Chemical, Biochemical & Environmental Engineering Three-Year Review

January 2016

The following data has been provided by OIR for the CBEE three year review:

Three-Year Faculty Profile

Department: Chemical, Biochemical and Environmental Engineering

	Fall 2011		Fall 2012		Fall 2013	
	Ten/ Ten Track	**Off Track**	**Ten/ Ten Track**	**Off Track**	**Ten/ Ten Track**	**Off Track**
Status						
Full-Time	10	8	11	2	9	3
Part-Time	0	3	0	1	0	4
Total	10	11	11	3	9	7

Source: DW.EMPLOYEES table

Prepared by: UMBC Office of Institutional Research, 09/2014.

UMBC FY 2015 Academic Program Review- Three Year Review

Three-Year Staff Profile

Department: Chemical, Biochemical and Environmental Engineering

	Fall 2011	Fall 2012	Fall 2013
Status			
Full-Time	5	4	4
Part-Time			
Total	5	4	5

Source: DW.EMPLOYEES table

Prepared by: UMBC Office of Institutional Research, 09/2014.

UMBC FY 2015 Academic Program Review- Three Year Review

Enrollment

Three-Year Undergraduate Student Profile:

Department: Chemical, Biochemical and Environmental Engineering

Plan: Chemical Engineering, BS

Level: Bachelor's	Fall 2011			Fall 2012			Fall 2013		
	Primary Plan	Add'l Plans*	All Plans	Primary Plan	Add'l Plans	All Plans	Primary Plan	Add'l Plans	All Plans
Status									
Full-Time	207	16	223	256	14	270	260	10	270
Part-Time	20	1	21	22		22	23	1	24
Total	227	17	244	278	14	292	283	11	294

* Additional plans are at the same degree level (bachelor's)

Source: DW.ReportFactStudentPlans

Prepared by: UMBC Office of Institutional Research, 09/2014.

UMBC FY 2015 Academic Program Review- Three Year Review

Degrees Granted

Department: Chemical, Biochemical and Environmental Engineering

Name of Degree	Program Name	Year	FY Total # of Degrees Awarded	FY # of Primary Degrees Awarded
UNDERGRADUATE:				
BS	*Chemical Engineering*	2011-12	37	37
		2012-13	33	33
		2013-14	28	28

SOURCE: DW.ReportFactDegreePlan table
Prepared by: UMBC Office of Institutional Research, 09/2014.
UMBC FY 2015 Academic Program Review- Three Year Review

The CBEE Operating Budget is $2,273,520 and the GA Allocation is $198,838 in stipends and $97,825 in tuition waivers. There were zero computers received through CRI and there were no changes in space. During the last ABET review, the Chemical Engineering Program received a Program Weakness noting that students are one of the identified constituencies, but their involvement in the review of the objectives was limited to the occasional acquisition of relevant information obtained during senior exit interviews and surveys. After meeting with the Advisory Board representatives, it was agreed to include current students to the Advisory Board. The program weakness was resolved and full accreditation was granted August 2012. Since the last ABET review Civil and Environmental Engineering was merged with CBE to form CBEE. Thus a new advisory board needs to be form that reflects the new makeup of the department.

An Environmental Engineering track was added since the merger and CBEE graduated its first Environmental Engineering track student in May 2014. Currently, there are 13 juniors and 15 sophomores who are completing their Chemical Engineering degree program in the Environmental Engineering track.

Since the last ABET accreditation, there have been several changes made to the ABET review process which include providing process safety requirements for Chemical Engineering programs, publicly stating its Program Educational Objectives and Student Outcomes, and to post annual student enrollment and graduation data per program (completed March 11, 2014). In addition, student outcomes will be mapped to 1-6 (versus a-k) in an attempt to force programs to put more an emphasis on innovations in the undergraduate programs. We will need to map our five C's to the new 1-6 (once they are approved August 2015) and be sure to concentrate our efforts on innovations to our program. The following course creations, innovations and process safety requirements have been established since the last ABET accreditation (2012).

ENCH 210 Creation:

This course provides an introduction to environmental quality and the development of the background necessary for understanding environmental engineering principles and problem solving. Flow and material balance concepts will be presented for tracking substances in the environment and in engineered systems. Simple quantitative engineering models will be developed describing the fate and transport of chemicals in reactors. A qualitative description of environmental control systems will be presented. An introduction to environmental laws will be provided pertaining to water and air quality and control of hazardous materials. The main outcome of this course will be an understanding of the concept of environmental quality and the background necessary to develop the vocabulary and elemental quantitative skills to describe principal factors that come into play to protect the environment, manage risk, and provide and maintain quality of air, water, and soil.

ENCH 225L Innovations:

The 4-credit course now meets for an equitable number of instructor hours (three 50-minute discussions and one 110-minute lab per week for all 14 weeks); in Spring 2011 and earlier the class only met for 50-minute discussions and 110-minute labs for 14 times each across the entire semester. Discussion times that were previously routinely canceled have been replaced with Problem Based Learning sessions where lab groups work for 50 minutes on an experimental design while the instructor and TAs provide guidance.

The cap on laboratory sections has been reduced from 30 to 25 to improve student-instructor/TA ratios. Lab group sizes are now capped at 5, as opposed to 6 in the Spring of 2010 and 2011. In three of the past six semesters that the course was taught (Spring 2012, Fall 2013, and Fall 2014), group sizes were capped at 4. Because of increased enrollment, groups of five have become common in the Spring semester. Research in engineering education suggests that groups of 6 or larger tend to break into subgroups of ~3 students each, impeding their ability to function as a whole.

A set of 2-5 structured sequential MATLAB assignments is now implemented in the computer lab portion of the course to provide students with contexts for flow control (conditional statements and loops), iterative methods (root finding by bisection, Newton-Raphson, and/or fixed point iteration), statistics, and systems of ordinary differential equations. In semesters in which only 2-3 problems are assigned, performance on the MATLAB exam has been lower compared to semesters with 5 problems. Prior to 2011, no MATLAB assignments were given.

Problem sets have been deconstructed so that students complete one problem in advance of each discussion, rather than a problem set each week, in order for students to keep up with the pace and complexity of material.

The course has secured Writing Intensive status. Students submit a draft and final version of an individual lab report and write 5 essays on topics in engineering ethics and safety. Students also write brief personal reflections between each lab to explain what they feel can be done to write better reports in the future. Discussions considering data fabrication, plagiarism, and other forms of academic misconduct easily fit into the professionalism lectures given during the semester.

Anecdotal feedback from the instructor of physical chemistry lab (taken by traditional track students the fall after ENCH 225L, for those “on track”) suggests these changes have noticeably improved chemical engineering majors’ performance in labs outside the department.

Because of the increased focus on computer programming, ENCH 225L has become a prerequisite for ENCH 442 (Process Control and Safety). ENCH 225L is now also a prerequisite for the senior labs. Attaining WI status justified the removal of ENGL 393 (Technical Writing) from degree requirements, reducing the number of credits required for graduation by 3.

ENCH 300 Innovations:

Chemical Engineering Thermodynamics (ENCH 300) has implemented a Team Based Learning strategy in many lecture sessions. For a typical unit, students must read the material and take an online assessment individually prior to class, and then retake the same assessment in fixed groups in class using the Immediate Feedback Assessment Technique. This device allows students to know immediately whether they answered a multiple-choice question correctly and facilitates team discussion. A Team Based Learning Interest Group has been formed with faculty in the humanities, natural and mathematical sciences, and engineering.

To promote self-regulation and self-assessment, a series of reflective writing exercises has been added to ENCH 300 where students explain their progress on homework, exams, and projects. Together with writing exercises in ENCH 442 (Process Control and Safety), this work was supported with a Hrabowski Academic Innovation Grant.

ENCH 310 Creation:

In this course, chemical and biological principles are discussed in the context of manmade and natural aquatic systems such as rivers, oceans, wetlands and the subsurface environment. Equilibrium and kinetic concepts will be reinforced with equilibrium and kinetic models. The student at the end of the course will be able to understand the basic chemical phenomena that control the fate of pollutants in the environment.

ENCH 333 Creation:

This course provides an orientation to the chemical engineering profession; internship, REU and graduate school application processes; the advising process; department student outcomes; and professional attributes such as ethics, lifelong learning, and awareness of environmental and societal factors, which are important in the careers of chemical engineers. The course consists of weekly fifty-minute seminars, led by visiting engineers (often alumni), current chemical engineering students and faculty, and professional staff from various campus departments. Key topics included each semester: the chemical engineering program student outcomes, job/internship/graduate school opportunities, advising, professional development and the wide variety of chemical engineering career opportunities.

ENCH 425 Innovations:

A computer simulation project was added to the Fall 2013 semester (and another was implemented in Fall 2014), bridging the numerical differential equations work from ENCH 225L (Experimental Design) and the computational heat transfer concepts in ENCH 427 (Transport Processes II).

The pencil-and-paper design project of Fall 2012 and earlier was replaced with an experimental design project in which students evaluate an experiment using a newly constructed piping network (experiments were designed by the students of ENCH 437L, Unit Operations Lab), or create an experiment of their own design using equipment in the unit ops lab. The former was done in 2013 and the latter in 2014.

ENCH 427 Innovations:

The high school outreach project has been expanded to include K-12 students. This inclusion is supported by the AIChE-NSF Workshop on Industry-Academia Alignment where industrial representatives from Dow, DuPont, BMS, Exxon-Mobile, Lubrizol, etc. stressed the importance of students having the ability to provide presentations on technical material to non-technical audiences.

ENCH 442 Innovations:

ENCH 442 has been developed to include a significant unit on chemical process safety, in part to meet the new curricular requirements for accreditation established in 2011, and in part to serve as a "pre-design" course in which students are required to combine their knowledge from ENCH 300 (Thermodynamics), ENCH 425 (Transport Processes I), ENCH 427 (Transport Processes II), and ENCH 440 (Chemical Reaction Kinetics). Students complete group projects and take individual exams to address the three main elements of the course: process optimization, control, and safety. Students also complete four certificates on process safety from SAChE, the safety division of the national professional organization AIChE. To make room for the safety content, a large amount of the mathematical analysis is now done on computers using skills developed in ENCH 225L (Experimental Design).

Because of the increased emphasis on design and safety, ENCH 442 is now a co-requisite (or pre-requisite) for ENCH 446 (Capstone Design II).

ENCH 444 Innovations:

In our capstone design I course, students are required to design a process, which converts raw materials into a desired product. This process design is completed in teams of 4-5 students, and each team designs a different process. The design assignment is split into four different sections, which include process synthesis, PFD and M&E balances; equipment design; process simulation; and process economics. In order to provide our students the opportunity to effectively communicate their work, critically analyze, and critique open-ended designs, the projects are rotated between teams for each section of the design. For the final design, each team is returned their original design project and critiques, in order to complete the final analysis. During the rotation of projects, the teams have the opportunity to evaluate one another's work, integrate design reviews into their final analysis and learn by critically analyzing other projects. In addition, students are required to complete an additional four additional certificates from SAChE, the safety division of the national professional organization AIChE. This course is taught by a faculty member with industrial experience, which supports the recommendations from the AIChE-NSF Workshop on Industry-Academia Alignment.

ENCH 470 Creation:

A new chemical engineering elective, Chemical and Environmental Modeling, was developed in part in response to senior exit surveys requesting more traditional chemical engineering electives (as opposed to electives in biotechnology or environmental engineering) and in part because of the expertise of the instructor. In this course, students build on their junior year to apply chemical engineering principles (material and energy balances, heat transfer, process control and chemical kinetics) to topics including epidemiology, physiology, and ecosystem dynamics. There is a heavy emphasis on the ability to analyze the stability of steady-state solutions to problems, to solve complicated ordinary and partial differential equations numerically, and to generate codes using advanced programming techniques (Monte Carlo analysis, animated Poincare maps, Graphical User Interfaces) in MATLAB.

Hrabowski Academic Innovation Projects

We have developed a structured sequence of hands-on activities specifically designed to crosscut a four-semester sequence of required courses in chemical engineering. By connecting these activities to a common space and network of process equipment, we hope to capitalize on students' context-dependent learning while demonstrating how the separate courses across five semesters are related. By designing the activities to be hands-on, we intend to encourage student development and processing of important knowledge and skills. We have specifically targeted courses in our curriculum where students most frequently comment on apparent disconnects between engineering tools and skills, as well as those where engineering education research has shown laboratory experiments can improve student understanding. The project required the construction of a new customizable laboratory setup consisting of pumps, piping, heat exchangers, and modern process control software comparable to industry. The project includes the creation of a set of multi-functional experimental procedures and activities to be implemented in five courses in the curriculum. To date the equipment has been used in three courses (ENCH 225L, 425, 437L) and once construction is complete, two others (ENCH 215, 427) should be able to use it.

We also received a small grant to analyze student writing in ENCH 300 (Thermodynamics) and ENCH 442 (Process Control and Safety). We have found there to be a positive correlation between student ability to explain how a homework problem relates to their personal life and potential future career and their performance on exams in ENCH 442. We also found there to be correlations between quality writing between the two courses. Preliminary results of this textual analysis will be presented at the 2015 ASEE Annual Conference.

Major Challenges:

The major challenges that face CBEE are: 1) increased UG enrollment (a summary enrollment data is given below) and 2) sustaining the student focused teaching innovations.

Because of increased enrollment we were forced to add additional sections of our core classes and labs (ENCH 215, 225L, 300, 425 and 437L), offered Chemical Engineering Analysis (ENCH 215) during the summer session to accommodate the increasing number of transfer students, and added additional sections of capstone design (ENCH 444 and 446). In 2011-2012, our department had 10 T/TT, 2 NTT, 2 PT teaching faculty to teach 25 courses with total class enrollments of 732. In fall 2012, we added an additional T/TT faculty member and one T/TT faculty member moved to a NTT line. CBEE lost two Senior Faculty (Drs. Ross and Good). We lost a lecturer at the end of the previous academic year 2015 (Dr. Enszer) and Dr. Taryn Bayles (PoP) left in Jan 2016. We are hiring two new TT faculty that are scheduled to start in January 2016. One of the faculty is an Assistant Professor and will have limited teaching responsibilities in his first three years. We will be challenged to teach 40 required courses with over 1600 total class enrollments in the up-coming academic year. The plan is to hire several part-time teaching faculty Fll 15/Spring16 and hire two lectures by the end of the current AY.

The teaching innovations that were described earlier were implanted in an era of much lower enrollment. We will have to scale back the innovations unless enrollments are reduced or additional lecturers are added.

Chemical, Biochemical & Environmental Engineering

Graduates, Majors, Classes, Total Class Enrollments & Teaching Faculty

	2011-12	**2012-13**	**2013-14**	**2014-15**	**2015-16**
BS Graduates	37	33	28	45*	65*
Undergraduate Majors	227	278	281	357	420*

Number of Classes Taught	25	30	32	39	40
Total Class Enrollments	732	951	894	974	1630*
T/TT Teaching Faculty	10	10	9	9	8
NTT Teaching Faculty	2	3	3	3	2
PT Teaching Faculty	2	2	2	5	3+

* Estimate