part due to advisory board feedback. Due to COVID many of our courses were remote, or hybrid during AY21, and several of the TEEs were canceled or modified. Of note, this is the third AY in which we offered the CEN1 program. Previous years had been under the CEN0 program.

(1) A significant curricular change in our program was to add CH367 – Introduction to Automatic Process Control as a required course in the major in AY17. The inaugural offering of CH367 successfully occurred in AY19-2, and this course is now an ongoing course offering. We continue to track process control on the FE exam to determine if this course has improved cadet performance with respect to the national average. Enclosure 3 shows the previous 10-year progression of our graduating chemical engineers performance on the Fundamentals of Engineering Exam (FEE) on the Process Control section. One can see that XE472, Dynamic Modeling and Control, the previous course taken before addition of CH367 was not providing adequate coverage of chemical engineering process controls. After the addition of CH367 in AY19 our cadets showed improvement on the process control portion of the FEE (not counting AY20 due to COVID-19; the entire class was unable to take the FEE). We define overall success on the FEE as passing; while we define success on the individual sections achieving the national average (+/-) one standard deviation.

(2) The standard 8TAP that reflects the curriculum is shown in Enclosure 1.

b. Student Outcomes (SO) Assessment:

(1) For AY21, the Chemical Engineering Program continued to assess performance against the SOs required by ABET and implemented in AY19. The updated assessment process was fully described in the 2019 Executive Summary of Chemical Engineering (CEN1) Program and more fully described in the 2020 ABET Self-Study.

(2) The SO assessment process requires analysis of our assessment data pack, followed by discussions among faculty members, advisory board members, and students. The assessment data pack for AY21 is included in the attached document "Encl 2 - exsum\_CEN1\_2021-08-Draft." However, the assessment process is not complete until our advisory board meets after Spring Break. A completed assessment will be submitted upon completion of our process. Of note, the performance of cadets on the Fundamentals of Engineering Exam (FEE) during AY21 was 15/20 (75%) cadets passing first try, above this year's national chemical engineering average pass rate of 74%. Two more chemical engineers passed the FEE on their second try for an overall 85% pass rate for Class of 2021. While we strive for a 100% pass rate, we are proud that we have exceeded the national average in each year the program has been offered.

(3) FE exam data for Student Outcome 8 is shown in the attached document "Encl 3 – exsum\_CEN1\_2021-08-FEE Results AY21." The data show an improvement this year in the Engineering Sciences and Ethics & Professional Practice sections respectively (See Enclosure 3 for FEE data comparison to previous years). Additionally, our cadets' aggregated scores, per section, were well within one standard deviation, except for the Solids Handling section, which was a new topic on the FEE in AY21.

(4) AY21 was the sixth iteration of the CH365 Chemical Engineering Thermodynamics course. This course was introduced to address low performance in thermodynamics on the FEE observed prior to AY16. For AY21, the CEN1 average was below the national average low but still within the standard deviation of the national average. We also still believe that there is a net upward trend in performance when observed over the past five 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. The previous ten years of FEE results for thermodynamics are shown in Encl 3. Whereby it is evident that after adding the course in AY16 there was an immediate improvement for our chemical engineering cadets (excluding AY20 due to COVID-19; the entire class was not able to take the FEE).

(5) Relatively low scores were seen in some of the embedded indicators for the communication outcome (SO3), particularly in the SWE in MC312. The SWE is administered by D/CME in the MC312 course. The mechanical engineering program

tracks scores in this activity by major and reports the results back to chemical engineering for our program assessment. Poor performance in this activity by some of our cadets results in relatively low scores overall. As a result, each chemical engineering cadet now has a chemical engineering faculty mentor for the activity. This change was implemented in AY21 and resulted in a significant increase in scores over last year, and our cadets were, on average, 9% higher than the course average (84.6% for chemical engineering versus 76.0% coursewide), with no D or F grades reported. In addition, CH459 Chemical Engineering Lab has a rigorous lab writing, drafting and in-progress-review process to ensure adequate coaching on technical communication best practices. This process ensures that each cadet receive feedback with respect to writing for each deliverable.

(6) The remaining topics on the FE exam were generally within historical variations and/or standard deviations.

(7) During AY21 the program continued to utilize the 1/0 rubrics to assist course directors in more precisely defining embedded indicators. Of significant note, all course directors completed this part of the program assessment correctly and on time. This saved considerable time in the preparation of the assessment data in Enclosure 2.

(8) We acknowledge lower than average scores shown in Encl 2 Program Assessment Data for CH400 on Student Outcome 1. This is due to the fact that for this course we present challenging homework and quiz problems to provide adequate FEE preparation for the Firsties. The program has a high level of expectation in CH400, and therefore the scores of the graded events are slightly lower on average than our other chemical engineering courses. CH400, Chemical Engineering Professional Practice is in the 8TAP because it provides a curricular review of relevant content as a way to prepare our Firsties for the FEE. This curricular review strategy is consistent with best practices in industry and academia. We also acknowledge that the cadet surveys have also rated CH400 lower than other courses due to the difficulty of graded events.

(9) The chemical engineering program addresses ethics as follows: 1. There is a 10 module Safety and Chemical Engineering Education (SACHE) certificate program that each Firstie must complete while enrolled in CH459; and 2. CH400 covers this topic as part of FEE preparation. Encl 3 shows that our cadets have outperformed the national average on this section of the FEE.

(10) The program continues to support the Academic Program Goals and the statements of What Graduates can do. The mapping between our student outcomes and the APG/WGCD statements is found in Enclosure 4.

c. CH450 Bioengineering Modeling and Analysis was added to the 2024 Redbook as an approved elective for chemical engineering, with 3.0 validated ET credit by the

ABET Committee. We have added as pilot courses: CH300 Biomedical Engineering and CH350 Bioprocess Engineering for AY22.

d. The Chemical Engineering program is not proposing any significant curricular changes moving into AY22. The program will be executing the same academic schedule as AY21, with one course, CH485 – Heat and Mass Transfer will stay a 30-lesson, 75-minute, course for AY22. There will be some possible COVID-19 scheduling modifications to length of class, number of cadets in class for in-person learning, and time between classes.

e. 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.

f. Assessment schedule. The program assessment process is currently in progress. The process is initiated during the summer when the data assessment packet is distributed to faculty for analysis. Program assessment for AY21 will be complete by 1 July 2022 (following our next advisory board meeting, at which time the board will evaluate the program data of AY2021) and an update will be added as an Appendix to this Executive Summary. The planned Advisory Board meeting for AY22 will occur in late April or early May 2022.

g. The ABET record year was AY19-20 with the remote onsite visit 14-19 November 2020. The program passed with flying colors. No program shortcomings were reported, and a program strength was reported for the process safety portion of the program and our unique implementation of process simulators in the curriculum

h. The program followed all USMA and department guidelines on sanitation during the COVID pandemic. While a few cadets tested positive for COVID and others were quarantined due to exposure, the program was able to offer courses remotely to cadets who could not come in person and did not experience any significant disruptions due to the pandemic.

2. We have examined the complimentary support courses and they do exactly what they should be doing which is providing foundations math and applied science framework. EE301, Fundamentals of Electrical Engineering, provides the basis for understanding of electronic circuits to aid chemical engineering process control modeling. MA364/365, Engineering Mathematics, provides the basis and background of the advanced math skills required to master the chemical engineering curriculum moving forward. PH206/256 Physics II provides a deeper understanding of the mathematics and underlying science that is part of the chemical engineering curriculum.

3. Technical writing has been a focus of the chemical engineering program for the previous several years, and many control measure, and techniques have been implemented to facilitate our cadets development in this space. For example, we assign writing coaches to each of our chemical engineers for the MC312 Significant Writing Event, and mandatory IPRs with lab reports, executive summaries and poster

deliverables in the context of CH459 Chemical Engineering Lab for Firsties. This has greatly improved our cadets technical writing ability, and we plan on sustaining these strategies moving forward.

4. Point of contact for this action is the AY21 Chemical Engineering Program Director, LTC Matthew Armstrong, at x8555.

4 Enclosures

1. Approved CEN1 8TAP
2. Assessment Process and Data
3. FEE Topical Outcomes Evaluation
4. APG-WGCD Mapping

MATTHEW J. ARMSTRONG

LTC, FA52

Chemical Engineering Program Director (AY21)

**Enclosure 2 to 2021 Executive Summary of Chemical Engineering Program  
Assessment: Assessment Process and Data**

This document is a separate file entitled Encl 2 - exsum\_CEN1\_2021\_08"

This file was published to the program on 1 August 2021. An updated file containing Faculty, Advisory Board, and Program Director survey data and input will be published o/a 1 June 2022.

**Enclosure 1 to 2021 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
<i>E</i> <b>MA103</b> 4.0	<i>E</i> <b>MA104</b> 4.5	<i>E</i> <b>MA205</b> 4.5	<i>R</i> <b>CH362</b> 3.5	<i>R</i> <b>CH363</b> 3.5	<i>R</i> <b>CH364</b> 3.5	<i>D,R</i> <b>CH459</b> 3.5	<b>CH402</b> 3.0
<b>EV203/ CH101</b> 4.0	<i>R</i> <b>CH101/ PH205</b> 4.0	<i>R</i> <b>PH205/ PH206</b> 4.0	<i>R/</i> <b>EV203/ PH206</b> 4.0	<i>R</i> <b>EE301</b> 3.5	<b>CH367</b> 3.0	<b>CH365</b> 3.0	<b>CH400</b> 1.5
<b>EN101</b> 3.0	<b>EN102</b> 3.0	<i>R</i> <b>CH102</b> 4	<b>MA364/5</b> 3.0	<i>R</i> <b>CH383</b> 3.5	<b>MC312</b> 3.0	<i>R</i> <b>CH485</b> 3.5	<b>Engr Elective</b> 3.0
<b>IT105</b> 3.0	<b>PL100</b> 3.0	<i>E</i> <b>DFL1</b> 4.0	<b>PY201</b> 3.0	<b>MC311</b> 3.5	<b>MC300</b> 3.0	<b>Engr Elective</b> 3.0	<b>LW403</b> 3.5
<b>HI105</b> 3.0	<b>HI108</b> 3.0	<i>R</i> <b>SS201</b> 3.5	<i>E</i> <b>DFL2</b> 4.0	<b>PL300</b> 3.0	<b>SS307</b> 3.5	<b>Engr Elective</b> 3.0	<i>R</i> <b>HI302</b> 3.0
			<i>R</i> <b>SS202</b> 3.5	<b>MA206</b> 3.0			<b>MX400</b> 3.0

*D* = Double blocked course

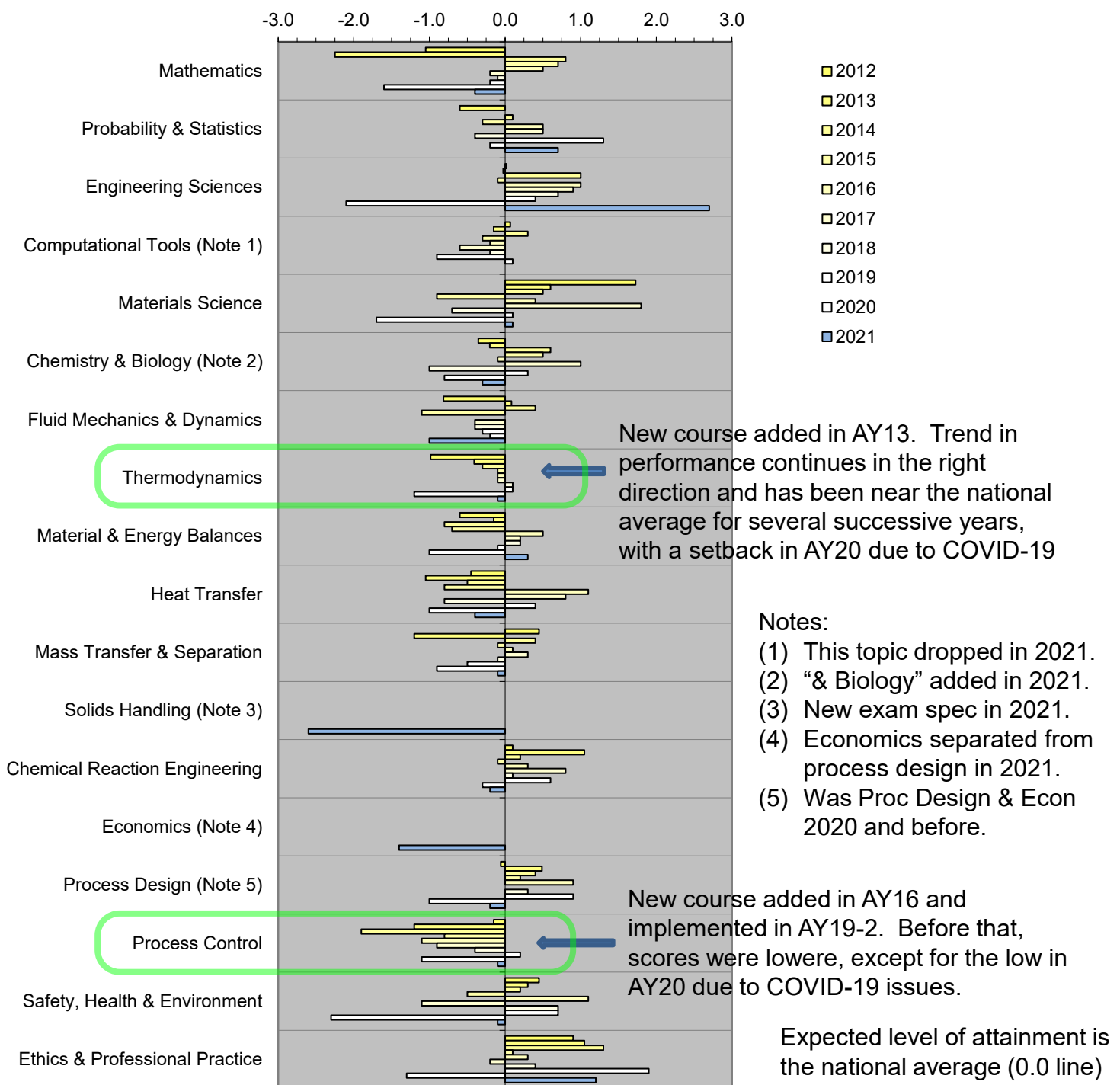
*R* = RSTU lab course

*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

# Encl 3 - FEE Results

Deviations from  
National Averages  
AY12 to AY21





Student Outcome	Communication					Critical/Creative Thinkin						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					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

Student Outcome	Communication					Critical/Creative Thinkin						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						4.25										4.25	4.25	4.25	4.25	
2						4.14	4.14		4.14		4.14					4.14		4.14		
3	4.51	4.51	4.51													4.51			4.51	4.51
4						4.13												4.13	4.13	
5	4.79		4.79		4.79	4.79	4.79						4.79			4.79	4.79	4.79	4.79	4.79
6										4.42					4.42	4.42		4.42		
7					4.46	4.46				4.46		4.46	4.46			4.46			4.46	4.46
Average	4.65	4.51	4.65		4.625	4.354	4.465		4.14	4.44	4.14	4.46	4.625		4.42	4.43	4.52	4.346	4.428	4.5867

Grade	A+	A	A-	B+	B	B-	C+
GPA	4.33	4.00	3.67	3.33	3.00	2.67	2.33
Scale:	5.00	4.62	4.24	3.85	3.46	3.08	2.69