CHEMICAL &
BIOLOGICAL
ENGINEERING

Academic Program Review

Site visit: May 8-9, 2018

Department of Chemical & Biological Engineering

School of Engineering

Contents

Criterion 0. Introductory Section and Background Information

0A. Executive Summary

An Executive Summary that provides a one to two-page summary/abstract of the information contained within the Self-Study Report.

This self-study report documents all aspects of the Chemical & Biological Engineering (CBE) department. It starts with a brief history, the organization structure, the most recent (2016) and successful ABET accreditation review and the previous Academic Program Review (APR) – including the findings and our response. A lot has changed since the last APR in April 2009. At that time the department had 11 faculty in chemical engineering. Now we have 15 faculty, including one lecturer, and three faculty at 0.5 FTE (so 13.5 FTE). As reported in the last APR, we had 60 ChE undergraduates. At present we have 293 students enrolled, part of the increase is due to our tracking students from the freshman year. Nonetheless it represents a significant increase in enrollments. The department is engaged in a major effort to revolutionize undergraduate education through the program FACETS funded by a $2M NSF grant.

The graduate student population has also grown but, as we will explain, is now split between chemical engineering, Nanoscience and Microsystems Engineering (NSME) and Biomedical Engineering (BME) which was formed since the last APR. Faculty in CBE developed these two interdisciplinary programs and support much of the teaching and advise the majority of students in those programs.

Our research expenditures are holding steady, with over $5M in expenditures in CY 2017, averaging over $400K per FTE research active faculty member (12.5 FTE). Support from I&G (Instruction and General) funds which support faculty and staff salaries was $1.72 M in the past fiscal year. There have been funding cuts and mid-year pull backs last two years, but the good news has been the addition of differential tuition. The undergraduate differential tuition (instituted in AY 2016-2017) and graduate differential tuition (instituted in AY 2017-2018) represent the only funding that scales with enrollment. Graduate differential tuition is split with the two other graduate programs BME and NSME.

In 2014 we spun off Nuclear Engineering as a separate department, and changed our name to Chemical & Biological Engineering. We moved recently into the remodeled Farris Engineering Center, the most modern and high tech building on the UNM campus. This move has had a major positive impact on faculty and staff housed in the department as will be evident during the visit, and it should have a positive impact on recruitment at both the graduate and undergraduate levels. Our faculty are now spread over three buildings, two on main campus (Farris Engineering Center – FEC and Centennial Engineering Center - CEC) and one building on the south campus (Advanced Materials Laboratory - AML). Most of our research is conducted through two research centers, Center for Microengineered Materials (CMEM) housed in the AML and the Center for Biomedical Engineering housed in the CEC, and to a lesser degree through the Center for High Technology Materials (CHTM) also located on the south campus. The center structure is unique at UNM since all indirect costs flow to the centers, with only a fraction of the grants housed in the department.

0B. History

A brief description of the history of each degree/certificate program offered by the unit.

The current Department of Chemical and Nuclear Engineering has its roots in an undergraduate Department of Chemical Engineering founded in 1946, and a graduate Nuclear Engineering department founded in 1965. The departments were administratively combined in 1972. In 2014, the departments were split into the CBE department and a separate NE department, though we continue to share some staff, courses and our administrative offices and student spaces. The present Department of Chemical and Biological Engineering offers an ABET-accredited B.S. degree in chemical engineering, as well as M.S. and Ph.D. in Engineering with concentration in Chemical Engineering. The B.S. chemical engineering program has been ABET accredited since 1976. More details on the last ABET visit are provided in Section 2, which has given us a 6 year accreditation with the next visit in 2022.

The faculty of the Department of Chemical and Biological Engineering also teach and provide support to the interdisciplinary graduate program in Nanoscience and Microsystems Engineering (NSME) and the Biomedical Engineering (BME) program. The graduate program in NSME originated from a NSF/IGERT grant (2005-2010) and was approved by the UNM faculty senate in 2007 and then by the NM Higher Education Department. The BME graduate program commenced in 2011. The NSME and BME graduate programs enable us to attract students from diverse disciplines such as chemistry, ceramics, and materials science as well as from other sciences and engineering disciplines. This is consistent with the interdisciplinary nature of the research conducted in CBE and provides a facile pathway for students to be mentored by our faculty even if they do not have a BS degree in chemical engineering.

0C. Organizational Structure and Governance

A brief description of the organizational structure and governance of the unit, including a diagram of the organizational structure.

The Dean of School of Engineering appoints the Department Chair, after consultation with faculty and other University officials. The Chair appoints the Associate Chairs and various committees. The leadership team in the Department consists of the Chair and the Associate Chairs who are also the Directors of the Graduate and Undergraduate Programs. The Department of Chemical & Biological Engineering involves faculty in all key academic decisions and the staff participate in departmental administration and student advising. The organizational structure is shown on the next page in Figure 1.

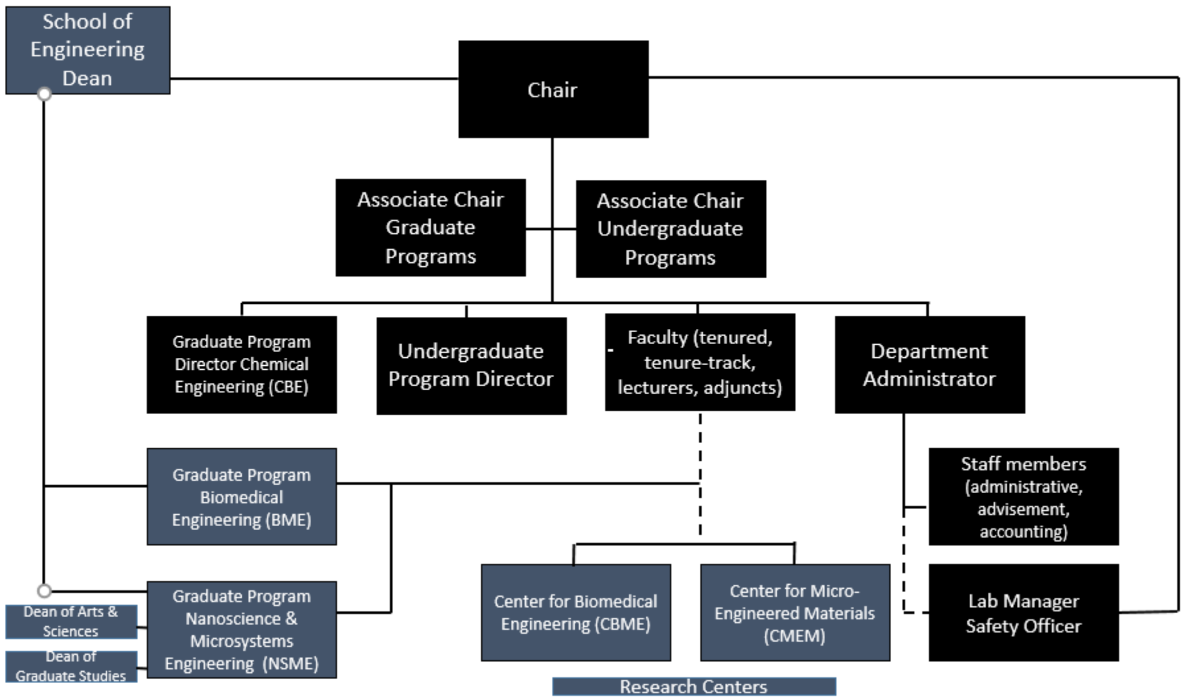


Figure 1 Organization chart for Chemical & Biological Engineering (CBE). While faculty in CBE manage the interdisciplinary programs BME & NSME and the research centers CBME and CMEM, these programs and centers do not report to the chair of CBE, hence they are shown with dotted lines. CBME reports to the Dean of Engineering, NSME to three Deans and CMEM reports to the VP for Research.

0D. Specialized and/or External Accreditations

Information regarding specialized/external program accreditation(s) associated with the unit, including a summary of findings from the last review, if applicable. If not applicable, indicate that the unit does not have any specialized/external program accreditation(s).

There is no accrediting body for the graduate programs in the Department of Chemical & Biological Engineering. The undergraduate program is accredited by the Engineering Accreditation Commission of ABET (Accreditation Board for Engineering and Technology). The ABET visit takes place once every 6 years.

The most recent ABET visit was in Fall of 2016. The final report was received in August 2017 and is included on the next 5 pages of this document. The “Summary of Accreditation Actions” stated that Chemical Engineering (BS) is “Accredited to September 30, 2023. A request to ABET by January 31, 2022 will be required to initiate a reaccreditation evaluation visit. The reaccreditation evaluation will be a comprehensive general review.

ABET
ENGINEERING ACCREDITATION COMMISSION

UNIVERSITY OF NEW MEXICO
Albuquerque, NM

FINAL STATEMENT
Visit Dates: October 9-12, 2016
Accreditation Cycle Criteria: 2016-2017

Introduction & Discussion of Statement Construct

The Engineering Accreditation Commission (EAC) of ABET has evaluated the chemical, civil, computer, construction, electrical, mechanical, and nuclear engineering programs of the University of New Mexico.

This statement is the final summary of the EAC evaluation, at the institutional and engineering-program levels. The statement consists of two parts: the first addresses the institution and its overall engineering educational unit, and the second addresses the individual engineering programs. It is constructed in a format that allows the reader to discern both the original visit findings and subsequent progress made during due process.

A program's accreditation action is based upon the findings summarized in this statement. Actions depend on the program's range of compliance or non-compliance with the criteria. This range can be construed from the following terminology:

- Deficiency: A deficiency indicates that a criterion, policy, or procedure is not satisfied. Therefore, the program is not in compliance with the criterion, policy, or procedure.

- Weakness: A weakness indicates that a program lacks the strength of compliance with a criterion, policy, or procedure to ensure that the quality of the program will not be compromised. Therefore, remedial action is required to strengthen compliance with the criterion, policy, or procedure prior to the next review.

- Concern: A concern indicates that a program currently satisfies a criterion, policy, or procedure; however, the potential exists for the situation to change such that the criterion, policy, or procedure may not be satisfied.

- Observation: An observation is a comment or suggestion that does not relate directly to the current accreditation action but is offered to assist the institution in its continuing efforts to improve its programs.

Information Received After the Visit

1. Seven-day response: The institution did not provide a seven-day response.

2. 30-day due-process response: Information was received in the 30-day due-process response period relative to the chemical, civil, computer, construction, electrical, mechanical, and nuclear engineering programs.

Institutional Summary

The University of New Mexico is a state-supported comprehensive research university located in Albuquerque with four branch campuses. There are approximately 1,200 tenured and tenure-track faculty members, 20,000 undergraduate students, and 7,000 graduate and professional students in the 16 colleges and schools at the main campus in Albuquerque. The School of Engineering has approximately 100 faculty members and enrolls approximately 2,300 undergraduate students and nearly 800 graduate students. There is currently a national search for a dean.

The following units were reviewed and found to adequately support the engineering programs: mathematics, physics, chemistry, biology, information technology, library, career services, registrar, and admissions.

Institutional Strengths

1. The State of New Mexico has invested $26M to renovate and expand the School of Engineering by 26,000 square feet. This significantly increases the footprint of the school, providing state-of-the-art laboratories, student space, and faculty offices.

2. The State of New Mexico provides tuition scholarships to all students who graduate from high schools in the state regardless of immigration status. This four-year scholarship, supported by the state lottery, pays between 90-100 percent of tuition at four-year institutions for eight semesters provided the student maintains a grade point average above 2.5. Garnering the advantage of the university as a Hispanic-Serving Institution, the School of Engineering is able to provide students from under-represented minority groups and first-generation college students access to engineering education in the state's flagship university. Programs are in place to provide the support students need to successfully complete degrees and either enter the workforce or attend graduate school.

Chemical Engineering
BS Program

Program Criteria for Chemical, Biochemical, Biomolecular, and Similarly Named Engineering Programs

Introduction

The chemical engineering BS program currently has 324 undergraduates served by 15 faculty members. The program produced 33 baccalaureate graduates during the 2013-14 academic year. The program has seen significant growth over the past five years, more than doubling its undergraduate enrollment since 2012.

Program Strengths

1. The program has strong ties to Sandia National Laboratories, other national laboratories, and several local industries. These relationships, along with opportunities within faculty members' laboratories, provide students with research and internship opportunities to augment their educational experiences. This results in a majority of students having a research experience by graduation.

2. The program, in conjunction with the Organization, Information and Learning Sciences program, has recently received a 5-year, $2 million NSF-funded project entitled "FACETS: Formation of Accomplished Chemical Engineers for Transforming Society," with the goal to train chemical engineers capable of addressing human needs and societal problems such as clean water, clean environment, sustainable energy, and improved health care. This grant is one of only seven awarded this year and is expected to improve student retention and increase student interest in engineering.

Program Concern

1. Criterion 4. Continuous Improvement This criterion requires that programs must regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained. Currently, assessment for student outcome (i) only measures recognition of the need for life-long learning. While the students currently engage

FINAL STATEMENT **UNIVERSITY OF NEW MEXICO**

in life-long learning by using AIChE online safety training, the ability to engage in life-long learning is not assessed. In addition, assessment for student outcome (k) only measures the students' ability using Matlab in a single course, representing a single engineering tool. Although students use many engineering tools including JMP, ASPEN Plus, and Excel, the ability to use other engineering tools and techniques is not systematically assessed. Without robust data the program may not be able to document attainment of these student outcomes. Thus, future compliance with this criterion may be jeopardized.

- 30-day due-process response: The EAC acknowledges receipt of documentation describing the revised assessment of student outcomes (i) and (k). The documentation included outcomes assessment data and described planned changes in the curriculum.

- The concern is resolved.

0E. Overview of Previous Academic Program Review

A brief description of the previous Academic Program Review Process for the unit. The description should:

- *note when the last review was conducted;*
- *provide a summary of the findings from the Review Team Report;*
- *indicate how the Unit Response Report and Initial Action Plan addressed the findings; and*
- *provide a summary of actions taken in response to the previous APR.*

The Department had its previous APR visit on April 27-29, 2009. Since both chemical & nuclear engineering programs were reviewed, the review team included 5 members, 2 ChE, 2 NE and one internal member as listed below. The full report is included as Appendix A.

<table>
<tr><td>Steven M. Cramer, Chemical Engineering
Rensselaer Polytechnic Institute, Troy, NY</td><td>John L. Falconer, Chemical Engineering
University of Colorado, Boulder, CO</td></tr>
<tr><td>Barry D. Ganapol, Mechanical Engineering
University of Arizona, Tucson, AZ</td><td rowspan="2">Andrew C. Klein, Idaho National Laboratory
Idaho Falls, ID and
Professor, Nuclear Engineering and Radiation
Oregon State University, Corvallis, OR</td></tr>
<tr><td>Kerry J. Howe, Civil Engineering
University of New Mexico Albuquerque, NM</td></tr>
</table>

We present here a summary points from the report (as they pertain to chemical engineering) and the departmental response (from 2009), as well as actions/updates through the present time. The complete departmental response and action plan from 2009 is presented as Appendix B along with responses to specific questions asked of the APR committee.

Summary

Department/Center Relationships

The APR committee voiced concern over the lack of policies for splitting or sharing of returned F&A between home departments of faculty and Centers where they may choose to submit their grants.

Department response (2009) The Department chair worked with affiliated Centers to support the department by partial Center support of department staff.

Update (2018) The F&A distribution model has not changed, so the department only receives F&A for grants submitted through the department. Most research continues to reside in centers. However, the centers have provided help with startups for new faculty hires and continue partial support for one staff member in CBE.

Graduate Recruiting

The APR team was concerned about graduate recruiting.

Departmental response (2009): This topic was discussed by the faculty and it was recognized that lack of funding to support first year graduate students remains a barrier for recruiting.

Update (2018): The new Dean in conjunction with the Dean of graduate studies provided funds to bring in graduate students for a common recruiting day. The first such event was held in March 2018. We hope that such recruitment efforts, along with improvements in the website, will help graduate recruiting in the future. The growth in NSME and BME graduate programs has helped attract more students to our department, and moving forward we are actively coordinating our graduate programs and recruitment efforts to make this more effective. The involvement of our faculty in three graduate programs could be considered a downside. However, it allows faculty in CBE to recruit students from diverse majors, which helps in recruitment efforts as will be evident when we present the numbers of graduate students later in this document.

Advisory Council and Strategic Planning

The APR team noted that the Advisory Council had not met for some time and there had not been any strategic planning.

Department response (2009): The Advisory Council was reconstituted and met in Nov. 2009. There was also a meeting in 2010, when the ABET visit happened, but after that there was again a gap.

Update (2018): After the present chair took over, the Advisory Council was reconstituted, and regular meetings have been held each year (2014, 2015, 2016 and 2017). The initial meetings have focused on changes to the undergraduate program, as part of the NSF RED grant planning. In future, the focus will be on strategic planning.

Faculty Mentoring

The APR team pointed out that a consistent faculty mentoring program was lacking in the department.

Department response (2009): The Chair recognized and agreed with that need. A better-defined mentoring program was initiated.

Update (2018): Each untenured faculty member is assigned a mentor, and in some cases more than one mentor. There is some discussion whether mentoring should also be continued with Associate

Professors. In addition, we are exploring peer observations of teaching as a way to share best practices and enhance our teaching.

Besides the general observations, the APR committee in 2009 was asked to respond to 7 specific questions. We present below a summary of the APR observations and the actions taken by the department. The formal departmental response in 2009 is included as *Appendix B*.

Specific APR Questions in 2009 and actions taken by the department

Question 1a: How does the undergraduate program for chemical and nuclear engineering compare with other well-respected programs across the country?

The APR committee had a very favorable impression of the undergraduate students and they noted the large percentage of students going to graduate school, and who had research experiences. The concerns were about ethics and plagiarism (copying HW), rigor of the courses (average GPA), faculty missing classes and/or not returning HW in time, high-performing faculty in research do not teach undergraduate classes, students not well informed about graduate school, the small number of courses that represent each concentration and the small size of the undergraduate program, which was not by itself judged to be a problem.

Department actions (2018): Since 2014 when the current chair took over, the major emphasis of the department has been on improvements to the undergraduate program. The ABET visit was coming up in 2016 which required faculty to focus on getting all documents in order. In addition, the Provost had asked in 2012 for all programs to reduce the credit hours for the BS degree to 120 hours. The department was actively engaged in examining each part of our program and ended up trimming to 123 credit hours. The reason we did not go down to 120 was that our faculty felt that one course needed to be dropped from the common core to maintain the balance between courses within and outside engineering. The exercise of going through the entire program helped the faculty focus on achieving the program goals more effectively. NSF announced the RED (Revolutionizing Engineering Departments) initiative in late summer 2014. The department went through an internal brainstorming exercise and through discussions with eminent educators around the country and our advisory board, the department submitted proposals to the NSF that were successful in securing funding. The department proposal called FACETS (Formation of Accomplished Chemical Engineers for Transforming Society) has engaged the entire faculty in undergraduate education. Even faculty who primarily taught only graduate courses are now involved in undergraduate classes in various capacities. Various models for engaging all faculty are being explored and this has led to vibrant discussions on undergraduate education. As part of FACETS, we are inviting faculty with a focus on Engineering Education research to present in the departmental seminar series. Faculty development workshops are focused on aspects of undergraduate education, including team work, plagiarism and we have now a major focus on enhancing writing in the curriculum. Looking at the success of our undergraduates, especially the schools where they have gone for graduate school, we are confident that our program is guiding students very well with regard to graduate school. Our faculty are also now engaged in pedagogical innovations that will be disseminated to the chemical engineering community. Faculty are presenting papers at the ASEE and workshops at the ASEE summer school for junior faculty. Our goal is to make a bid to host the next ASEE summer school on the UNM campus, which would allow us to showcase our educational innovations. All of these efforts help to build the quality and reputation of the undergraduate program.

Question 1b. How does the graduate program for chemical engineering and nuclear engineering compare with other well-respected programs across the country?

The APR committee noted the small size of the graduate program, emphasis on Masters compared to PhD, many graduate students coming from UNM, large numbers of post-docs and research faculty and only 6 faculty with chemical engineering degrees. There was also a concern about the rigor of the courses, with the average GPA being 3.84/4.0.

Department actions (2018): The growth in size of our graduate program, the mix of graduate students and their publications and awards provide evidence for the quality of the graduate program. A concerted effort is underway to publicize our faculty research and accomplishments, including a newsletter and improvements to our website. We feel our metrics are better than our ranking (#72) in the US News and World report, hence we will diligently work to get the message out so we can be recognized for our graduate program. The composite h-index was calculated in 2017 to be 123, ie the department collectively has 123 publications with more than 123 citations. As noted by the panel, there were 3 faculty with h-indexes above 30 in 2009, now we have 7 faculty with h-indexes above 30. More information is included in the section on faculty.

Question 2: Are the undergraduate laboratory facilities and experiments adequate and competitive with other strong programs? Do you have suggestions for improvements in this regard?

The APR committee felt positively about the large laboratory, the connection between the 4-lab sequence and theory courses and having a staff person to run the lab. They commented about some safety concerns during the walk through.

Department actions (2018): We have made a concerted effort to add training in safety to the curriculum. Students do the AIChE/SACHE certificate courses throughout the curriculum, each lab now involves a job safety assessment and we do a refresher each semester where all students and faculty attend. For the lab, we have added two important components, a course on Applied Statistics and a special emphasis on writing. By using an embedded writing instructor (from the English department) we hope to create a sustainable model for improving the communication skills of our students. We have submitted papers to the ASEE on this approach and will continue to refine this lab sequence and eventually disseminate our findings.

Question 3: What strategies might help us to improve the success of our graduate student recruiting?

The APR committee noted the low number of PhD students, the policy of recruiting students to work directly with a faculty member, the need for fellowships to support graduate students during their first year. Also, the lack of a strong recruiting effort, bringing students in for a visit was also noted. Better visibility was a key factor. The panel recommended recruiting students from UNM with majors outside chemical engineering.

Department actions (2018): A common graduate recruiting day was held for the first time with funds provided by the Dean's office and the combined CBE/BME/NSMS programs had over 6 students visiting. The growth of the NSME and BME programs now allow us to recruit UNM undergraduates with majors outside chemical engineering. The 4+1 combined program has also increased the pool of graduate students. The website is being revamped but a brochure is still needed, and is in the works.

Question 4: Do we have enough faculty to compete effectively for funding opportunities in the various research focus areas that we have targeted? If adding faculty were possible, what research areas would you recommend strengthening?

The APR panel noted that faculty numbers were stagnant for 20 years and there were 11 faculty in 2009. But the department managed to keep research activity high by having post-docs and research professors. There was also a concern that some actions by senior faculty may have undermined the success of junior faculty.

Department actions (2018): The CBE department has lost one faculty member to retirement in 2014, but gained three faculty members through school-wide hires in the area of energy materials. The present group of faculty are collegial, committed to the success of junior faculty and are well placed to complete effectively in major funding opportunities.

Question 5: What are best or suggested practices for effective coordination of departmental administration and the administration of affiliated centers in order to maximize the positive impacts of these centers? Specific issues that are of interest include financial coordination and cooperation, balancing of faculty workload expectation and duties, and reporting/credit for productivity.

The APR committee voiced concerns about the lack of resources coming to the department via indirect cost recovery. A policy for release time and course buyout was recommended.

Department actions (2018): The SOE faculty voted on a workload policy that clarified the teaching workload and has led to some release time being generated in recent years. The center directors are committed to the success of the department and many aspects such as graduate recruiting, public relations, etc. are being coordinated between the centers and the departments.

Question 6: What are the suggested practices for effective administration and coordination of interdisciplinary degree programs that are largely supported or led by department faculty? Specific issues that are of interest include impact on enrollments in department programs, student credit hour generation, and faculty workload credit.

The APR noted half of the faculty did not have chemical engineering degrees, which limits who is available to teach core courses. A more formal policy on workload credit is needed. And a strategic plan to clarify the roles of interdisciplinary degree programs with respect to faculty hiring is needed.

Department actions (2018): The graduate committee now includes the directors of all three programs and one ChE faculty member who helps to unify these into a coordinated and coherent effort. The goal is to create a unified experience to all students in the department, so they don't see widely different rules for different students working with the same professor. The common STEM symposium in spring and a common seminar program helps bring these different programs into one umbrella.

Question 7: Do you see opportunities that either of the programs in the department is not recognizing or capitalizing on?

The APR team commented on programs that unify chemical & nuclear engineering, since we were a joint department at that time. This is no longer true. Hence no response is needed.

Criterion 1. Student Learning Goals and Outcomes

The unit should have stated student learning goals and outcomes for each degree/certificate program and demonstrate how the goals align with the vision and mission of the unit and university. (Differentiate for each undergraduate and graduate degree and certificate program offered by the unit.)

1A. Vision and Mission

Provide a brief overview of the vision and mission of the unit and how each offered degree/certificate program addresses the vision and mission of the unit.

The school of Engineering sets the common mission and vision for all its departments:

The Mission

The mission of the School of Engineering (SOE) at the University of New Mexico is to educate students in engineering and computer science to contribute to the social, technological, and economic development of our state, nation, and global community. We offer a superior education in engineering and computer science in an environment that fosters teamwork, cultural and intellectual diversity, a strong sense of public responsibility, and lifelong learning.

The Vision

The School of Engineering at the University of New Mexico offers broad access to high-quality research-based education by:

- Creating and communicating knowledge through outstanding educational programs that promote learning by uniting teaching and research,
- Recognizing and utilizing cultural and intellectual diversity as creative forces that underlie and enable excellence in engineering and computer science, and
- Stimulating and engaging the School's programs to advance economic development and address critical technological challenges for New Mexico, the nation, and the global economy.

The forward-looking integration of these elements will place the School among the nation's leading comprehensive public engineering colleges.

1B. Relationship between the Unit and University's Vision and Mission

Describe the relationship of the unit's vision and mission to UNM’s vision and mission. In other words, to assist the university in better showcasing your unit, please explain the importance of its contribution to the wellbeing of the university, including the impact of the unit’s degree/certificate program(s) on relevant disciplines/fields, locally, regionally, nationally, and/or internationally.

University Vision Statement

UNM will build on its strategic resources:

- to offer New Mexicans access to a comprehensive array of high quality educational, research, and service programs,
- to serve as a significant knowledge resource for New Mexico, the nation, and the world; and
- to foster programs of international prominence that will place UNM among America's most distinguished public research universities.

University Mission

The University will engage students, faculty, and staff in its comprehensive educational, research, and service programs.

- UNM will provide students the values, habits of mind, knowledge, and skills that they need to be enlightened citizens, to contribute to the state and national economies, and to lead satisfying lives.
- Faculty, staff, and students create, apply, and disseminate new knowledge and creative works; they provide services that enhance New Mexicans' quality of life and promote economic development; and they advance our understanding of the world, its peoples, and cultures.
- Building on its educational, research, and creative resources, the University provides services directly to the City and State, including health care, social services, policy studies, commercialization of inventions, and cultural events.

The School of Engineering’s vision and mission and the University’s are in alignment. In particular, the SOE mission statement emphasizes teamwork, cultural and intellectual diversity, public responsibility, lifelong learning and the contributions to social, technological, and economic development from local to global scales, so it is relevant and directly applicable to each of the three University’s mission statements.

1C. Unit Goals and Student Learning Outcomes

List the overall program goals and student learning outcomes for each degree/certificate program within the unit. Include an explanation of how they are current and relevant to the associated discipline/field. In accordance with the Higher Learning Commission’s criteria for accreditation, student learning goals and outcomes should be articulated and differentiated for each undergraduate and graduate degree and post-graduate and certificate program.

Consistent with the vision and mission of SOE, the Department of Chemical and Biological Engineering sets the following educational objectives for the undergraduate program:

Graduates of the chemical engineering program at the University of New Mexico will be able to:

- Meet or exceed the expectations of their professional position
- Successfully pursue advanced study in a graduate or professional program
- Assume leadership roles in their professions and/or communities

These objectives, as well as the student learning outcomes listed below, are in compliance with the current requirements set by the accreditation body of our undergraduate program, ABET. The graduate program objectives are similar to those of the undergraduate program, with the added emphasis on making original contributions to the field of chemical engineering through scholarship and on achieving societal impact through the products of their research.

Student Learning Outcomes (B.S. in Chemical Engineering)

By the time our graduates complete the engineering engineering program, they will have successfully demonstrated the following:

Prior to fall 2017 (ABET Student Outcomes):

a. An ability to apply knowledge of mathematics, science and engineering.
b. An ability to design and conduct experiments, and analyze and interpret data.
c. An ability to design processes, systems or components to meet desired needs and subject to realistic constraints, such as economic, environmental, social, political, ethical, health, safety, manufacturability, and sustainability.
d. An ability to function on multidisciplinary teams.
e. An ability to identify, formulate and solve engineering problems.
f. An understanding of the professional and ethical responsibilities of engineers.
g. An ability to communicate effectively.
h. An understanding of the global, economic, environmental and societal impacts of engineering activities.
i. A recognition of the need for lifelong learning and awareness of how this can be achieved in their subsequent career.
j. A knowledge of contemporary issues.
k. An ability to use modern techniques, skills and engineering tools to address problems encountered in engineering practice.

Fall 2017 – current (updated ABET Student Outcomes):

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. an 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.
3. an ability to communicate effectively with a range of audiences.

4. an 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.
5. an 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.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Student Learning Outcomes (M.S. in Chemical Engineering)

Students receiving the M.S. degree will:

1) Exhibit knowledge of engineering and science fundamentals appropriate for the Chemical Engineering discipline and/or specialization.
2) Be able to communicate effectively.
3) Demonstrate the ability to critically assess information in the Chemical Engineering discipline and/or specialization.

Student Learning Outcomes (Ph.D. in Chemical Engineering)

Students receiving the PhD degree will:

1) Exhibit knowledge of engineering and science fundamentals appropriate for the Chemical Engineering discipline and/or specialization.
2) Demonstrate a depth of knowledge in the specialization.
3) Have the ability to conduct original research.
4) Have demonstrated the ability to perform a critical review of the literature in the area of specialization.
5) Be able to communicate effectively.

1D. Constituents and Stakeholders

Describe the unit's primary constituents and stakeholders. Include an explanation of: (1) how the student learning goals and outcomes for each degree/certificate program are communicated to students, constituents, and other stakeholders; and (2) how satisfaction of the student learning goals and outcomes for each degree/certificate program would serve and support students' academic and/or professional aspirations. Provide specific examples.

The constituents of the Department are its students, faculty and staff. Other primary stakeholders include the School of Engineering, the Advisory Council of the Department, our alumni, and employers of our graduates. The program objectives and student outcomes are posted on the departmental webpages. The outcomes are set by ABET (undergraduate) and the School of Engineering (graduate). The program objectives are set by faculty with periodic discussion with the CBE Advisory Council. The most recent example is the Advisory Council meeting on November 17, 2017, where the Council endorsed our current program objectives.

The Program Educational Objectives have been reviewed and approved by all constituency groups. According to survey results, all groups responded favorably and agreed that the Program Educational Objectives fulfill their needs. While the PEOs were considered more than sufficient, specific suggestions were made by alumni and employers to improve our program. For instance, the employer survey conducted in Spring 2014 strongly suggested that employers would like to see our graduates having the exposure to project management and the ability to work in teams. As a result of this survey and faculty discussion, we have incorporated project management in our capstone design courses (493L and 494L sequence). We also implemented peer-assessment rubrics in laboratory courses (318L, 319L, 418L, and 419L) to promote ability to function in teams. We have seen improvement in student participation and team dynamics since these elements were implemented. In spring 2018, we plan to award an open badge to recognize students who are deemed to be “Outstanding team members” by their peers. The alumni survey conducted in Spring 2015 also confirmed the benefit of working in teams fostered through laboratory and design courses. Alumni valued the laboratory experience and projects done in the unit operations course. The most recent update to the PEOs was done on November 17, 2017 at the CBE Advisory Council meeting to refine the objectives to more accurately reflect what we expect our graduates to be doing 3 to 5 years after graduation.

1E. Primary Constituents and Stakeholders

Describe the unit’s primary constituents and stakeholders.

See 1D.

1F. Student Learning Goals and Outcomes Strategic Planning

Discuss how the unit’s strategic planning efforts have evolved in relation to student learning goals and outcomes of its degree/certificate program(s), serving its constituents and stakeholders, and contributing to the well-being of the university and UNM community. Include an overview of the unit’s strategic planning efforts going forward. For example, discuss the strengths and challenges of the unit, including the steps it has taken to maximize its strengths and address both internal and external challenges.

The department constantly assesses student outcomes to ensure student success, making changes to the program to correct any issues that become evident through the outcomes assessments. Assessment data collection and storage has proved to be challenging. Prior to fall 2016, data collection was entirely paper-based. Since then, we have set up UNM-supported Share Point folder for faculty to electronically submit course information, assessment data, and instructor reflections. This electronic assessment data collection vastly simplified our assessment process and increased availability and accessibility of the assessment material. The results of the outcome assessment are analyzed by the undergraduate committee, recommendations are made at the faculty retreats and changes in the program are discussed. As needed, the curriculum is revised after considering input from various stakeholders. The processes used for continuous improvement are described in the next section.

Criterion 2. Teaching and Learning: Curriculum

The unit should demonstrate the relevance and impact of the curriculum associated with each degree/certificate program. (Differentiate for each undergraduate and graduate degree and certificate program offered by the unit.)

2A. Curricula

Provide a detailed description of the curricula for each degree/certificate program within the unit. (1) Include a description of the general education component required and program-specific components for both the undergraduate and graduate programs. (2) If applicable, provide a justification as to why any bachelor's degree program within the unit requires over 120 credit hours for completion.

2A.1. Undergraduate Program

Students completing the B.S. degree program in chemical engineering are prepared for professional careers as well as further study. The curriculum contains mathematics, science, and a rigorous set of chemical engineering courses that prepare students for a variety of careers. This is evident in the career paths of our students. The majority of our students leave with jobs as engineers in industry, national labs or government or enroll for graduate study in engineering, business, law or medicine.

UNM Core Curriculum

All undergraduates at UNM are required to complete the UNM core curriculum. The UNM core courses are classified into seven areas: Writing and Speaking, Mathematics, Physical and Natural Sciences, Social and Behavioral Sciences, Humanities, Foreign Language, and Fine Arts. Students have numerous options for satisfying the UNM core. These can be found at: https://unmcore.unm.edu/index.html .

CBE Program Curriculum

A detailed listing of the B.S. Chemical Engineering curriculum requirements is provided in Tables 2A-1A through 2A-1E. Table 2A-1A outlines the requirements for the Chemical Process Engineering Concentration, Table 2A-1B outlines the requirements for the Bioengineering Concentration, Table 2A-1C outlines the requirements for the Environmental Engineering Concentration, Table 2A-1D outlines the requirements for the Materials Processing Concentration, and Table 2A-1E outlines the requirements for the Semiconductor Manufacturing Concentration. The list of Approved Technical Electives is presented in Table 2A-2. The curriculum is based on a semester system, requiring a minimum of 123 credits for graduation. One semester credit is normally defined as one hour of lecture per week or three hours of laboratory with additional 2 hours or more of work (per credit hour) outside of the classroom, such as for individual study, for completing homework or projects. Each semester normally involves 15 weeks of classes, exclusive of final exams and breaks.

Table 2A-1A: Curriculum

Chemical Engineering, Chemical Process Engineering Concentration

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE.[1]	Subject Area (Credit Hours)				Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered[2]
		Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (√)	General Education	Other		
CBE 101: Intro to Chemical Engineering & Biological Engineering	R		.5		.5	F15, S16	150
CHEM 121: General Chemistry I	R	3				F15, S16	180
CHEM 123L: General Chemistry I Lab	R	1				F15, S16	24
ENGL 110: Accelerated Composition (or ENGL 112: Composition II or ENGL 113: Enhanced Composition)	R			3		F15, S16	25
MATH 162: Calculus I	R	4				F15, S16	32
CORE: Humanities	SE			3		F15, S16	VARIES

							(Example: HIST 101 – 160)
CHEM 122: General Chemistry II	R	3				F15, S16	150
CHEM 124L: General Chemistry II Lab	R	1				F15, S16	24
ENGL 120: Composition III	R			3		F15, S16	23
MATH 163: Calculus II	R	4				F15, S16	34
PHYC 160: General Physics	R	3				F15, S16	300
CORE: Social & Behavioral Sciences	SE			3		F15, S16	VARIES (Example: PSY 105 – 830)
CBE 251: Chemical Process Calculations	R		3			F15	126
CHEM 301: Organic Chemistry	R	3				F15, S16	120
CHEM 303L: Organic Chemistry Lab	R	1				F15, S16	18
MATH 264: Calculus III	R	4				F15, S16	33
PHYC 161: General Physics	R	3				F15, S16	200
CBE 253: Chemical and Biological Engineering Computing	R		3			S16	50
CBE 302: Chemical Engineering Thermodynamics	R		3			S16	101

ECON 105: Introductory Macroeconomics	R			3		F15, S16	64
MATH 316: Applied Ordinary Differential Equations	R	3				F15, S16	44
CHEM 302: Organic Chemistry	R	3				F15, S16	120
CBE 311: Introduction to Transport Phenomena	R		3			F15	81
CBE 317: Numerical Methods for Chemical & Biological Engineering	R		2			F15	100
CBE 318L: Chemical Engineering Laboratory I	R		1			F15	24
CBE 361: Biomolecular Engineering	R		3			F15	70
ENGL 219: Technical and Professional Writing	R			3		F15, S16	25
CHEM 311: Physical Chemistry	R	3				F15	80
CBE 312: Unit Operations	R		3√			S16	80
CBE 321: Mass Transfer	R		3			S16	55
CBE 319L: Chemical Engineering Laboratory II	R		1			S16	24
CBE 371: Introduction to Materials Engineering	R		3			S16	80
ENG 301: Fundamentals of Engineering - Dynamics	R		1			S16	200 (online)
ENG 302: Fundamentals of Engineering – Electrical Circuits	R		1			S16	200 (online)
CHEM 312: Physical Chemistry	R	3				S16	80
CBE 418L: Chemical Engineering Laboratory III	R		1			F15	24

CBE 454: Process Dynamic & Control	R		3			F15	60
CBE 461: Chemical Reactor Engineering	R		3			F15	60
CBE 486: Introduction to Statistics & Design of Experiments	R		2			F15	60
CBE 493L: Chemical Engineering Design	R		3√			F15	60
Technical Elective (Engineering, Math or Science)	SE	3				F15, S16	VARIES, (Example: MATH 314 – 35)
CBE 419L: Chemical Engineering Laboratory IV	R		1			S16	24
CBE 451: Senior Seminar	R		1			S16	16
CBE 494L: Advanced Chemical Engineering Design	R		3√			S16	46
Technical Elective (Engineering)	SE		3			F15, S16	VARIES, (Example: CE 335 – 36)
CORE: Fine Arts	SE			3		F15, S16	VARIES, (Example: MUS 139 – 280)
CORE: Humanities	SE			3		F15, S16	VARIES, (Example: RELG 107 – 500)

CORE: Foreign Language	SE			3		F15, S16	VARIES, (Example: SPAN 101 – 25)
TOTALS-ABET BASIC-LEVEL REQUIREMENTS		45	50.5	27	.5		
OVERALL TOTAL CREDIT HOURS FOR COMPLETION OF THE PROGRAM	123						
PERCENT OF TOTAL		37%	41%	22%	<1%		
Total must satisfy either credit hours or percentage	Minimum Semester Credit Hours	32 Hours	48 Hours				
	Minimum Percentage	25%	37.5 %				

1. **Required** courses are required of all students in the program, **elective** courses (often referred to as open or free electives) are optional for students, and **selected elective** courses are those for which students must take one or more courses from a specified group.
2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the maximum enrollment in each element. For selected elective courses, indicate the maximum enrollment for each option.

Instructional materials and student work verifying compliance with ABET criteria for the categories indicated above will be required during the campus visit.

Table 2A-1B: Curriculum

Chemical Engineering, Bioengineering Concentration

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE.[1]	Subject Area (Credit Hours)				Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered[2]
		Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (√)	General Education	Other		
CBE 101: Intro to Chemical Engineering & Biological Engineering	R		.5		.5	F15, S16	150
CHEM 121: General Chemistry I	R	3				F15, S16	180
CHEM 123L: General Chemistry I Lab	R	1				F15, S16	24
ENGL 110: Accelerated Composition (or ENGL 112: Composition II or ENGL 113: Enhanced Composition)	R			3		F15, S16	25
MATH 162: Calculus I	R	4				F15, S16	32
CORE: Humanities	SE			3		F15, S16	VARIES (Example: HIST 101 – 160)

CHEM 122: General Chemistry II	R	3				F15, S16	150
CHEM 124L: General Chemistry II Lab	R	1				F15, S16	24
ENGL 120: Composition III	R			3		F15, S16	23
MATH 163: Calculus II	R	4				F15, S16	34
PHYC 160: General Physics	R	3				F15, S16	300
CORE: Social & Behavioral Sciences	SE			3		F15, S16	VARIES (Example: PSY 105 – 830)
CBE 251: Chemical Process Calculations	R		3			F15	126
CHEM 301: Organic Chemistry	R	3				F15, S16	120
CHEM 303L: Organic Chemistry Lab	R	1				F15, S16	18
MATH 264: Calculus III	R	4				F15, S16	33
PHYC 161: General Physics	R	3				F15, S16	200
CBE 253: Chemical and Biological Engineering Computing	R		3			S16	50
CBE 302: Chemical Engineering Thermodynamics	R		3			S16	101
ECON 105: Introductory Macroeconomics	R			3		F15, S16	64

MATH 316: Applied Ordinary Differential Equations	R	3				F15, S16	44
CHEM 302: Organic Chemistry	R	3				F15, S16	120
CBE 311: Introduction to Transport Phenomena	R		3			F15	81
CBE 317: Numerical Methods for Chemical & Biological Engineering	R		2			F15	100
CBE 318L: Chemical Engineering Laboratory I	R		1			F15	24
CBE 361: Biomolecular Engineering	R		3			F15	70
ENGL 219: Technical and Professional Writing	R			3		F15, S16	25
BIOL 201L: Molecular & Cell Biology	R	4				F15, S16	144 (Lecture), 24 (Lab)
CBE 312: Unit Operations	R		3√			S16	80
CBE 321: Mass Transfer	R		3			S16	55
CBE 319L: Chemical Engineering Laboratory II	R		1			S16	24
CBE 371: Introduction to Materials Engineering	R		3			S16	80
ENG 301: Fundamentals of Engineering - Dynamics	R		1			S16	200 (online)
ENG 302: Fundamentals of Engineering – Electrical Circuits	R		1			S16	200 (online)
CHEM 312: Physical Chemistry	R	3				S16	80
CBE 418L: Chemical Engineering Laboratory III	R		1			F15	24
CBE 454: Process Dynamic & Control	R		3			F15	60

CBE 461: Chemical Reactor Engineering	R		3			F15	60
CBE 486: Introduction to Statistics & Design of Experiments	R		2			F15	60
CBE 493L: Chemical Engineering Design	R		3√			F15	60
Technical Elective (Engineering, Math or Science)	SE	3				F15, S16	VARIES, (Example: MATH 314 – 35)
CBE 419L: Chemical Engineering Laboratory IV	R		1			S16	24
CBE 451: Senior Seminar	R		1			S16	16
CBE 494L: Advanced Chemical Engineering Design	R		3√			S16	46
Technical Elective (Engineering)	SE		3			F15, S16	VARIES, (Example: CE 335 – 36)
CORE: Fine Arts	SE			3		F15, S16	VARIES, (Example: MUS 139 – 280)
CORE: Humanities	SE			3		F15, S16	VARIES, (Example: RELG 107 – 500)
CORE: Foreign Language	SE			3		F15, S16	VARIES, (Example:

							SPAN 101 – 25)
TOTALS-ABET BASIC-LEVEL REQUIREMENTS		46	50.5	27	.5		
OVERALL TOTAL CREDIT HOURS FOR COMPLETION OF THE PROGRAM	124						
PERCENT OF TOTAL		37%	41%	22%	<1%		
Total must satisfy either credit hours or percentage	Minimum Semester Credit Hours	32 Hours	48 Hours				
	Minimum Percentage	25%	37.5 %				

1. **Required** courses are required of all students in the program, **elective** courses (often referred to as open or free electives) are optional for students, and **selected elective** courses are those for which students must take one or more courses from a specified group.
2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the maximum enrollment in each element. For selected elective courses, indicate the maximum enrollment for each option.

Instructional materials and student work verifying compliance with ABET criteria for the categories indicated above will be required during the campus visit.

Table 2A-1C: Curriculum

Chemical Engineering, Environmental Engineering Concentration

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE.[1]	Subject Area (Credit Hours)				Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered[2]
		Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (√)	General Education	Other		
CBE 101: Intro to Chemical Engineering & Biological Engineering	R		.5		.5	F15, S16	150
CHEM 121: General Chemistry I	R	3				F15, S16	180
CHEM 123L: General Chemistry I Lab	R	1				F15, S16	24
ENGL 110: Accelerated Composition (or ENGL 112: Composition II or ENGL 113: Enhanced Composition)	R			3		F15, S16	25
MATH 162: Calculus I	R	4				F15, S16	32
CORE: Humanities	SE			3		F15, S16	VARIES

							(Example: HIST 101 – 160)
CHEM 122: General Chemistry II	R	3				F15, S16	150
CHEM 124L: General Chemistry II Lab	R	1				F15, S16	24
ENGL 120: Composition III	R			3		F15, S16	23
MATH 163: Calculus II	R	4				F15, S16	34
PHYC 160: General Physics	R	3				F15, S16	300
CORE: Social & Behavioral Sciences	SE			3		F15, S16	VARIES (Example: PSY 105 – 830)
CBE 251: Chemical Process Calculations	R		3			F15	126
CHEM 301: Organic Chemistry	R	3				F15, S16	120
CHEM 303L: Organic Chemistry Lab	R	1				F15, S16	18
MATH 264: Calculus III	R	4				F15, S16	33
PHYC 161: General Physics	R	3				F15, S16	200
CBE 253: Chemical and Biological Engineering Computing	R		3			S16	50
CBE 302: Chemical Engineering Thermodynamics	R		3			S16	101
ECON 105: Introductory Macroeconomics	R			3		F15, S16	64

MATH 316: Applied Ordinary Differential Equations	R	3				F15, S16	44
CHEM 302: Organic Chemistry	R	3				F15, S16	120
CBE 311: Introduction to Transport Phenomena	R		3			F15	81
CBE 317: Numerical Methods for Chemical & Biological Engineering	R		2			F15	100
CBE 318L: Chemical Engineering Laboratory I	R		1			F15	24
CBE 361: Biomolecular Engineering	R		3			F15	70
ENGL 219: Technical and Professional Writing	R			3		F15, S16	25
BIOL 201L: Molecular & Cell Biology	R	4				F15, S16	144 (Lecture), 24 (Lab)
CBE 312: Unit Operations	R		3√			S16	80
CBE 321: Mass Transfer	R		3			S16	55
CBE 319L: Chemical Engineering Laboratory II	R		1			S16	24
CBE 371: Introduction to Materials Engineering	R		3			S16	80
ENG 301: Fundamentals of Engineering - Dynamics	R		1			S16	200 (online)
ENG 302: Fundamentals of Engineering – Electrical Circuits	R		1			S16	200 (online)
CHEM 312: Physical Chemistry	R	3				S16	80
CBE 418L: Chemical Engineering Laboratory III	R		1			F15	24
CBE 454: Process Dynamic & Control	R		3			F15	60

CBE 461: Chemical Reactor Engineering	R		3			F15	60
CBE 486: Introduction to Statistics & Design of Experiments	R		2			F15	60
CBE 493L: Chemical Engineering Design	R		3√			F15	60
Technical Elective (Engineering, Math or Science)	SE	3				F15, S16	VARIES, (Example: MATH 314 – 35)
CBE 419L: Chemical Engineering Laboratory IV	R		1			S16	24
CBE 451: Senior Seminar	R		1			S16	16
CBE 494L: Advanced Chemical Engineering Design	R		3√			S16	46
Technical Elective (Engineering)	SE		3			F15, S16	VARIES, (Example: CE 335 – 36)
CORE: Fine Arts	SE			3		F15, S16	VARIES, (Example: MUS 139 – 280)
CORE: Humanities	SE			3		F15, S16	VARIES, (Example: RELG 107 – 500)
CORE: Foreign Language	SE			3		F15, S16	VARIES, (Example:

							SPAN 101 – 25)
TOTALS-ABET BASIC-LEVEL REQUIREMENTS		46	50.5	27	.5		
OVERALL TOTAL CREDIT HOURS FOR COMPLETION OF THE PROGRAM	124						
PERCENT OF TOTAL		37%	41%	22%	<1%		
Total must satisfy either credit hours or percentage	Minimum Semester Credit Hours	32 Hours	48 Hours				
	Minimum Percentage	25%	37.5 %				

1. **Required** courses are required of all students in the program, **elective** courses (often referred to as open or free electives) are optional for students, and **selected elective** courses are those for which students must take one or more courses from a specified group.
2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the maximum enrollment in each element. For selected elective courses, indicate the maximum enrollment for each option.

Instructional materials and student work verifying compliance with ABET criteria for the categories indicated above will be required during the campus visit.

Table 2A-1D: Curriculum

Chemical Engineering, Materials Processing Concentration

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE.[1]	Subject Area (Credit Hours)				Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered[2]
		Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (√)	General Education	Other		
CBE 101: Intro to Chemical Engineering & Biological Engineering	R		.5		.5	F15, S16	150
CHEM 121: General Chemistry I	R	3				F15, S16	180
CHEM 123L: General Chemistry I Lab	R	1				F15, S16	24
ENGL 110: Accelerated Composition (or ENGL 112: Composition II or ENGL 113: Enhanced Composition)	R			3		F15, S16	25
MATH 162: Calculus I	R	4				F15, S16	32
CORE: Humanities	SE			3		F15, S16	VARIES

								(Example: HIST 101 – 160)
CHEM 122: General Chemistry II	R	3					F15, S16	150
CHEM 124L: General Chemistry II Lab	R	1					F15, S16	24
ENGL 120: Composition III	R			3			F15, S16	23
MATH 163: Calculus II	R	4					F15, S16	34
PHYC 160: General Physics	R	3					F15, S16	300
CORE: Social & Behavioral Sciences	SE			3			F15, S16	VARIES (Example: PSY 105 – 830)
CBE 251: Chemical Process Calculations	R		3				F15	126
CHEM 301: Organic Chemistry	R	3					F15, S16	120
CHEM 303L: Organic Chemistry Lab	R	1					F15, S16	18
MATH 264: Calculus III	R	4					F15, S16	33
PHYC 161: General Physics	R	3					F15, S16	200
CBE 253: Chemical and Biological Engineering Computing	R		3				S16	50
CBE 302: Chemical Engineering Thermodynamics	R		3				S16	101
ECON 105: Introductory Macroeconomics	R			3			F15, S16	64

MATH 316: Applied Ordinary Differential Equations	R	3				F15, S16	44
CORE: Foreign Language	SE			3		F15, S16	VARIES, (Example: SPAN 101 – 25)
CBE 311: Introduction to Transport Phenomena	R		3			F15	81
CBE 317: Numerical Methods for Chemical & Biological Engineering	R		2			F15	100
CBE 318L: Chemical Engineering Laboratory I	R		1			F15	24
CBE 361: Biomolecular Engineering	R		3			F15	70
ENGL 219: Technical and Professional Writing	R			3		F15, S16	25
CHEM 311: Physical Chemistry	R	3				F15	80
CBE 312: Unit Operations	R		3√			S16	80
CBE 321: Mass Transfer	R		3			S16	55
CBE 319L: Chemical Engineering Laboratory II	R		1			S16	24
CBE 371: Introduction to Materials Engineering	R		3			S16	80
ENG 301: Fundamentals of Engineering - Dynamics	R		1			S16	200 (online)
ENG 302: Fundamentals of Engineering – Electrical Circuits	R		1			S16	200 (online)
CHEM 312: Physical Chemistry	R	3				S16	80

CBE 418L: Chemical Engineering Laboratory III	R		1			F15	24
CBE 454: Process Dynamic & Control	R		3			F15	60
CBE 461: Chemical Reactor Engineering	R		3			F15	60
CBE 486: Introduction to Statistics & Design of Experiments	R		2			F15	60
CBE 493L: Chemical Engineering Design	R		3√			F15	60
CHEM 431: Advanced Inorganic Chemistry or CHEM 471: Adv T: Polymer Science or CHEM 471: Chemistry & Physics at the Nanoscale	SE	3				F15, S16	VARIES, (Example: CHEM 431 – 45)
CBE 419L: Chemical Engineering Laboratory IV	R		1			S16	24
CBE 451: Senior Seminar	R		1			S16	16
CBE 494L: Advanced Chemical Engineering Design	R		3√			S16	46
Technical Elective (Engineering, Math or Science)	SE	3				F15, S16	VARIES, (Example: MATH 314 – 35)
Technical Elective (Engineering)	SE		3			F15, S16	VARIES, (Example: CE 335 – 36)
CORE: Fine Arts	SE			3		F15, S16	VARIES, (Example:

							MUS 139 – 280)
CORE: Humanities	SE			3		F15, S16	VARIES, (Example: RELG 107 – 500)
TOTALS-ABET BASIC-LEVEL REQUIREMENTS		45	50.5	27	.5		
OVERALL TOTAL CREDIT HOURS FOR COMPLETION OF THE PROGRAM	123						
PERCENT OF TOTAL		37%	41%	22%	<1%		
Total must satisfy either credit hours or percentage	Minimum Semester Credit Hours	32 Hours	48 Hours				
	Minimum Percentage	25%	37.5 %				

1. **Required** courses are required of all students in the program, **elective** courses (often referred to as open or free electives) are optional for students, and **selected elective** courses are those for which students must take one or more courses from a specified group.
2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the maximum enrollment in each element. For selected elective courses, indicate the maximum enrollment for each option.

Instructional materials and student work verifying compliance with ABET criteria for the categories indicated above will be required during the campus visit.

Table 2A-1E: Curriculum

Chemical Engineering, Semiconductor Manufacturing Concentration

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE.[1]	Subject Area (Credit Hours)				Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered[2]
		Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (√)	General Education	Other		
CBE 101: Intro to Chemical Engineering & Biological Engineering	R		.5		.5	F15, S16	150
CHEM 121: General Chemistry I	R	3				F15, S16	180
CHEM 123L: General Chemistry I Lab	R	1				F15, S16	24
ENGL 110: Accelerated Composition (or ENGL 112: Composition II or ENGL 113: Enhanced Composition)	R			3		F15, S16	25
MATH 162: Calculus I	R	4				F15, S16	32
CORE: Humanities	SE			3		F15, S16	VARIES

							(Example: HIST 101 – 160)
CHEM 122: General Chemistry II	R	3				F15, S16	150
CHEM 124L: General Chemistry II Lab	R	1				F15, S16	24
ENGL 120: Composition III	R			3		F15, S16	23
MATH 163: Calculus II	R	4				F15, S16	34
PHYC 160: General Physics	R	3				F15, S16	300
CORE: Social & Behavioral Sciences	SE			3		F15, S16	VARIES (Example: PSY 105 – 830)
CBE 251: Chemical Process Calculations	R		3			F15	126
CHEM 301: Organic Chemistry	R	3				F15, S16	120
CHEM 303L: Organic Chemistry Lab	R	1				F15, S16	18
MATH 264: Calculus III	R	4				F15, S16	33
PHYC 161: General Physics	R	3				F15, S16	200
CBE 253: Chemical and Biological Engineering Computing	R		3			S16	50
CBE 302: Chemical Engineering Thermodynamics	R		3			S16	101
ECON 105: Introductory Macroeconomics	R			3		F15, S16	64

MATH 316: Applied Ordinary Differential Equations	R	3				F15, S16	44
CHEM 312: Physical Chemistry	R	3				S16	80
CBE 311: Introduction to Transport Phenomena	R		3			F15	81
CBE 317: Numerical Methods for Chemical & Biological Engineering	R		2			F15	100
CBE 318L: Chemical Engineering Laboratory I	R		1			F15	24
CBE 361: Biomolecular Engineering	R		3			F15	70
ENGL 219: Technical and Professional Writing	R			3		F15, S16	25
CHEM 311: Physical Chemistry	R	3				F15	80
CBE 312: Unit Operations	R		3√			S16	80
CBE 321: Mass Transfer	R		3			S16	55
CBE 319L: Chemical Engineering Laboratory II	R		1			S16	24
CBE 371: Introduction to Materials Engineering	R		3			S16	80
ENG 301: Fundamentals of Engineering - Dynamics	R		1			S16	200 (online)
ENG 302: Fundamentals of Engineering – Electrical Circuits	R		1			S16	200 (online)
ECE 371: Materials & Devices	R		4			F15	50
CBE 418L: Chemical Engineering Laboratory III	R		1			F15	24
CBE 454: Process Dynamic & Control	R		3			F15	60

CBE 461: Chemical Reactor Engineering	R		3			F15	60
CBE 486: Introduction to Statistics & Design of Experiments	R		2			F15	60
CBE 493L: Chemical Engineering Design	R		3√			F15	60
CHEM 431: Advanced Inorganic Chemistry	SE	3				F15	45
CBE 419L: Chemical Engineering Laboratory IV	R		1			S16	24
CBE 451: Senior Seminar	R		1			S16	16
CBE 494L: Advanced Chemical Engineering Design	R		3√			S16	46
Technical Elective (Engineering, Math or Science)	SE	3				F15, S16	VARIES, (Example: CE 335 – 36)
CORE: Fine Arts	SE			3		F15, S16	VARIES, (Example: MUS 139 – 280)
CORE: Humanities	SE			3		F15, S16	VARIES, (Example: RELG 107 – 500)
CORE: Foreign Language	SE			3		F15, S16	VARIES, (Example: SPAN 101 – 25)

TOTALS-ABET BASIC-LEVEL REQUIREMENTS		45	51.5	27	.5		
OVERALL TOTAL CREDIT HOURS FOR COMPLETION OF THE PROGRAM	124						
PERCENT OF TOTAL		36%	42%	22%	<1%		
Total must satisfy either credit hours or percentage	Minimum Semester Credit Hours	32 Hours	48 Hours				
	Minimum Percentage	25%	37.5 %				

1. **Required** courses are required of all students in the program, **elective** courses (often referred to as open or free electives) are optional for students, and **selected elective** courses are those for which students must take one or more courses from a specified group.
2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the maximum enrollment in each element. For selected elective courses, indicate the maximum enrollment for each option.

Instructional materials and student work verifying compliance with ABET criteria for the categories indicated above will be required during the campus visit.

Table 2A-2 List of Approved Technical Electives

Students must take 6 credit hours of technical electives from the list below. Three credit hours must be an engineering course from the list below. Semiconductor Manufacturing Concentration students must take ECE 371L as their three-credit hour engineering technical elective.

Biomedical Engineering Technical Electives

BME 556 - Protein and Nucleic Acid Engineering (cross-listed with CBE 499, 515)

BME 544 - Thermodynamics of Biological Systems (cross-listed with CBE 499, 515, 542)

Chemical & Biological Engineering **Technical Electives**

CBE 213 - Laboratory Electronics for Nuclear, Chemical and Biological Engineers (AOA NE 213)

CBE 412/512 - Characterization Methods for Nanostructures (AOA CHEM 469/569, NSMS 412/512)

CBE 417/517 - Applied Biology for Biomedical Engineers (AOA BME 517)

CBE 447/547 - Biomedical Engineering Research Practices (AOA BME 547)

CBE 472/572 - Biomaterials Engineering (AOA BME 572)

CBE 477/577 - Electrochemical Engineering

CBE 479/579 - Tissue Engineering (AOA BME 579, NSMS 574)

CBE 491-492 - Undergraduate Problems*

CBE 499 - Protein and Nucleic Acid Engineering (cross-listed with CBE 515, BME 556)

CBE 499 - Selected Topics

* - CBE 491/492 must be taken as a 3 hr course and must be approved by Director of UG Programs

Civil Engineering **Technical Electives**

CE 302 - Mechanics of Materials

CE 335 - Environmental and Water Resources Engineering

CE 350 - Engineering Economy

CE 431/531 - Physical-Chemical Water and Wastewater Treatment

CE 433/533 - Environmental Microbiology

CE 436/536 - Biological Wastewater Treatment

CE 438/538 - Sustainable Engineering

CE 440/540 - Design of Hydraulic Systems

CE 441/541 - Hydrogeology (AOA EPS 462)

CE 442 - Hydraulic Engineering and Hydrology

Computer Science **Technical Electives**

CS 375 - Introduction to Numerical Computing (AOA MATH 375)

CS 412 - Introduction to Computer Graphics: Scanline Algorithms (AOA ECE 412)

CS 427/527 - Principles of Artificially Intelligent Machines

Electrical Engineering Technical Electives

ECE 371 - Materials and Devices

ECE 412 - Introduction to Computer Graphics: Scanline Algorithms (AOA CS 412)

Mechanical Engineering **Technical Electives**

ME 365 - Heating, Ventilating and Air Conditioning Systems

ME 405/505 - High Performance Engines

ME 419/519 - Theory, Fabrication, and Characterization of Nano and Microelectromechanical Systems (NEMS/MEMS) (4 hrs)

Nuclear Engineering **Technical Electives**

NE 213 - Laboratory Electronics for Nuclear, Chemical and Biological Engineers (AOA CBE 213)

NE 230 - Principles of Radiation Protection

NE 231 - Principles of Nuclear Engineering

NE 323L - Radiation Detection and Measurement

NE 439 - Radioactive Waste Management (AOA CE 539)

Biochemistry **Technical Electives**

BIOC 423 - Introductory Biochemistry

Biology Technical Electives

BIOL 202L - Genetics (4 hrs)

BIOL 237 - Human A&P I for the Health Sciences

BIOL 238 - Human A&P II for the Health Sciences

BIOL 239L - Microbiology for Health Sciences and Non-Majors (4 hrs)

BIOL 247L - Human Anatomy and Physiology Lab I (1 hr)

BIOL 248L - Human Anatomy and Physiology Lab II (1 hr)

BIOL 425 - Molecular Genetics

BIOL 429 - Molecular Cell Biology I

BIOL 446/546 - Laboratory Methods in Molecular Biology (4 hrs)

Chemistry Technical Electives

CHEM 253L - Quantitative Analysis (4 hrs)

CHEM 411L - Laboratory Methods in Physical Chemistry

CHEM 412 - Advanced Physical Chemistry

CHEM 421 - Biological Chemistry

CHEM 425 - Organic Chemistry of Biological Pathways

CHEM 431 - Advanced Inorganic Chemistry

CHEM 432L - Advanced Synthetic Chemistry Laboratory

CHEM 453L - Analytical Instrumentation: Theory and Application (4 hrs)

CHEM 457 - Environmental Chemistry

CHEM 469/569 - Characterization Methods for Nanostructures (AOA CBE/NSMS 412/512)

Earth & Planetary Sciences **Technical Electives**

EPS 301 - Mineralogy/Earth and Planetary Materials

EPS 302L - Mineralogy Laboratory (2 hrs)

EPS 303L - Igneous and Metamorphic Petrology (4 hrs)

EPS 304L - Sedimentology and Stratigraphy (4 hrs)

EPS 307L - Structural Geology (4 hrs)

EPS 333 - Environmental Geology

EPS 352 - Global Climate Change (AOA GEOG 352)

EPS 365 - Exploring the Solar System

EPS 400 - Topics in Earth and Planetary Sciences

EPS 405L/505L - Stable Isotope Geochemistry

EPS 410/510 - Fundamentals of Geochemistry

EPS 411L - Invertebrate Paleontology (4 hrs)

EPS 415/515 - Geochemistry of Natural Waters

EPS 420L/520L - Topics in Advanced Field Geology

EPS 427/527 - Geophysics (AOA PHYC 327)

EPS 428/528 - Applied Math for Earth & Environmental Sci

EPS 433 - Statistics and Data Analysis in Earth Science

EPS 439 - Paleoclimatology

EPS 443/543 - Aquifers and Reservoirs

EPS 450L/550L - Volcanology (4 hrs)

EPS 455L/555L - Computational and GIS Applications in Geomorphology

EPS 465/565 - Mars Evolution

EPS 476/576 - Physical Hydrogeology

EPS 481L/581L - Geomorphology and Surficial Geology (4 hrs)

EPS 482L/582L – Geoarchaeology (AOA ANTH 482L/582L)

EPS 485L/585L - Soil Stratigraphy and Morphology

Mathematics & Statistics Technical Electives

MATH 311 - Vector Analysis

MATH 312 - Partial Differential Equations for Engineering

MATH 313 - Complex Variables

MATH 314 - Linear Algebra with Applications

MATH 317 - Elementary Combinatorics

MATH 318 - Graph Theory

MATH 319 - Theory of Numbers

MATH 321 - Linear Algebra

MATH 322 - Modern Algebra I

MATH 327 - Introduction to Mathematical Thinking and Discrete Structures

MATH 356 - Symbolic Logic (AOA PHIL 356)

MATH 375 - Introduction to Numerical Computing (AOA CS 375)

MATH 401 - Advanced Calculus I (4 hrs)

MATH 402 - Advanced Calculus II

MATH 415 - History and Philosophy of Mathematics (AOA PHIL 415)

MATH 421 - Modern Algebra II

MATH 422 - Modern Algebra for Engineers

MATH 431/535 - Introduction to Topology

MATH 441 - Probability (AOA STAT 461/561)

MATH 462/512 - Introduction to Ordinary Differential Equations

MATH 463/513 - Introduction to Partial Differential Equations

MATH 464/514 - Applied Matrix Theory

MATH 466 - Mathematical Methods in Science and

MATH 471 - Introduction to Scientific Computing

MATH 472/572 - Fourier Analysis and Wavelets

STAT 345 - Elements of Mathematical Statistics and Probability Theory

STAT 434/534 - Introduction to Differential Geometry

STAT 461/561 - Probability (AOA MATH 441)

Physics & Astronomy Technical Electives

PHYC 302 - Introduction to Photonics

PHYC 303 - Analytical Mechanics I

PHYC 304 - Analytical Mechanics II

PHYC 330 - Introduction to Modern Physics

PHYC 405 - Electricity and Magnetism I

PHYC 406 - Electricity and Magnetism II

PHYC 430 - Introduction to Solid State Physics

PHYC 491 - Intermediate Quantum Mechanics I

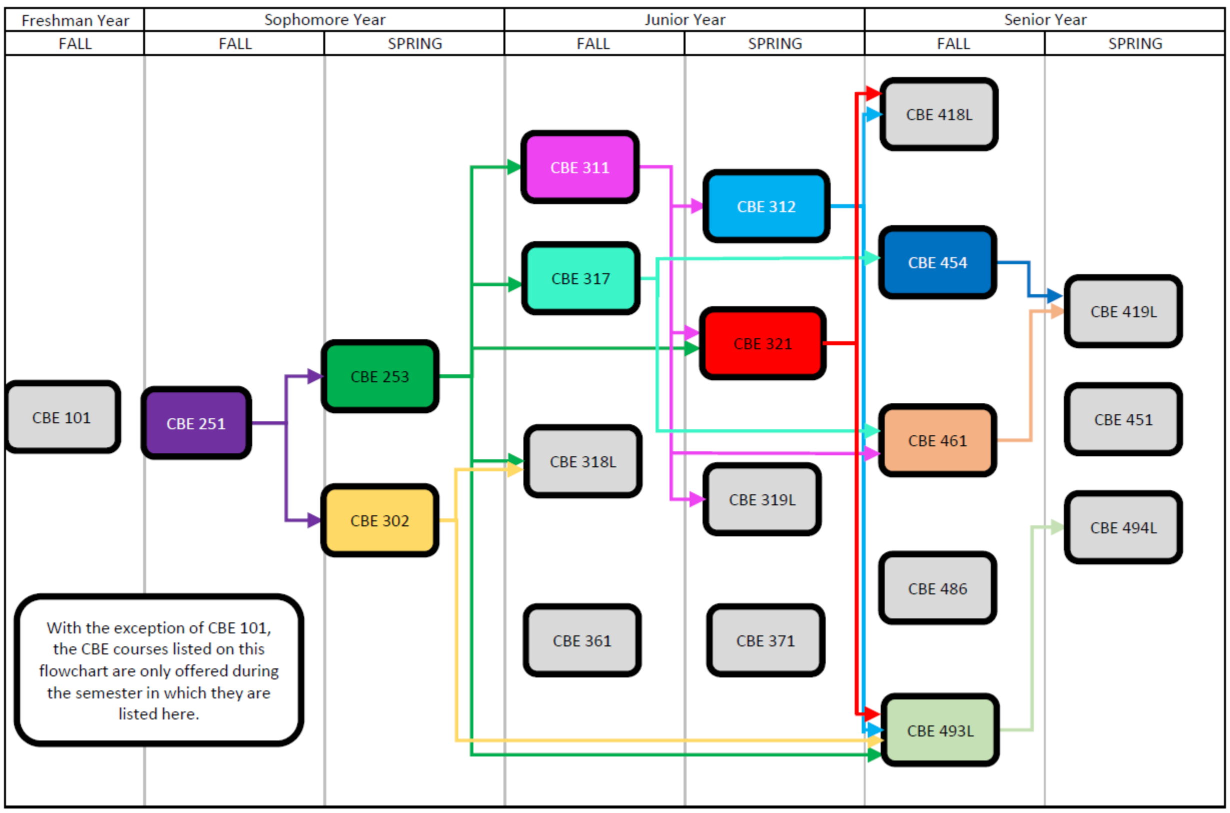
PHYC 492 - Intermediate Quantum Mechanics II

PHYC 493L - Contemporary Physics Laboratory

PHYC 495 - Theory of Special Relativity

Students are required to take courses in a specific sequence to ensure they have adequate background for mastery of more complex science and engineering topics, as students are expected to apply knowledge and skills learned in lower level courses to upper level courses such as Design. The prerequisite sequence is shown in Figure 2A-3.

Figure 2A-3: Course prerequisites sequence for the B.S. Chemical Engineering program



The courses associated with the mathematics and basic sciences portion of the curriculum constitute 37% of total credits (45-46 credit hours). Courses associated with the engineering sciences and design constitute 41% (50.5 credit hours), and courses associated with general education objectives constitute 22% (27 credit hours).

The basic sequence of courses provides the majority of basic sciences and math in the first two years. The first chemical engineering courses, Chemical Process Calculations (CBE 251 and 253) and Thermodynamics (CBE 302) are taken in the sophomore year. This provides the foundation for the junior year when the students take many of the chemical engineering core courses, including transport phenomena, mass transfer, and unit operations. Students in the senior year enroll in reactor engineering, process control, Design I, and Design II. The curriculum has four semesters of laboratory (318L, 319L, 418L, and 419L), with each laboratory designed to correspond to, and follow, a particular lecture/theory course. The first laboratory focuses on thermodynamics, the second with fluids and heat transfer, the third with mass transfer, and the fourth course involves kinetics, controls, and experimental design. These laboratories are in addition to CBE 312 Unit Operations. Students also complete a two-semester design sequence that is described in more detail below.

The design experience begins in the freshman year with small projects in the CBE 101 course. In the sophomore year, students are introduced to Aspen process simulation software, completing relatively well-defined problems and learning how to build flowsheets. In the junior year the students complete small-scale design projects in the unit operations course, and the design experience culminates in the senior year with the two-semester capstone design sequence (CBE 493L/494L).

The first (fall) semester design course (CBE 493L) effectively draws upon skills and knowledge from throughout the curriculum, augments that with new content, and prepares students for the largely independent capstone project that will be the emphasis of the second semester course. The first semester of design is a largely textbook-based course with mostly individual or small team work problems covering a broad range of process and product design topics. The course covers much of the widely used Turton *et al.* textbook. The second semester features an emphasis on process safety, largely on analysis of previous industrial accidents, accident and loss prevention by HAZOP and other methods, and environmental issues related to design. However, the majority of the semester is unstructured and devoted to unique open-ended capstone project work, chosen by individual groups of students. Since many students do not choose the traditional process engineering career path, we have for many years chosen to give students options for their capstone project, allowing for a design experience that is better tailored to their own interests or career plans. The deliverables for all projects are the same, and all projects culminate in formal written reports and oral presentations. Most projects are completed in teams of three or four, though individual projects are allowed in some cases. Because each project is unique, faculty work with students to develop a set of production limit, economic, and safety constraints appropriate for each project.

Some sample capstone design project options are shown below:

1) Complete the AIChE National Student Contest Problem either individually or in a group of two or three. This can be performed under the AIChE rules or outside the rules.

2) Carry out a major individual project under the guidance of a faculty member – this may have a research or design emphasis.

3) Complete one of the Waste Education and Research Consortium (WERC) design contest problems. This can be completed individually or as part of a team, either under the contest rules or outside the rules.

4) Complete a design project (individual or teams up to three) based on selected problem statements taken from old AIChE contest problems or problem statements from Seider *et al.* or another design text.

5) Develop a design that can be used as the basis for a business plan to be entered into the UNM Technology Business Plan Competition.

The design constraints (i.e., economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability) are implicitly and explicitly applied for each project. Economic, environmental, health and safety are implicit constraints for all the design projects. Students are required to design plant facilities according to federal and state regulations. Environmental regulations are specifically cited in the design report where applicable. Plant layouts (by way of sketch) are required to be designed with the neighboring community in mind and a HAZOP analysis conducted for each project. Students are also required to estimate a rate of return constraint before embarking on the project. Some examples of capstone projects and project constraints are as follows:

'Non-alcoholic Beer for Gulf Brewing Company' - a product with less than 0.5% ABV and 2.5 volumes of carbon dioxide; retain the high quality hop dominant flavor profile of an IPA (e.g. **social**); 15,000 to 6 million bbl/yr to qualify product as a craft brew; achieve a rate or return on investment (ROROI) of 6.6% or greater; meet state and federal emissions requirements which will be done by minimizing carbon emissions by recycling CO_2 back into the finished product (e.g. **environmental**).

'Tertiary Treatment of Wastewater and Removal of Pharmaceutical Constituents' - cost effective (e.g. **economic**), efficient and robust; 100 gpm water treatment system that incorporates mechanical, chemical, and/or controls to remove a known wastewater contaminant (e.g. **safety**) from a treated waste water stream intended for reuse in a community; design should address the specific reuse(s) of the treated water as well as deployability, outreach (e.g. **ethical**), and other barriers to a successful implementation of your design in a specific area/region/community/municipality of your team's choice; meet an ROI of at least 10%.

'Non-egg based platform for Influenza Vaccine' - faster and more versatile (e.g. **manufacturability**) than the current egg based platform; the Endotoxin level must be less than 20 ng/mL; each antigen concentration should be 30 µg/mL to meet federal regulations; must pass a sterility test with no growth on a bacteria plate for greater than 14 days (e.g. **health**); final consumer price must be equal to or lower than that of already commercially available egg-free, trivalent vaccines (e.g. **political**), such as Flublok® at $32.75/dose.

'Alternate Methods for Sour Water Stripping Design' - 20-50 gpm sour water containing 300-3000 ppm NH3, 5 ppm H_2S and trace amounts of propane treated water; direct discharge as waste or further cleanup for steam generation (e.g. **sustainable**); disposal of any waste according to state regulations; meet an ROROI of at least 10%.

Other examples of student capstone design projects for Academic Year 2016 are

Economic Recovery of Edible Protein from Cheese Whey by Ultrafiltration

Switchgrass gasification and Fisher-Tropsh Catalysis to Alcohols

Clean Drinking Water for Residents of Flint Michigan

Ethanol Production from Sugarcane Bagasse

Tertiary Treatment of Wastewater and Removal of a Pharmaceutical Constituent

Biomass Synthesized Syngas to Ethylene

Carbon Dioxide Recovery for Recycle from Local Brewery

Students in our program may participate in cooperative education programs or summer industrial internships. However, these experiences play no formal role in the curriculum. There are two mechanisms by which such experience can potentially be used to satisfy curricular requirements. First, students may take an examination to establish or validate credit in a course if they believe that they have the appropriate knowledge gained through work. The procedure can be found at http://catalog.unm.edu/catalogs/2016-2017/student-services-information.html. Second, students may arrange for an Undergraduate Problems course (CBE 491-492) under the supervision of a faculty member for project work performed at the university or national laboratories. Up to 3 credits of Problems can be used as technical electives in our program. Research used for credit as Undergraduate Problems must be unpaid.

Throughout the curriculum, we emphasize safety and awareness of hazards in the design, analysis, and control of chemical, physical, and/or biological processes. The faculty discuss case studies in class, have students present process safety cases, and require students take the Safety and Chemical Engineering Education (SACHE) certificate courses provided by American Institute of Chemical Engineers (AIChE) as part of course requirements. The details of this practice are provided in more detail on the next few pages under Program Criteria.

PROGRAM CRITERIA

Per the American Institute of Chemical Engineers, a lead society in Chemical Engineering, the following program criteria apply to engineering programs that include “chemical,” “biochemical,” “biomolecular,” or similar modifiers in their titles.

The curriculum must provide a thorough grounding in the basic sciences including chemistry, physics, and/or biology, with some content at an advanced level, as appropriate to the objectives of the program. The curriculum must include the engineering application of these basic sciences to the design, analysis, and control of chemical, physical, and/or biological processes, including the hazards associated with these processes.

a. The section on curriculum describes our curriculum, which provides grounding in the basic sciences (18 credits of basic science) and 9 credits of advanced chemistry (or biology) courses. One technical elective can be either in science or engineering, and could potentially provide 3 additional advanced chemistry credits.

b. As described in the section on curriculum, we provide a total of 51 credit hours of courses that involve engineering applications to the design, analysis and control of chemical, physical and biological processes. One technical elective (if not taken in the sciences) could provide additional 3 credits of engineering content.

c. The design, analysis and control of the hazards associated with chemical, physical and/or biological processes is embedded in our curriculum at all levels, starting with the freshman course and through the capstone design course at the senior level. We require students to take and pass the AIChE/SACHE online safety modules at various stages as they progress through the curriculum, see table below. The SACHE certificates provide an excellent approach to teaching elements of safety and also helping students develop lifelong learning skills, through online education. We require students to do these certificates at various stages in their program. Obtaining a SACHE certificate is a requirement for completion of the course. SACHE certificate courses are integrated into the curriculum by making them part of a homework or project. The teaching of safety in the class is supplemented by other material available on the CCPS and SACHE websites. There are 10 online modules and certificates that have been developed so far by SACHE and the table below shows how they are integrated into the CBE curriculum, or how the teaching of process safety is done in the core ChE curriculum. Each of the chemical engineering core courses include a discussion of process safety through class lecture, homework, and presentations. This content is highlighted in each of the course notebooks, and is included as a separate notebook documenting the work done by each student.

Table PC-1: Examples of how process safety is taught throughout the chemical engineering curriculum. ELA numbers are course numbers by SACHE.

Course	What is covered in class	What students should do online	% of students who completed module
CBE 101 Fall/Spring Freshman	Introduce Lab safety in class; discuss some of the concepts in the online module. Students complete the online certificate before they can come to the lab. They perform a Job Safety Assessment (JSA) as part of the pre-lab.	ELA – 909 Basics of Lab Safety. Students who have not completed this module will be required to complete it during their first lab class, CBE 318L in the fall semester junior year.	100% (Spring 2015, Fall 2015, Spring 2016).
CBE 251 Fall Sophomore	Introduce Process Safety through case studies.	HW 2 problem on pressure in chilled tanks for HW 2	91% (Fall 2015)
CBE 253 Spring Sophomore	During the teaching of ASPEN, we introduce some examples, case studies and calculations relevant to Safety.	Students watch a video on reactor safety in class to compliment the lecture on Aspen Plus reactor blocks. Attendance taken	90% (Spring 2016)
CBE 302 Spring Sophomore	The students had a dedicated recitation class on hazards and nitrogen safety and were also given materials for self-studies developed by the US Chemical Safety and Investigations Board. Some particular topics (e.g. methanol toxicity, handling strong acids, etc.) were addressed during lectures.	ELA - 904 Chemical Reactivity Hazards ELA – 910 Nitrogen's role in Safety	96% (Spring 2016)
CBE 311 Fall Junior	Introduce safety through examples involving venting, or relief valves, rupture discs, etc. Use water reservoir design and force balance (barometric equation) to emphasize proper engineering design.	ELA – 907 Process Safety 101	87% (Fall 2015)

CBE 312 Spring Junior	The examples in the course ELA 908 are relevant to Unit operations: e.g., process relief valves, imploding tank cars due to lack of vacuum relief, and cavitation in pumps due to flashing of liquid. These examples involve aspects of process design safety.	ELA – 908 Process Safety Lessons Learned from Experience.	91% (Spring 2016)
CBE 318L/319L Fall/Spring Junior	Introduce the Job Safety Analysis as an integral part of the pre-lab assignment.	Complete ELA 909 if they have not already done it. Student teams submit a JSA for each experiment on the course website.	100% (Spring 2016)
CBE 321 Spring Junior	Use Kirtland Airforce Base jet fuel leak as a case study to address environmental remediation, storage safety, monitoring, and prevention.	Complete ELA – 901 Safety in the Chemical Process Industries.	82% (Spring 2015)
CBE 418L	Each student prepares an individual JSA for each laboratory experiment.	ELA – 906 Dust Explosion Control	72% (Fall 2015)
CBD 419L	Each student prepares an individual JSA for each laboratory experiment.		90% (Spring 2016)
CBE 461 Fall Senior	Discuss safety through chemical reactions going autothermal, lightoff, etc.	ELA – 902 Runaway Reactions	85% (Fall 2015)
CBE 493/494	Integrate safety considerations including HAZOP analysis into capstone design project.	ELA – 905 Inherently Safer Design ELA – 903 Risk Assessment	98% (Spring 2016)
CBE 454	Design of controllers that stabilized disturbances to a process. Analysis of stability of control systems. A final project that required safety considerations in the	Students address the safety aspect in the temperature controller design for a chemical reactor equipped with a cooling jacket.	86% (Spring 2016)

	design of a temperature controller system on a reactor with a cooling jacket.		
CBE 451 Spring Senior	In-class discussion of case studies on safety coming from the literature, or those that may be happening locally or nationally at that time (e.g., Fire at Formosa Plastics Corporation); presentation on Chemical Process safety	ELA – 901 Chemical Process Safety in the Chemical Process Industries.	89% (Spring 2016)

2A.2 Graduate Program

Degrees Offered

Master of Science in Chemical Engineering (M.S.)

Doctor of Philosophy in Engineering (Ph.D.)

Concentration: Chemical Engineering

The Department of Chemical and Biological Engineering offers programs in chemical engineering leading to the Master of Science and the Doctor of Philosophy degrees. A GPA of 3.0 in the last two years of undergraduate study, and/or in previous engineering graduate study, is normally required for admission. In addition, the GRE is required of all Chemical Engineering applicants.

Students with an undergraduate degree in chemical engineering may directly enter the graduate chemical engineering program. Students from other engineering/science fields are also encouraged to apply. However, certain undergraduate background courses, as determined by the graduate advisor on an individual basis, must be completed as prerequisites to graduate study.

All graduate students in Chemical and Biological Engineering are required to complete a set of core courses as part of an MS or PhD programs. PhD students may satisfy these requirements with equivalent courses taken as part of an MS program as approved by the CBE Graduate Program Director. The CBE Graduate Core consists of six courses:

1. CBE 501 Chemical and Biological Engineering Seminar (1 credits – this is a 1 credit class taken by MS students for 4 semesters and by PhD students for 8 semesters)
2. CBE 502 Chemical and Biological Engineering Research Practices (3 credits)
3. CBE 521 Advanced Transport Phenomena I (3 credits)
4. CBE/NE 525, BME 558 Methods of Analysis in Chemical, Nuclear, and Biological Engineering (3 credits)
5. CBE 542 Advanced Chemical Engineering Thermodynamics (3 credits)
6. CBE 561 Kinetics of Chemical Processes (3 credits)

Equivalent graduate-level courses taken at another institution may be used to satisfy this requirement, but this must be decided on a case-by-case basis by the Graduate Program Director.

Master of Science in Chemical and Biological Engineering (MSCBE) Degree

The Master of Science (M.S.) in Chemical Engineering degree is offered under Plan I, Plan II, and Plan III. Under Plan I (thesis), 30 credit hours are required with 24 credit hours of course work and 6 credit hours of thesis. Of the 24 credit hours of course work, 9 credit hours are required at the 500-level with a maximum of 3 credit hours in problems courses. Plan II (non-thesis) requires 30 credit hours of course work, including a maximum of 6 credit hours for problems courses and completion of a Master's Project and Master's Examination. Plan III (course work) requires 30 credit hours of course work, including a maximum of 6 credit hours of problems courses.

A program that allows the Plan II to be completed in one calendar year is also offered. This program should be requested at the time of application and should begin in the summer or fall semester. The program typically includes a course load of 15 credit hours in the fall semester (two core courses, two electives and graduate seminar), 15 credit hours in the spring semester (two core courses, two electives and graduate seminar).

All candidates for the M.S. degree must satisfactorily pass a final oral examination which emphasizes the fundamental principles and applications in chemical engineering. This examination is normally the thesis defense for Plan I students, and is based on a project for Plan II students, including those in the one year program. The examination is conducted by a committee of at least three faculty members. This committee is formed in consultation with the student's research advisor or project advisor and is approved by the Department Chairperson.

The plan III M.S. degree does not currently require any exit examination.

Shared-Credit Program: B.S. to M.S. in Chemical and Biological Engineering

The School of Engineering offers a Shared Credit Degree Program designed to allow students to complete a BS and MS degree in five years (depending upon the student's mathematics preparation upon entering UNM as a first-year student). To accomplish this, some courses are counted towards both the Bachelor's and Master's degrees.

Curriculum

School of Engineering courses that can be shared between BS and MS degrees fall into two categories:

1) Courses that are designated in the undergraduate program as either technical electives, track electives, engineering electives, management electives, or advanced science electives. In the shared-credit degrees program, these courses are replaced by appropriate 500-level graduate courses that count towards both degrees, and;

2) Courses that are offered at both the 400- (undergraduate) and 500- (graduate) levels. Students in the shared-credit degrees program will take these courses at the 500-level with the course counting towards both the BS and MS degrees.

This program is intended to facilitate both disciplinary and interdisciplinary BS and MS degree programs. The exact curriculum for each student is determined with consultation from the director of undergraduate studies for the student's BS degree and the director of graduate studies for the student's MS degree, and is approved by the School of Engineering Associate Dean for Academic Affairs.

Students pursuing an interdisciplinary shared-credit degrees program may be required to take prerequisite courses for the graduate level courses in the MS program. Thus, an interdisciplinary shared-credit degrees program may require more than the nominal five years to complete.

The Department of Chemical and Biological Engineering allows up to 12 credit hours of undergraduate electives to be replaced by 500-level graduate courses that count towards both degrees.

Eligibility: Students may apply to the Shared-Credit Program during the undergraduate junior year, after completing 75 credit hours applicable to the degree. At least 64 credit hours need to be mathematics, science, and engineering courses (CE, CHEM, CS, ECE, MATH, ME, PHYS, STAT) applicable to the B.S. degree. A cumulative GPA of at least 3.50 is normally required, counting only the completed courses applicable to B.S. at the time of application. (Students with a cumulative GPA below 3.5 but above 3.0 have the opportunity to apply, but a recommendation from a faculty member is required.)

Admission

The B.S./MS Shared-Credit Degrees Program is a special program for which a student applies during the junior year of the BS program. Students may apply after completing 75 credit hours applicable to the BS degree. In order to be eligible for the shared-credit Degree Program, students must have already been admitted to a BS degree program in the School.

PhD in Engineering Degree (Concentration in Chemical and Biological Engineering)

General requirements for the Ph.D. degree are set by the School of Engineering and Graduate Studies, and are stated in the university Catalog. Required core courses are mentioned above. Students who wish to be admitted to the doctoral program in Chemical Engineering must pass a program qualifying examination. The qualifying examination consists primarily of an oral examination based on a short research proposal developed by the student. Written exams in core subject areas may also be required depending on performance in the core courses. The qualifying exam should be completed as soon as possible after entering the program and completing the core courses. Advancement to candidacy for the Ph.D. degree in Chemical Engineering requires the student to demonstrate potential for independent study and research. A comprehensive examination based on the student's written research proposal for their dissertation research is used to determine if the student should be advanced to candidacy status.

Course Requirements

In addition to the general University doctoral degree requirements listed in the Graduate Program section of the Catalog, students pursing a Ph.D. in Engineering with a concentration in Chemical Engineering must meet the following criteria:

1. A maximum of 6 credit hours of problems courses (CBE 551/552) are allowed beyond the master's degree.

2. All students are required to enroll in CBE 501 every semester up to a maximum of eight semesters beyond the B.S.Ch.E., or four semesters beyond the Masters degree. Up to 3 credit hours of CBE 501 earned after an M.S. degree, or 6 credit hours total beyond a Bachelors degree, may be applied toward the 48 credit hour course work requirement for the Ph.D. Students at remote locations who are unable to attend departmental seminars must make special arrangements with the seminar instructor to satisfy the seminar requirements.
3. Students must complete CBE 502 Chemical and Biological Engineering Research Practices, preferably in their first semester in the program. This course is a prerequisite to taking the oral portion of the Ph.D. Qualifying Exam.
4. Students admitted to the chemical engineering doctoral program are required to complete the chemical engineering core courses. Other than the core courses, no specific courses are required for doctoral students. Courses are selected by the student in consultation with the research advisor and Committee on Studies.

Qualifying Examination

The Qualifying Examination must be passed before applying for Candidacy or proceeding to the Comprehensive Exam. The PhD Qualifying Examination remains one of the major components of quality control in this program.

Comprehensive Examination

Students are admitted to candidacy for the doctoral degree by the University following approval of their application for candidacy by the program faculty and Dean of Graduate Studies and successfully passing a Doctoral Comprehensive Examination.

Defense of Dissertation

All candidates must pass a Final Examination (Defense of Dissertation). The Dissertation Committee conducts the defense of the dissertation.

Minor in Chemical Engineering (Ph.D.)

Graduate students interested in obtaining a minor in Chemical Engineering must apply to the program. Forms are available on the department Web site.

https://cbe.unm.edu/admissions/graduate/summary-of-admissions-procedure-and-documents.html

The student must complete a total of 9 credit hours by choosing three out of the four core courses listed below:

1. CBE 521 Advanced Transport Phenomena I
2. CBE/NE 525, BME 558 Methods of Analysis in Chemical, Nuclear, and Biological Engineering
3. CBE 542 Advanced Chemical Engineering Thermodynamics
4. CBE 561 Kinetics of Chemical Processes

2B. Contributions to other Units

Discuss the significance of the unit's contributions to and/or collaboration with other internal units within UNM, such as offering general education core courses for undergraduate students, common courses for selected graduate programs, courses that fulfill pre-requisites of other programs, courses that are electives in other programs, cross-listed courses, etc.

Faculty in the CBE department have been active in developing interdisciplinary graduate educational programs. The Biomedical Engineering (BME) program and the Nanoscience & Microsystems programs originated from faculty in CBE. Over the past few years these programs have grown and they involve faculty from Engineering and from other schools, including the Health Sciences Center. As a result, many of the interdisciplinary courses offered by CBE faculty in these programs are cross listed with other departments spanning the School of Engineering, College of Arts and Sciences, and School of Medicine.

Spring 2018	CBE 501	BME 567
Spring 2018	CBE 503	NONE
Spring 2018	CBE 504	NONE
Spring 2018	CBE 515: Prot & Nucleic Acid Eng	BME 556, CBE 499
Spring 2018	CBE 515: Energy Materials Sem	CBE 499
Spring 2018	CBE 515: Intro to Light Hydrocarbon	CBE 499
Spring 2018	CBE 515: Chem & Physics of Nanoscale	CBE 499, CHEM 471, CHEM 567, NSMS 510, PHYC 581
Spring 2018	CBE 515: Scientific Publishing	BME 598
Spring 2018	CBE 515: Biomaterials Engineering	BME 572, CBE 499
Spring 2018	CBE 542	BME 544, CBE 499
Spring 2018	CBE 551	NONE
Spring 2018	CBE 561	BME 598, CBE 499
Spring 2018	CBE 599	NONE
Spring 2018	CBE 699	NONE
Fall 2017	CBE 501	BME 567
Fall 2017	CBE 502	BME 547, CBE 499
Fall 2017	CBE 503	CBE 403

Fall 2017	CBE 504	CBE 404
Fall 2017	CBE 512	CBE 412, CHEM 469, CHEM 569, NSMS 512
Fall 2017	CBE 515: Biodesign	BIOM 505, BME 598, CBE 499, ECE 595, ME 561, NSMS 595
Fall 2017	CBE 515: Global Health	BME 598, CBE 499
Fall 2017	CBE 515: Energy Materials Sem	CBE 499
Fall 2017	CBE 515: Semiconductor Material Sci	NONE
Fall 2017	CBE 517	BME 517, CBE 417
Fall 2017	CBE 521	NONE
Fall 2017	CBE 525	BME 558, NE 525, Mechanical Engineering
Fall 2017	CBE 551	NONE
Fall 2017	CBE 557	CBE 477, CHEM 471, CHEM 567, NSMS 595
Fall 2017	CBE 586	CBE 486
Fall 2017	CBE 599	NONE
Fall 2017	CBE 699	NONE
Summer 2017	CBE 551	NONE
Summer 2017	CBE 599	NONE
Summer 2017	CBE 699	NONE

The CBE department in collaboration with the NSME and BME programs co-sponsors a one day symposium each spring that is organized entirely by the three graduate student organizations. This symposium is open to students in related disciplines and we see students from Physics, Chemistry, Biomedical Sciences and other engineering departments participating. The symposium includes a lunch during the poster session and a sit down dinner where cash prizes are awarded.

The first two pages from this year's symposium are listed below.

Acknowledgements

Welcome to the 3rd Annual STEM Research Symposium!

The primary focus of this event is to give graduate students within the STEM fields a platform to present their research findings to the UNM community and the general public. As such, we thank you for being here today. This is a free, annual, student led, collaborative effort between UNM's student groups and as such we would like to take this time to thank both those who have funded this event through donations and those who have taken precious time to make sure this event was possible.

We thank the following groups/businesses for financial support for today's activities:

Chemical, Biological, and Biomedical Engineering GSA

Nanoscience and Microsystems Engineering Program | Chemistry and Chemical Biology Department | Chemical and Biological Engineering Department

Kellojo Designs by wine · The University of New Mexico · Stubbs Engineering, Inc. · Parametrix Engineering . Planning . Environmental Sciences · dugan production corp.

Special Thanks to the event committee members who spent countless hours working on this event:

UNM Outreach Team:	Adam Quintana, Adan Myers y Gutierrez, and Annette Fernandez
Fundraising Team:	Emma Garcia, Jane Romero-Kotovsky, Joseph Alden, and Tracy Mallette
Guest Speaker Team:	Christian Denny, and Courtney Pruitt
Student Associations:	AIChE, BSGP, CGSA, IEEE, NSME and SWE

2C. Community Engaged Learning

UNM has an office of Community Engaged Learning and Research (CELR) whose mission is to foster quality experiential learning opportunities for students, support faculty with their community-based teaching and scholarship, and facilitate mutually beneficial campus-community partnerships.

The goal of our NSF/RED project is to introduce changes in our curriculum that will allow us to engage diverse students more effectively. With this in mind, we are introducing design challenges that will show students that chemical engineering is relevant to the problems in their communities. We are slowly threading these into the core curriculum, listed below are some of the initial learning experiences we have designed.

CBE 101: Antimicrobial Products

In this challenge, students design and pitch applications of OPEs (Oligo phenylene ethynelenes), which are polymers with remarkable antimicrobial resistance. This prototypical entrepreneurial challenge exposes students to current research conducted by faculty member Dr. Whitten and engages students in solving problems caused by ever-present bacteria and microbes.

CBE 101: Contamination from Abandoned Mines

In this community-based challenge, students investigate hazards of acid mine drainage from abandoned mines, which are abundant in New Mexico. One such mine had a major release of contaminated water, causing hardships in Native American and Hispanic farming communities downstream of the spill. Students develop prevention or emergency response systems for rural communities, along with a community engagement strategy. We created a modified version of this challenge, which graduate student (and lecturer II in Community & Regional Planning) Jordan O. James used in his introductory planning course. We made minor refinements and developed rubrics for the CBE version.

CBE 251: Algal Biofuels

Algae grow faster than land-based plants (e.g., corn, sugarcane) and can be used as a source of fuel. In this community-, industry-, and research-based challenge, students work in teams to develop a conceptual design for a community. Generating fuel from algae takes place in three production phases: growth, harvesting and extraction. In the first implementation, students were divided into three large teams, one for each production phase (growth, harvesting and extraction). Students in the growth phase choose a community where critical growth requirements such as carbon dioxide supply, type and density of culture, water supply and exposure to light can be met. Separation of algae from its growth medium is carried out in the harvesting phase; students research techniques that would allow for a less energy intensive process, including filtration and centrifugation. Extraction involves removing the oil from the algae; students contrast two major methods—mechanical and chemical—based on handling and chemical safety. All three phases prompt students to link knowledge gained from the design challenge to the disciplinary course content by way of deliverables, which were submitted with each of the six homeworks.

CBE 311: Kirtland Air Force Base Jet Fuel Spill

This community-based design challenge for the junior-level Transport Phenomena course tasks students with characterizing and mitigating the jet fuel spill first detected in 1999 on the Kirtland Air Force Base in Albuquerque, NM. This spill resulted in great alarm, mobilizing the Air Force Base, citizens, and local government to proactively begin evaluation and remediation steps. With the environmental accident and ensuing social/political/legal dynamic in the backdrop, the purpose of this design challenge was (1) to assess possible engineering approaches to contain and remediate the leak of ethylene dibromide, (2) to improve tank designs to prevent future breaches, and (3) to provide economically and environmentally sound long-term methods to assess the level of spread, and monitor and treat the contaminated underground water. While tackling the multiplexed design challenge, the problem had to be well-defined, focused, and closely connected to the engineering concepts (e.g., barometric equation, Bernoulli’s principle, head loss, shaft work, etc.) introduced in class, such that 3rd-year students could provide solutions with a reasonable level of technical details.

Science on Tap

An activity that originated from connections to the Nanoscale Informal Science Education (NISE) network is the Science on Tap where we bring speakers to a local bar so the results of research at UNM and elsewhere in Albuquerque can be conveyed to the public. This activity has been very successful and continues now in its 4th year. The next page shows the schedule of events for this past academic year.

SCIENCE ON TAP (SOT) is modeled after similar successful series in other metropolitan cities around the country and is an opportunity for anyone to explore the latest ideas in science and technology in a relaxed, informal environment. SoT Albuquerque debuted in August of 2012 at Cosmo Tapas. There have been 45 presentations on topics from Nanotechnolgy to Colossal Failures in High-Tech Projects! (Full list of presentations attached)

The talks are free and are for those who are 21 and older. They take place on the first Thursday of each month. The program begins with a 30-minute presentation by a featured speaker, followed by 30 minutes for attendees to ask questions and gain additional information.

The Departments of Chemical and Biological Engineering, Computer Science, Nuclear Engineering, Biology and UNM Nanoscience and Microsystems (NSMS) have partnered with Explora! and the National Museum of Nuclear Science & History to present this innovative lecture series. The goals of "Science on Tap" are to bring science to the public, to increase public awareness and pride in the research accomplishments of area scientists, and to provide area science enthusiasts a fun and unique venue for meeting and interacting with one another.

ATTENDANCE: 30 – 60+ depending on speaker and topic

DATES AND TIME: First Thursday of the month: August/November and February/May; 5:30 pm • 40-minute presentation, followed by 15-20 minutes for questions

TARGET AUDIENCE: UNM students, faculty, staff, museum patrons, Sandia National Labs technical staff and anyone with a curiosity about science and related fields

Science on Tap Blog – Science on Tap NM (http://scienceontapnm.blogspot.com)

Representative SoT talks from the past 6 years:

How to Mend a Broken Heart:
Bioengineering Advances in Treatment of Cardiovascular Disease
Heather Canavan
Associate Professor
Center for Biomedical Engineering
University of New Mexico

Water Resources in the Middle Rio Grande: A Storm is Brewing but It Doesn't Look Like Rain
Bruce Thomson
Professor of Civil Engineering
Director, Water Resources Program
University of New Mexico

Colossal Failures in High-Tech Projects,
And What We Can (or Should) Learn From Them
John H. Stichman, PhD
Sandia National Labs – retired

When is a "Law" not a Law? When it's Moore's
Joe Cecchi
Professor of Chemical and Nuclear Engineering
University of New Mexico

Anything You Can Do, I Can Do Better: Biomimicry in Action
Heather Canavan, Associate Professor
Alex Maciejewski, soon to be UNM graduate
UNM
Chemical & Biological Engineering

Plasma Sculpture
Carl Willis
Qynergy Corporation

Trinity Test: 70 Years Later
Duane Hughes
Historian and Docent for the National Museum of Nuclear Science & History

(de)Testable You
Bioengineering approaches to personalized medicine
Professor Sally McArthur
Swinburne University of Technology
Australia
Professor Heather Canavan
University of New Mexico

Raman spectroscopy: A 90-year story of the intersection of science and technology
Professor Andrew Shreve
University of New Mexico

Radioactivity
Veena Tikare
Multiscale Science
Sandia National Laboratories

How Safe is Safe? A Water Engineer's Perspective on Water and Public Risk
Bruce M. Thomson
Professor Emeritus & Research Professor
Civil Engineering
UNM

Infectious Diseases: where's the line between public health and security
Lisa Astuto-Gribble, PhD, MPH
Sandia National Laboratories

2D. Course Delivery Modes

Discuss the efficiency and necessity of the unit's mode(s) of delivery for teaching courses.

Undergraduate Program

All undergraduate courses are offered once per year with the exception of CBE 101 which is offered each semester. The mode of delivery is lecture, except for some electives which are cross listed as graduate courses, where the online synchronous mode is offered. The Engineering Science courses CBE 300 and 301 are only offered in the online asynchronous mode, since they are taught by faculty outside CBE and are available to students through the school of engineering. The department offers a 4-semester sequence of laboratory classes in the last two years of the undergraduate curriculum. Electives and graduate level courses are generally offered once a year, but in some cases the offering is less frequent.

Graduate Program

The main mode of delivery of the graduate courses is lecture. In many cases the class is offered in online synchronous mode, which allows for the students to attend remotely and/or watch recordings of the lectures. This applies to both core and elective classes. The core courses are offered once a year. The frequency of the elective courses is once a year or in some cases every other year.

2E. Teaching and Learning: Curriculum Strategic Planning

Discuss the unit's strategic planning efforts going forward for identifying, changing and/or examining areas for improvement in its curricula.

Undergraduate Program

The department revises the curriculum based on results of the outcomes assessments, as described in the next chapter on Continuous Improvement

Graduate Program

Planning for the core chemical engineering curriculum is based on the results of outcomes assessments. Since the CBE department faculty support a total of 3 graduate programs (NSME, BME and Chemical Engineering), the last few years have seen a push to consolidate core courses so they minimize duplication and improve efficiency. Three of the chemical engineering core courses, Research Methods, Thermodynamics and Methods of Analysis, are also now core courses in the Biomedical Engineering program. The curriculum in these classes will continue to be revised as the needs of each program evolve. Specifically, the Research Methods course in its current form is specifically devoted to preparing students to write a NSF –style GRFP proposal, so students are better prepared for the PhD qualifying exam.

Criterion 3. Teaching and Learning: Continuous Improvement

The unit should demonstrate the relevance and impact of the curriculum associated with each degree/certificate program. (Differentiate for each undergraduate and graduate degree and certificate program offered by the unit.)

3A. Overview of Assessment Process

Describe the assessment process and evaluation of the student learning outcomes for each degree/certificate program by addressing the items below. • Describe the overall skills, knowledge, and values are expected of all students at the completion of the program (refer to the program learning goals outlined in Criterion 1)? • Explain how the current direct and indirect assessment methods are established and administered as program-level assessments including how they are used to measure each student learning outcomes. Also, provide a description of the courses in which the assessment methods are administered and the extent to which students are expected to meet each student learning outcomes. • Explain and provide evidence of how the program has progressively improved, evolved and/or maintained the quality and effectiveness of its assessment structure and activities in order to reflect, sustain and/or maximize student learning (i.e., updated assessment plans, annual assessment reports, assessment maturity scores, etc.)

Undergraduate Program

The assessment plan for the Chemical and Biological Engineering Department at the University of New Mexico is designed to assess the ABET outcomes, which are the same as the student learning outcomes in Criterion 1C. The goals of the CBE assessment plan are to determine if undergraduate students, at the completion of the degree program, are satisfactorily knowledgeable in each of the outcome areas and to establish a framework for the continuous improvement of the program.

The student learning outcomes are closely related to the program educational objectives. Achievement of the student outcomes is necessary for chemical engineering graduates to be able to achieve the program educational objectives. Table 3A-1 maps the student outcomes prior to fall 2017 onto the chemical engineering program objectives and Table 3A-3 maps the current student outcomes onto the chemical engineering program objectives. *This change was necessitated since ABET revised outcomes in fall 2017*.

Prior to fall 2017 (based on ABET Student Outcomes):

Table 3-1 below outlines the relationship between Student Outcomes (ABET Student Outcomes prior to fall 2017) and Program Educational Objectives. Most of the program outcomes support the “meeting/exceeding the expectations of professional positions”, and “successfully pursuing advanced study in a graduate/professional program” educational objectives, while Outcomes (d), (i), and (j) strongly support the “assuming leadership roles in professions/communities” objective.

Table 3A-1. Matrix showing how Student Outcomes support Program Educational Objectives.

Program Educational Objectives	Supporting Student Outcomes

1) Meet or exceed the expectations of their professional position	(a), (b), (c), (d), (e), (f), (g), (h) and (k)
2) Successfully pursue advanced study in a graduate or professional program	(a), (b), (c), (e), (f), (g), (i) and (k)
3) Assume leadership roles in their professions and/or communities	(b), (c), (d), (f), (g), (h), (i), (j) and (k)

The chemical engineering student outcomes, associated performance criteria, intended assessment methods, and assessment status are provided on the following pages. For joint classes involving both chemical and nuclear engineers, we record information only for the chemical engineering students in the class; information on nuclear engineering students is kept by the Nuclear Engineering Department.

The student outcomes were assessed from 2010 to spring 2017 in different required classes as shown in Table 3A-2. Each student outcome is listed along with the classes in which that specific outcome was assessed. Some of the required classes were not directly involved in the assessment, usually because they were taught early in the program. A later course was more effective for assessing each outcome. The entries in the table indicate the outcome by letter and the courses used for outcome assessment purposes, Outcomes are assessed in multiple courses.

Table 3A-2. Core chemical engineering courses used for direct assessment of Student Outcomes.

Outcomes Assessment																		
CHNE / CBE Course → Outcome ↓	251	253	302	311	312	317	318	319	321	361	371	418	419	451	454	461	493	494
(a)	1			2					2	2						2		
(b)							1	2					1					
(c)															1		2	
(d)												1						2
(e)				1	2										1			
(f)										2				2				
(g)												2		2				1
(h)														2				2
(i)									1			1		2				2
(j)										2				2				1
(k)		1				2	1											

*The numbers indicate the importance of each course in the overall outcome assessment; level 2 is higher than level 1. The courses used to track the trends over time for Student Outcomes and corresponding Performance Criteria are listed at level 2. The courses labeled at level 1 are used to evaluate Student Outcomes, but they are not tracked for year-to-year trending.

Each Student Outcome is assessed using 1 to 5 Performance Criteria, which serve to break down each Outcome into a few measurable components. The types of assessment instruments used to evaluate each Student Outcome include questions/problems from exams, quizzes, midterms, final exams, individual homework problems, homework assignments, projects, essays, in-class debates, oral presentations, lab reports, and design reports.

A full cycle of (a)-(k) outcomes assessment occurs once a year, spread across courses in both Fall and Spring semesters. Expected levels of attainment of outcomes depend on the instructor's determination of a minimum adequate score to meet expectations for attainment of that outcome. This minimum score reflects achievement of specific performance criteria for each outcome. The target is that 75% of the students should meet or exceed expectations for attainment of the outcome.

The Undergraduate Committee reviews outcomes assessment results after faculty submit their assessment data. One-on-one meetings with individual faculty member may supplement this assessment submission. The data are compiled and archived by the ABET Coordinator who is also a member of the Undergraduate Committee. The UG committee also reviews the course content, the syllabus, and how the performance meets the program goals. The results are then presented to the entire faculty during the annual retreat in August and corrective actions are proposed and discussed. The assessment results are evaluated by the faculty and after changes are made we determine if the problems were corrected. This is a continuous loop that leads to program improvement.

Fall 2017 - present (based on new ABET Student Outcomes):

In October 2017, ABET published a new set of Student Outcomes (see Criterion 1C). In response, the ABET Coordinator and the UG Committee of CBE met and revised our assessment plan. Table 3A-3 below outlines the relationship between the new ABET Student Outcomes and Program Educational Objectives. Most of the program outcomes support the "meeting/exceeding the expectations of professional positions", and "successfully pursuing advanced study in a graduate/professional program" educational objectives, while Outcomes 3 and 5 strongly support the "assuming leadership roles in professions/communities" objective.

Table 3A-3. Matrix showing how Student Outcomes support Program Educational Objectives.

Program Educational Objectives	Supporting Student Outcomes
1) Meet or exceed the expectations of their professional position	1, 2, 3, 4, 5, 6, and 7
2) Successfully pursue advanced study in a graduate or professional program	1, 2, 3, 4, 5, 6, and 7
3) Assume leadership roles in their professions and/or communities	3, 4, 5, and 7

Each Student Outcome is assessed in 3 core chemical engineering classes, which provide a few measurable components (see Table 3A-4). The types of assessment instruments used to evaluate each Student Outcome include questions/problems from exams, quizzes, midterms, final exams, individual homework problems, homework assignments, projects, essays, in-class debates, oral presentations, lab reports, and design reports.

Table 3A-4. Core chemical engineering courses used for direct assessment of Student Outcomes.

Outcome s	Core Chemical Engineering Courses used for direct assessment of Student Outcomes																			
	101	251	253	302	311	312	317	318L	319L	321	361	371	418L	419L	451	454	461	486	493L	494L
1							x			x							x			
2					x						x									x
3													x	x	x					
4											x				x				x	
5		x						x												x
6									x					x				x		
7	x*			x*	x*	x*		x*				x	x*		x*		x*			x*
Process Safety SAChE	ELA 909			ELA 904 910	ELA 907	ELA 908		ELA 909					ELA 906		ELA 901		ELA 902			ELA 903 905

Notes:

x* - Process safety SAChE Certificates will count towrds Outcome 7

ELA are course numbers of SAChE modules

A full cycle of 1-7 outcomes assessment occurs once a year, spread across courses in both fall and spring semesters. In addition, Process Safety is also assessed in multiple classes. Expected levels of attainment of outcomes depend on the instructor's determination of a minimum adequate score to meet expectations for attainment of that outcome. This minimum score reflects achievement of specific performance criteria for each outcome. The target is that 75% of the students should meet or exceed expectations for attainment of the outcome.

The Undergraduate Committee reviews outcomes assessment results after faculty submit their assessment data. One-on-one meetings with individual faculty members may supplement this assessment data submission. The data are compiled and archived by the ABET Coordinator who is also a member of the Undergraduate Committee. The UG committee also reviews the course content, the syllabus, and how the performance meets the program goals. The results are then presented to the entire faculty during the annual retreat in August and corrective actions are proposed and discussed. The assessment results are evaluated by the faculty and after changes are made we determine if the problems were corrected. This is a continuous loop that leads to program improvement. Our assessment ensures that if we do not hit our performance targets, we make changes that help us reach the goal.

Improving the Assessment Process

Several significant improvements to the assessment process have been made in the past two years. Assessment data prior to fall 2016 were entirely collected and stored as hard copies. An electronic submission system was set up for instructors to submit assessment data. Folders on UNM supported SharePoint were setup for each course. All faculty in the CBE department have access to edit these folders. Additionally, to create uniformity, a template that included instructions, a checklist, and instructor assessment was also created and distributed to each faculty.

As described earlier, the ABET assessment plan was revised in response to the new ABET 1-7 student learning outcomes. In the new plan, each outcome is assessed in three classes and the assessment is done every year. The structure of the assessment has also been changed, eliminating Performance Criteria.

Graduate Programs

Outcomes for PhD Degree Program - Students receiving the PhD degree will:

1) Demonstrate knowledge of engineering and science fundamentals pertinent to Chemical and Biological Engineering.
2) Have the ability to conduct original research.
3) Demonstrate the ability to perform a critical review of the literature in the area of Chemical and Biological Engineering.
4) Be able to communicate effectively, both in written and oral form.

Outcomes for MS Program - Students receiving the MS degree will:

1) Exhibit knowledge of engineering and science fundamentals appropriate for the Chemical Engineering discipline and/or specialization.
2) Be able to communicate effectively.
3) Demonstrate the ability to critically assess information in the field Chemical and Biological Engineering.

Assessment Plans - For students receiving a PhD or an MS degree, the student's exam committee determines whether the student has achieved the outcomes based on the student's dissertation, thesis, or report of the independent study/project work. This is documented on a rubric that is developed for this purpose (please see below). This rubric is filled out by a consensus of the committee rather than by each individual member of the committee.

Results of the outcomes assessment for each student are evaluated by the department's graduate committee. The evaluations prepared by the graduate committee are reported to the SOE graduate committee for analysis, discussion, feedback, and any necessary action.

PhD Degree Outcomes Assessment Rubric

UNM SCHOOL of ENGINEERING

CBE PhD Outcomes Assessment Rubric

To be completed by committee chair in consultation with exam committee.

Student: ___________________ Degree program/concentration:_____________

Date:______________________

Outcome	Unacceptable (1)	Marginal (2)	Acceptable (3)	Exceptional (4)	Rating
1) Knowledge of CBE fundamentals appropriate for discipline and specialization	No evidence of PhD-level fundamental knowledge in CBE.	Rudimentary knowledge of CBE exhibited in written document and oral presentation.	Knowledge of CBE fundamentals evident in written and oral presentation.	Demonstrates mastery of appropriate fundamentals of CBE.	
2) Depth of knowledge in specialization	Only rudimentary knowledge in specialization.	Some knowledge of specialization demonstrated.	Demonstrates appropriate level of knowledge in specialization.	Demonstrates knowledge of specialization comparable to experienced practitioner.	
3) Ability to conduct original and independent research	No evidence of planning and execution of research program.	Some useful research results with some evidence of original work.	Carried out good research program, achieved useful and novel results.	Excellent planning and execution of research program. Excellent results.	
4) Ability to perform critical review of literature in CBE and area of specialization	Rudimentary literature review.	Some review of the literature, but little critical evaluation.	Comprehensive review of literature with evidence of critical thinking about further needs for research in this area.	Extensive review of literature with critical evaluation comparable to a review article in literature.	
5) Able to communicate effectively	Dissertation poorly written. Oral exam not well planned or presented. Unable to answer questions.	Dissertation mostly clearly written. Presented main points clearly. Able to answer some but not all of the questions posed by committee.	Well written and well organized dissertation. Well organized and clear presentation. Good ability to answer questions.	Excellent job of writing and organizing dissertation. Well organized talk. Able to respond to questions and facilitate further discussion of results.	
Overall Assessment	Unacceptable (1)	Marginal (2)	Acceptable (3)	Exceptional (4)	

Comments (use back if necessary):

What curricular or process changes can you suggest to improve student performance in these areas (use back if necessary)?

Form to be sent to department/program grad committee and SoE Associate Dean for Academics.

MS Degree Outcomes Assessment Rubric

UNM SCHOOL of ENGINEERING

CBE Masters Degree Outcomes Assessment Rubric

To be completed by committee chair in consultation with exam committee.

Student: ___________________ Degree program/concentration:_______________

Date:______________________

Outcome	Unacceptable (1)	Marginal (2)	Acceptable (3)	Exceptional (4)	Rating
1) Knowledge of CBE fundamentals appropriate for discipline and specialization	No evidence of Masters level fundamental knowledge of CBE.	Rudimentary knowledge of CBE exhibited in written document and/or oral presentation.	Knowledge of fundamentals of CBE evident in written and/or oral presentation.	Demonstrates mastery of appropriate fundamentals of CBE for the discipline.	
2) Ability to communicate effectively in oral and/or written form	Document poorly written; and/or poorly organized oral presentation.	Document mostly clearly written. Presented main points clearly; and/or oral presentation mostly clear and well-organized.	Well written and well organized document; and/or good job of organizing talk and well presented oral report.	Excellent job of writing and organizing document and discussion of results; and/or excellent job of organizing and presenting oral report.	
3) Ability to critically assess or apply information in CBE and specialization	Rudimentary review or application of disciplinary information.	Some review or application of disciplinary information, but little critical evaluation.	Comprehensive review or application of disciplinary information with evidence of critical thinking about further needs for research or study in this area.	Extensive review or application of disciplinary information with critical evaluation comparable to a review article in literature; or knowledge comparable to that of an experienced practitioner in CBE.	
Overall Assessment	Unacceptable (1)	Marginal (2)	Acceptable (3)	Exceptional (4)	

Comments (use back if necessary):

What curricular or process changes can you suggest to improve student performance in these areas (use back if necessary)?

Form to be sent to department grad committee and SoE Associate Dean for Academics.

Qualifying Examination Assessment Rubric

CHEMICAL & BIOLOGICAL ENGINEERING

Department of Chemical & Biological Engineering (CBE)
[SEMESTER] - Ph.D. Qualifying Examination Report

Name of Student		**UNM ID #**
Faculty Advisor(s)		**Committee Chair**
Committee Member		**Committee Member**
Exam Date	**Exam Time**	**Exam Location**
Journal Article Title		

INSTRUCTIONS FOR STUDENT

1) Attach a copy of your unofficial transcripts and a set of your PowerPoint slides (3 per page) to this form.

2) Bring a copy of this form to your Qualifying Examination. Be sure you have a copy of this form, a set of transcripts, and a set of PowerPoint slides for each of your three committee members.

INSTRUCTIONS FOR EXAMINATION COMMITTEE

1) After evaluating the Qualifying Examination, each committee member should fill out the response sheets provided. For each attribute, a short explanation should be provided.

2) All evaluation documents, including rubrics and written comments, must be complted by ALL committee members.

3) The committee chair is responsible for submitting a copy of the completed evaluation documents (both rubrics and written comments) for each of the committee members to Sarah Dominguez (by hand or scanned and emailed to skieltyk@unm.edu) immediately following the Qualifying Examination.

4) Completed forms are to be treated as confidential.

5) Committee members may be asked to defend their grading to the CBE Faculty, at the faculty meeting on [DATE].

6) A verbal summarization of the overall evaluation by the committee may be provided to the student by the chair of the examining committee if requested by the student. The student may also meet individually with the committee members after the exam to receive feedback.

Department of Chemical & Biological Engineering (CBE)

[SEMESTER] - Ph.D. Qualifying Examination Report - RUBRIC

Student Performance (Critical Analysis of Journal Article and Student's Research Proposal)

Category	Unacceptable (1)	Marginal (2)	Good (3)	Excellent (4)	Rating (1-4)
Critical Analysis of Journal Article	Insufficient depth. Inappropriate technical level. Missed the big picture - impact and significance of the journal article.	Understood some aspects of the paper, but the overall presentation lacked depth. Technical content was too low for PhD level.	Most topics sufficiently described, but not enough emphasis on the most important points. Technical level is appropriate.	Demonstrates excellent understanding of the paper with emphasis placed on the most significant areas, at a high technical level.	
Ability to answer questions on the technical aspects of the journal article. Background and preparation in the CBE core subjects and in the fundamental science and engineering concepts	Student was unable to answer questions	Student could answer some questions, but overall had difficulty answering in-depth technical questions	Student answered most technical questions adequately, but showed some deficiencies in a particular area	Student could answer most questions adequately to demonstrate a sound technical knowledge of the basic underlying principles	
Relevance and technical feasibility of proposed research	Proposed research has no apparent connection to the paper reviewed or research is not feasible	Research is loosely related to the paper. Not much thought given to how research can be accomplished.	The proposed research covers similar ground as the paper, but does not lead to new directions. The necessary equipment or theoretical framework is well defined but with some gaps.	Research proposal makes good use of the paper as a springboard to delve into new areas. The proposed research is both feasible and novel and the tools - experimental and theoretical are available	
Novelty and Originality	Proposed research lacks novelty and originality. Research is a simple continuation of previous work.	Proposed research has some novel aspects, but these are poorly developed and without a clear design.	Research breaks new ground, demonstrates a clear understanding of the needs and goals.	Proposes original work that is well thought out and justified. The research problem is clearly stated.	
Research Plan	No appreciation for the timeline, how long it would take to do the research.	A reasonable timeline is presented, but the resources available (time and equipment) do not match what is needed.	A good deal of though has been devoted to the conduct of the research, an experimental plan is proposed.	A well-defined research plan, with clear milestones and deliverables. The work can definitely be accomplished within the scope of a PhD.	
Technical discussion of the proposed work	Speaker evades answering any questions that were asked or cannot answer simple technical questions	Speaker has difficulties in handling most questions.	Speaker is able to address most questions with confidence.	Speaker is able to answer all questions clearly, effectively, and with confidence.	

SCORE: ______ /24

COMBINED OVERALL SCORE: ______ /32

Student - [NAME] **Faculty Advisor** - [NAME] **Committee Chair** - [NAME]

Department of Chemical & Biological Engineering (CBE)

[SEMESTER] - Ph.D. Qualifying Examination Report - RUBRIC

Student Performance (General Observations)

Category	Unacceptable (0)	Marginal (1)	Good (2)	Rating (0-2)
Organization & Structure	No clear organization.	Some organization is present, but there are several significant gaps in the presentation.	Organized, with a small number of minor gaps.	
Timing	Significantly over or under the requested time for the presentation, with no justification.	Presentation is moderately over or under the requested time.	Presentation is slightly over or under the requested time.	
Oral Presentation	Confused speech, with poor use of technical English. Speaker is difficult to understand or even to hear properly.	Some significant flaws in use of technical English. Speech is somewhat awkward or some minor effort is required to understand the speaker.	Use of technical English is good, with only a few minor flaws. Speech is audible and understandable.	
Visual Effectiveness	Visual aids are illegible or not understandable without substantial effort. Visual aids make no contribution to the overall effectiveness of the presentation.	A minority of the visual aids are clear and well described. Most visuals do not contribute to the effectiveness of the presentation.	Most visual aids are clear and well described. Most contribute to the overall effectiveness of the presentation.	

SCORE: ______ /8

Student: [NAME] **Faculty Advisor:** [NAME] **Committee Chair:** [NAME]

Department of Chemical & Biological Engineering (CBE)
[SEMESTER] - Ph.D. Qualifying Examination Report - Written Comments
Overall Rating

SCORE RANGES

0 -16. Based on the presentation and discussion, this student is **not prepared** for successfully completing work at the PhD level.
17-21. Based on the presentation and questions, this student is **minimally prepared** for successfully completing work at the next level. A student at this level may struggle with the tasks necessary for successfully completing work at the next level. For example, this student may have had a hard time evaluating journal articles, stating research questions, identifying an appropriate research design, analyzing data, or interpreting the results without serious assistance from an advisor. The student may also be lacking in some of the core knowledge on the fundamentals of chemical engineering that will need to be addressed to progress a the PhD level.
22-27. Based on this examination, this student is **satisfactorily prepared** for successfully completing work at the next level. A student at this level will have little difficulty producing quality work at the next level. However, some areas of improvement are recommended. For example, a student at this level may need to work on their presentation skills or take a relevant course to become proficient in a particular nanoscale field.
28-32. Based on the current product, this student is **well prepared** for successfully completing work at the next level. This student can produce high quality work at the next level with little or no supervision or input from others.

SUMMARY

RECOMMENDATION (circle one): PASS CONDITIONAL PASS RETAKE FAIL

COMBINED OVERALL SCORE: ______/32

Committee Member Comments: ______________________________

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____
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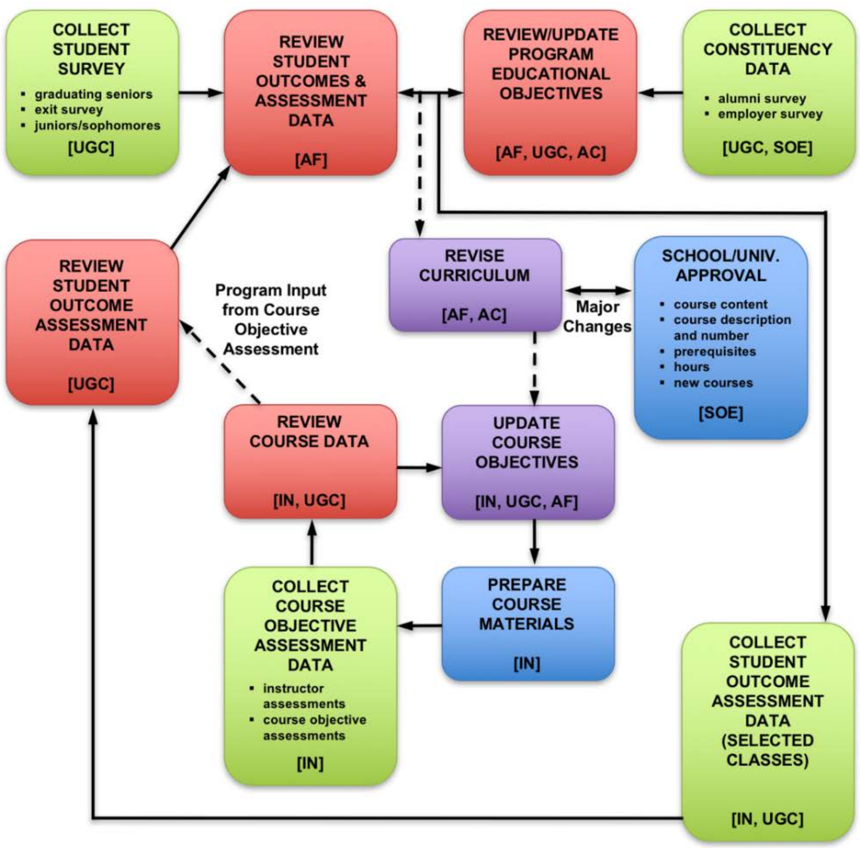
Student - [NAME] **Faculty Advisor -** [NAME] **Committee Chair -** [NAME]

3B. Impact of Assessment Process on Unit

Synthesize the impact of the annual assessment activities for each degree/certificate program by addressing the items below. • How have the results of each of the aforementioned program-level assessment methods been used to support and inform quality teaching and learning? • How have the results/data from the program's assessment methods and/or activities been used for program improvement and/or to maximize student learning? • Overall, how does the program utilizes it assessment structure to engage in a coherent process of continuous curricular and program improvement? Include an explanation of how the program strategically monitor the short- and/or long-term effects and/or impact of it changes.

Undergraduate Program

Program improvement is a continuous process as illustrated in Figure 3B-1 below.



Acronym	Group	Frequency
IN	Course Instructor	Term
UGC	Program Undergraduate Committee	Term
AC	Advisory Council	Annually
SOE	School of Engineering	As Needed
AF	All Faculty	Annually

Figure 3B-1: Schematic of the overall process for continuous program improvement, and review of Program Educational Objectives and Student Outcomes.

The instructor of each course performs an assessment of student learning outcomes, documenting the percentage of students who achieve satisfactory performance based on rubrics and performance criteria as outlined previously. The instructor prepares a summary of the outcome assessment and recommendations for changes to be made. Each semester, the undergraduate committee reviews these outcome assessment summaries for the courses that were taught in the previous semester. The committee reviews the content of the course, along with any issues arising from lack of student preparation from previous courses and ensures that the courses meet the goals of the program. We also collect data from student surveys to gauge satisfaction with our program and to learn about any concerns that might negatively impact student learning.

Figure 3B-1 also shows the decision pathways that lead to change in our program. At the course level (the inner loop in Fig. 3B-1), the instructor, in conjunction with the Undergraduate Committee, is responsible for the assessment and achievement of student outcomes, maintaining documentation related to course outcomes, and making most course level decisions. Decisions that impact other courses in the curriculum involve the Undergraduate Committee. The Undergraduate Committee is a standing committee responsible for recommending curriculum or other program changes based on several sources of information, including course outcomes assessment records, student or instructor feedback, and input from the chair based on exit surveys and student surveys done at the end of each academic year. The Undergraduate Committee also provides course and curriculum-level feedback to the faculty at the annual retreat, acting as the link between course level assessment and change (inner loop of Fig. 3B-1) and program level assessment and change (outer loop of Fig. 3B-1). The annual retreat, held before the start of the fall semester provides an opportunity for the entire faculty to review recommendations from the undergraduate committee, results of surveys of alumni, employers, exit survey of seniors and the survey of current students. Faculty make changes to the program based on course-level assessment and the other sources of information such as student feedback, interviews, advisory board suggestions, and faculty feedback. Minutes of faculty meetings, retreats, survey results, etc. to substantiate the continuous improvement cycle will be available to Program Evaluators. Highlights of changes made to the program as a result of this continuous improvement strategy are listed below.

During AY 2010-2011, to address concerns from the previous ABET visit, the requirements for accepting equivalents to CS 151 were implemented to ensure that transfer students had the requisite background in MATLAB. During the course of discussions for a reduced credit hour curriculum in AY 2012-2013, the faculty examined all aspects of the curriculum to determine if there were redundancies, and whether some courses could be eliminated or modified. It was discovered that since CS 151 was taken during the freshmen year, students were not very proficient when they came to the junior year to take CBE 317, numerical methods. However, CS 151 was a pre-requisite for Math 316, the ordinary differential equations (ODE) course. The faculty member responsible for teaching CBE 317 met with the undergraduate program chair in Math and developed a plan to modify CBE 253 so that the course would now include MATLAB and the Math department would consider it as a co-requisite for the ODE class. The content of CBE 253 was therefore modified in our reduced credit hour curriculum, and since Fall 2015, the requirement of taking CS 151 has been dropped from our program. MATLAB is now taught in CBE 253, which is a required core course and is taught within our department. According to the new curriculum, all students in our department study MATLAB in CBE 253. Because the curriculum transition happened in 2015, a portion of the CBE 253 students had already taken CS 151. A survey conducted in CBE 253 showed that the students who had not taken CS 151 felt that this course was suitable for them to a slightly higher degree than the students who had taken CS 151. Specifically, the suitability points were 4.2 for the former group and 3.9 for the latter group out of 5.0 scale. Thus, the curriculum transition for CBE 253 was successful. To evaluate if the new curriculum is more effective in training our students in MATLAB, we compared the fraction of students who achieved target program outcomes (a), (e), and (k) between the years 2014 and 2015 in CBE 317. In CBE 317, advanced numerical methods to solve chemical engineering problems are discussed and MATLAB is used for programming. In 2014, the fraction was 93%, 93%, and 85% for (a), (e), and (k), respectively. In comparison, in 2015 after CBE 253 is taught, the fraction increased to 98%, 95%, and 96% for (a), (e), and (k), respectively. Therefore, the introduction of MATLAB in CBE 253 has better prepared our students for CBE 317.

The revision of course content in CBE 253 gave us an opportunity to drop the module on Applied Statistics. This module had been introduced to provide students with an appreciation for applied Statistics and its application to error analysis. However, the outcomes assessments revealed that students were not very proficient in these concepts when they had to apply them in their senior lab CBE 419L for an experiment on Statistical Design of Experiments (DOE). A survey of students revealed that they did not find the statistics module in CBE 253 relevant to their curriculum. That was because they did not get a chance to apply these concepts until they were in the senior year. Beginning in fall 2015, a new course on Introduction to Statistics and Design of Experiments was introduced in the fall semester of the senior year. By teaching this content during the semester before students do the lab on DOE, we found that students are better able perform the DOE experiment and use the concepts they learned during the previous semester. We have taught the course CBE 486 once, so the effect of this change has not been fully assessed. But the students were quite fluent in use of the JMP software that is used for the DOE experiment, having used it in class the previous semester. In past years, the students had to be given a refresher in statistics during the senior lab, and that is not necessary any more. Hence, the department has now secured a license that allows students to install JMP software on their computers and use the program to analyze their results. Understanding core concepts in Applied Statistics and Design of Experiments and the ability to apply them in a laboratory setting is something that our employers and alumni have suggested is an important skill students should master before they graduate. This is an example of how the internal outcome assessments and student surveys, and external input from constituents, have led to a change in our program.

During AY 2011-2012 the faculty reviewed and revised the core chemistry and technical electives taken by students in the bioengineering concentration. Before the revision, BIOC 423 Biochemistry class was the only technical elective available to bioengineering concentration students. This was problematic in several respects. Our students generally lacked sufficient preparation for the class. As a result, the vast majority of our students needed course waivers to register for the class and after they register, the majority of students dropped the class. To increase the options available to students, a revised set of core and elective courses for the bioengineering concentration was developed. Technical electives now include 200 and 300 level biology courses as well as 400 level courses in the Biomedical Engineering graduate program. This curriculum change vastly expanded options available to our students and mitigated the many problems encountered previously.

During AY 2012-2013, the guidelines for using research to substitute for a technical elective were developed. The recommendations by the undergraduate committee were adopted to ensure that the outcomes, contact hours and faculty commitment, and student deliverables were clearly defined prior to approval of a problems course as a replacement for a technical elective. To receive credit, the student and his/her faculty mentor complete an Undergraduate Problems Course Waiver (see template in Criterion 1), in which they detail research activity and expectations for the problems course. The waiver is then reviewed and approved by the Director of Undergraduate Programs. Student work products from the problems course (e.g., written report) are being collected and archived.

During AY 2013-2014 the faculty performed a review of the entire curriculum, since the Provost had proposed that all programs consider adopting a 120 credit hour curriculum to ensure student success and increase graduation rates (See program history, Section B, for an explanation for the Provost request and how the School of Engineering responded to this request). A series of faculty meetings were devoted to considering alternate proposals developed by the undergraduate committee for curricular revisions. Elimination of CS 151L as a required class helped to address the concern from the previous ABET review. We also eliminated one Advanced Chemistry course, to bring the total to 3 courses, and converted the Basic Engineering Elective to two required 1credit online courses on Circuits and on Dynamics. This helps provide students with exposure to the breadth of engineering sciences. We have yet to graduate our first class with the 123 credit hour curriculum, the graduates in Sp 2016, even though most switched to the new catalog, did not benefit from a reduced credit hour program. The impact on retention and graduation rates will be evident as we track our students in the coming years.

In recent years, we have seen increasing enrollments in our program. In Fall 2014, with a class size over 100, we were assigned a classroom in the education building. However, the aspect ratio of the room and its infrastructure was not conducive to student learning. Overwhelming student comments were received from students in CBE 251 about the ineffective layout of the EDUC 105 classroom resulting in impaired learning for students sitting at the rear, as well as poor student participation due to layout of the two projector screens. These issues were discussed and a plan was developed to address the learning environment for our growing student numbers. A proposal was submitted to move the class to the collaborative teaching and learning building (CTLB) to include more active learning strategies in the Introductory Chemical Engineering course. In Fall 2015, the new collaborative learning classroom CTLB 300, helped to address the previously mentioned issues with increased student-instructor interaction and enhanced student learning as course material was adapted to promote more in-class team activity using the new technologies embedded for teaching support. In Fall 2015, the sophomore class CBE 251 saw a 96% student retention into the program, up from 68% in Fall 2014.

During AY 2014-2015, the faculty actively participated in a school-wide effort to win approval of differential tuition for engineering students. Even though a modest increase of $15 per credit hour was proposed, it had to win approval of the students and the Regents, who were under pressure to not increase tuition. A strong case was made by the Dean since the proposal required that the funds were to be devoted exclusively for undergraduate education. With support from undergraduate students, the proposal was unanimously adopted by the Regents in the spring semester 2015. During its first year, the CBE department received over $110k of funding through differential tuition. The faculty discussed methods to handle the larger class sizes and enrollments and it was decided that the revenue from undergraduate differential tuition would be used to provide peer-learning facilitators (tutors) for some of the core classes at the sophomore and junior levels. This change was instituted in Spring 2016, the impact of this change will be evaluated over the next academic year. During the summer of 2016, we are using the differential tuition funds develop new laboratory experiments for the senior lab. These experiments are guided by the philosophy of change articulated in the NSF/RED proposal, as explained next. The specific experiments will involve one for students in the materials concentration and another for students in the bioengineering concentration. The bioengineering experiment will expose students to a real-world challenge, that of developing biocidal materials for killing bacteria and combating infections. This experiment builds on research by one of our faculty and will involve the use of flow cytometry and cell culture techniques. This laboratory will combine elements of research since the efficacy of newly developed compounds is being determined in this research program. A second experiment on materials will involve students studying the role of precipitation hardening to develop strength in aluminum alloys. What is common to both experiments is that they allow us to integrate research and education, which is one of the themes of the RED proposal.

In fall 2014 NSF announced a program in the Engineering Education and Centers Division called Professional Formation of Engineers. There were many components to the PFE solicitation, but the centerpiece was a call for Revolutionizing Engineering Departments (RED). Faculty in CBE did an analysis on what we could do to completely transform undergraduate education and also our department. Our department is typical of many research active departments in the country where leading edge research is conducted by the faculty, but the benefits do not necessarily reach the undergraduate students. We therefore felt that we could make a significant impact by bringing some of the research challenges to the classroom. A brainstorming session was held with the CBE advisory council and a proposal was submitted in Nov. 2014. Subsequently, a smaller proposal was also submitted to the PFE:RIEF (Research Initiation in Engineer Formation) solicitation. While our first RED proposal was not funded, we did receive the PFE:RIEF award. This grant allowed us to build a partnership with the OILS (Organization Information and Learning Sciences) program. As part of the RIEF grant, we have explored the use of digital badging as a means for credentialing students and to improve retention of diverse student groups, who are under-represented in engineering.

The PFE:RIEF grant allowed us to begin a program of faculty development workshops, to enhance faculty interest in engineering education research and to learn best practices around the world. We will provide more details on the four workshops we conducted during the previous academic year in Section E Support for Faculty Professional Development under Criterion 8 Institutional Support. The initial work done with the PFE:RIEF grant allowed us to refine our model for the next RED proposal that was submitted in Dec. 2015. This proposal, entitled FACETS (Formation of Accomplished Chemical Engineers for Transforming Society) recognizes that our students have a range of identities, the purpose of our program is to recognize and build on the assets students bring, especially those who may not have the family or support structure needed to persist in engineering. We propose to introduce design challenges as a method of teaching the core curriculum, but to address the concerns from reviewers in our first proposal, we broaden the challenges to include those derived from community, industry, research and entrepreneurship. Our RED proposal was awarded by NSF with a $2M grant over 5 years to revolutionize our department. A team of faculty and students has been working on developing design challenges to be used in teaching of our introductory classes, CBE 101 and CBE 251 and more advanced core classes, including CBE 302, CBE 311, and CBE 321. One challenge used in CBE 101 involves the use of phase change and evaporative cooling for shipping of biological samples and the second one for treatment of contaminated wastewater from mining operations in the Rocky Mountains. We are currently exploring the use of digital badging, since it represents a unique approach to recognize what students have learned and to capture it in a form that can be shared and used as a motivational tool, much as fitness trackers provide badges to recognize achievement. Since the start of our grant in July 2016, we have made connections to educators worldwide, and will continue to make continuous improvements in our program and lasting change that can be disseminated to other programs around the country.

A major effort is underway to enhance the writing abilities of our students. Our laboratory sequence involved 3 experiments each semester over 4 semesters in the junior and senior years. In each lab, the students were required to submit one individual short report, one group full length report and one group oral presentation. Our observations were that the oral presentations were excellent, but even after going through the three lab sequence, students were deficient in writing when they submitted their individual reports in their 4th lab (ie senior year spring semester). The effort spent by faculty in grading reports did not appear to lead to improvements in writing, because very few students took the time to revise their reports. And being a 1 credit lab, students did not feel motivated to spend a lot of time on their writing, since the grade for the group reports made up for the deficiencies in the grade on their individual reports. It was decided in the summer of 2017 to explore alternatives to the way we planned the writing assignments. Through a series of meetings with a Professor in English, we concluded that it was unrealistic to expect that students would have learnt technical writing through the course taught through the English department, since it catered to students from all majors. We explored a different model, where a writing instructor would be embedded in our program. The experiment started in the fall 2017 semester and continues through Spring 2018. The writing instructor works with the CBE faculty member to create rubrics, help in grading the writing and serve as a resource person. The funding was provided through the differential tuition account.

The fall 2017 senior lab course findings have been submitted for publication in ASEE and will be presented in the summer 2018 meeting. The title of the paper is “Peer review and reflection in engineering labs: Writing to learn and learning to write.” Instead of decrying students’ skills or blaming the English department, we decided to reframe writing as a process of collaboration, rather than a final product. Working with an English faculty member embedded in our department, we designed a peer review and reflection activity for junior and senior level chemical engineering laboratory courses. We hypothesized that incorporating this would improve student writing by providing more writing time and facilitating knowledge transfer from lower-level composition courses. We concluded that embedding the process of writing in a lab setting provides a structured opportunity for students to review their own and another's work critically. Through this process engineering students can be guided toward improved technical writing.

During spring 2018, we modified the senior laboratory to cut down the number of experiments to 2, instead of 3, and focus only on short reports, based on the suggestion of the CBE advisory council. The technical portion of the lab, ie conduct of the experiment, analysis of data, and the oral presentation, were done as a group effort. These also involved significant faculty and/or TA involvement in providing feedback on the drafts, rather than simply grading the final product. In parallel with the lab, student did small portions of writing, as suggested by the English faculty member. Hence, the report writing was broken down into short segments, Introduction, Methods, Results, Discussion, Conclusions and Recommendations and finally, the Abstract. By having the writing instructor grade these first, and give feedback, the final assembled reports were dramatically improved. We see major improvements in the writing produced by these students and their technical presentations are also much better since they received feedback on their drafts. Going forward, we will need to examine how to make the process more sustainable, in terms of faculty time. We also will propose that the 3 credits assigned to the Technical Writing class be assigned instead to the lab distributed over our 3 labs. This way, instead of teaching a standalone Technical Writing class, the instructor hired by the English department can work with the CBE faculty to help teach students technical writing in the context of their lab experiment. Once we work out this model, we will propose it to the school of Engineering.

Graduate Programs

A major topic of discussion has been the poor preparation of our students in the PhD qualifying exam. The scores are generally low, with most students in the marginal pass category. The reason is not their lack of technical knowledge, since a low score there results in failing the exam, rather it is their inability to present a convincing research proposal. Our qualifying exam, explained in the previous section, requires a student to critically analyze a published journal article (selected out of 3 provided) and over a 2 week period, working independently, develop a critique and a research proposal. This exam is usually taken at the start of the 2nd year of graduate study, and the student gets one opportunity to retake, if unsuccessful. In light of the poor performance of students, we have created a core class, Research Methods, that is devoted to teaching students to prepare a NSF GRFP style proposal based on a published journal article of their choice. The new format of this class was introduced in fall 2017, we will analyze the results next year to see if it achieved our goals of better preparing graduate students to advance to PhD candidacy. The rubrics for assessment of graduate student outcomes are used during each oral examination, the PhD candidacy or MS thesis exam, and the PhD dissertation defense. The results of these outcome assessments have been satisfactory, hence no program changes have been instituted. However, a review of graduate courses and the graduate programs is planned during the next academic year, when we will explore changes to the curriculum, as needed.

Criterion 4. Students (Undergraduate and Graduate)

The unit should have appropriate structures in place to recruit, retain, and graduate students. (If applicable, differentiate for each undergraduate and graduate degree and certificate program offered by the unit.)

4A. Student Recruitment and Admissions

Discuss the unit's admission and recruitment processes (including transfer articulation(s)) and evaluate the impact of these processes on enrollment.

4.A.1 B.S. in Chemical Engineering

The Engineering Student Success (ESS) Center in the School of Engineering coordinates the recruitment of undergraduate students through events like SOE Open House, Senior Day, and visits to high schools throughout the state and in neighboring states. The CBE faculty are working closely with ESS to enhance recruiting. The research opportunities and employment possibilities offered by a chemical engineering degree are highlighted during recruiting trips made by Steve Peralta, the ESS Director. One of the assignments in our freshmen in CBE 101 class requires them to interview alumni and to create a brochure to highlight opportunities in chemical engineering to high school students. These brochures will help us enhance recruiting. Also, the CBE 101 course has been completely revamped to introduce freshmen to real world engineering problems that originate from communities, industry, research and entrepreneurship. Faculty in CBE are working closely with the Director of the Innovation Academy, which is helping undergraduates to develop entrepreneurship skills. The entrepreneurial challenges embedded in the chemical engineering curriculum will allow students to qualify for certificates awarded by the Innovation Academy. All of these activities will help to enhance recruiting of high school students into chemical engineering.

When students apply to UNM, they choose a proposed major. If they choose an engineering major, they are placed into one of seven pre-major categories: pre-chemical engineering, pre-civil engineering, etc. Admission to major status occurs when students have completed 18 hours of course work applicable to the degree (typically calculus, physics, chemistry, etc.), with a minimum required GPA. The list of courses that count towards the 18 hours and the minimum GPA required vary depending on the intended program; the minimum GPA varies between 2.5 and 2.75. Once students have completed the required 18 hours with the required GPA, they apply for admission to the degree program. Decisions on admission to the program are made by the Associate Chair for Undergraduate Affairs (or equivalent) in each department.

Transfer students are handled similarly. Those who have not completed the required 18 hours before admission to UNM are placed into pre-major status by UNM Admissions. Those who have already completed the required hours with the required GPA may be admitted directly into the degree program.

Students who initially began their college career at UNM but in a college outside of engineering may seek transfer into a School of Engineering program. These students can be transferred into one of the seven pre-engineering programs by speaking with the professional advising staff in the program they wish to enter. If eligible, the advisor will move them into the pre-major status, or directly into major status if the student has completed the required coursework with the minimum GPA for admission.

Pre-requisites to admission to the undergraduate program in Chemical Engineering include Chemistry 121/122/123L (General Chemistry I, II & General Chemistry I lab), Math 162/163 (Calculus I & II), Physics 160 (General Physics I), and CBE 101 (Introduction to Chemical and Biological Engineering). Students are also required to complete English 110 (Accelerated Composition) for admission. Students are encouraged to apply for admission during the semester they expect to complete the pre-requisites.

To apply to the program, students complete an application form through Engineering Student Success (ESS). Once grades from all pre-requisite courses become available, applications are forwarded to the Program Advisement Coordinator who transfers the information to an internal application form, verifies the information, and prints an unofficial transcript. This packet is then reviewed by the Director of Undergraduate Programs, who makes the admission decisions. Students are admitted to the department (if GPA from required courses listed above is 2.50 or higher) or denied admission (if GPA from required courses listed above is below 2.50). In rare and special circumstances, a student with a GPA below, but close to, 2.50 may be admitted to the department after a meeting with the Director of Undergraduate Programs; academic performance of these students is closely monitored by the Director of Undergraduate Programs and the Program Advisement Coordinator through the Academic Success Plan (see the following section) process to ensure student success.

Admissions decisions are then forwarded to the Associate Dean of the School of Engineering for final review and approval. A designee in ESS updates the students' records to reflect admission to the School of Engineering and the change in major.

Finally, an admission letter is emailed to the student along with a "Welcome to the Department of Chemical & Biological Engineering" information packet to notify the student of their admission to our chemical engineering program.

4.A.2 M.S. and Ph.D. in Chemical Engineering

Graduate applicants apply for admission through the centralized university online system similar to the undergraduate application. The decision, however, is made by the department. The departmental Graduate Committee, under the leadership of Director of Graduate Programs, reviews the credentials including past academic performance, statement of intent, GRE scores, and letters of recommendation. Faculty also recruit students directly into their own programs. The department then works with the faculty to admit the student. Admission to the BME and NSME graduate programs is handled by a separate office.

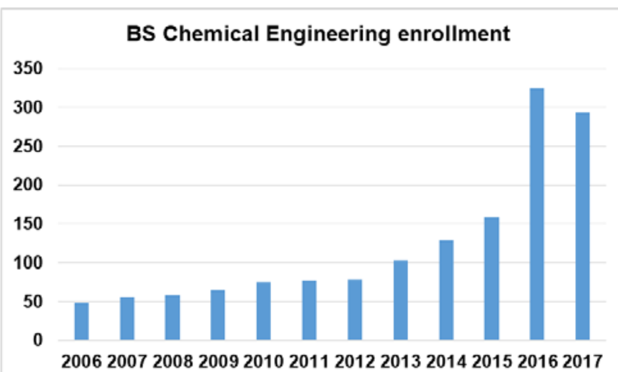
The majority of graduate students are supported as research assistants. A very small number are supported by other departments. A number of our current graduate students are also employed off campus, the majority of whom are interns or staff members at Sandia National Laboratories, Air Force Research Laboratory or Los Alamos National Laboratory. We do not have an Teaching Assistant appointments. When a student works as a TA, they are paid hourly, just as we pay undergraduate students. In fact, we have found that undergraduate students who have taken a class the previous year are far more effective in helping the instructor teach the class. We call them Peer Learning Facilitators (PLFs) or Undergraduate Teaching Assistants (UTAs).

The School of Engineering initiated the Shared Credit Program since the 2014-2015 academic year. The program was designed to encourage qualified undergraduate students to stay on for the graduate program, with a shortened duration toward the Master's degree. To accomplish this, some courses are double counted towards both the Bachelor's and Master's degrees. Students in the 4+1 program are not supported by the department, hence they take up the TA and PLF positions for senior year classes. There has been a significant increase in undergraduate students signing up for the 4+1 program in Biomedical Engineering, as will be seen in the next section.

4B. Enrollment Trends, Persistence, and Graduation Trends

Provide an analysis of the unit's enrollment, persistence/retention, and graduation trends, including an explanation of the action steps or initiatives the unit has taken to address any significant challenges or issues highlighted in these trends.

The enrollment data for the three degree programs in Chemical Engineering for the current and past ten years are shown in Table 4B.1. The numbers are based on the official record, tallied at the end of three weeks into each Fall semester. Table 4B.2 shows the degree production for the three programs in Chemical Engineering over the current and past eleven academic years. Number of B.S. degrees awarded has significantly increased over the past 10 years. The numbers fluctuate, but there has been a significant increase in UG enrollment, increasing over 3-fold from 2006 to 2015. The numbers doubled in 2016 because pre-majors were now assigned to the departments.



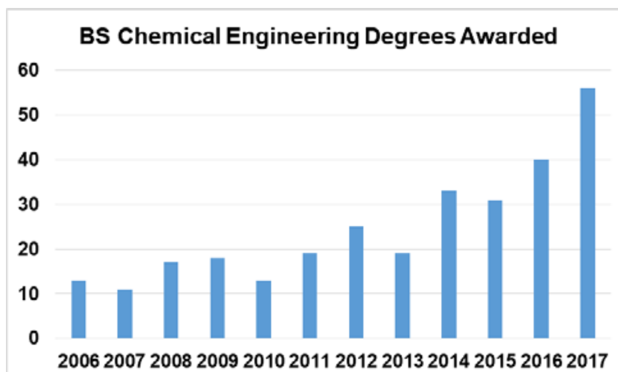


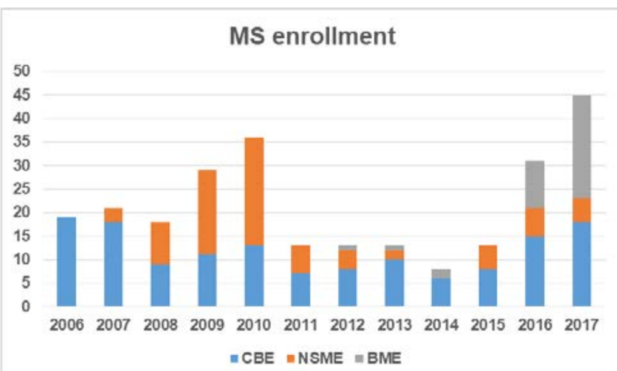
Table 4B.1 Enrollment data since 2006.

B.S. Program Enrollment											
Fa06	Fa07	Fa08	Fa09	Fa10	Fa11	Fa12	Fa13	Fa14	Fa15	Fa16	Fa17
48	56	58	64	75	77	78	103	129	159	324	293
M.S. Program Enrollment											
Fa06	Fa07	Fa08	Fa09	Fa10	Fa11	Fa12	Fa13	Fa14	Fa15	Fa16	Fa17
19	18	9	11	13	7	8	10	6	8	15	18
Ph.D. Program Enrollment											
Fa06	Fa07	Fa08	Fa09	Fa10	Fa11	Fa12	Fa13	Fa14	Fa15	Fa16	Fa17
35	37	35	34	31	24	19	15	13	13	18	13

Table 4B.2 CBE Graduation data since 2006.

B.S. Degrees Awarded											
2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
13	11	17	18	13	19	25	19	33	31	40	56
M.S. Degrees Awarded											
2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
7	4	5	8	5	5	3	5	6	1	3	5
Ph.D. Degrees Awarded											
2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
7	4	3	8	5	7	5	5	7	3	2	5

The enrollment in the M.S. and Ph.D. programs in chemical engineering has shown a significant decline over the past ten years. This is largely due to the creation and growth of NSME and BME programs led by CBE faculty. The overall graduate student enrollment in the combined graduate programs is shown in graphical form below and can be seen to have increased over the last 10 years. More details are provided in Tables 4B.3 and 4B.4. Since a fraction of BME and NSME students are advised by faculty outside CBE, these numbers do not reflect just the contributions of our faculty, but since our faculty also advise students in other departments, on balance this is a reasonable picture of our graduate programs The number of M.S. and Ph.D. degrees awarded through all three graduate programs, chemical engineering, NSME and BME has also not decreased.



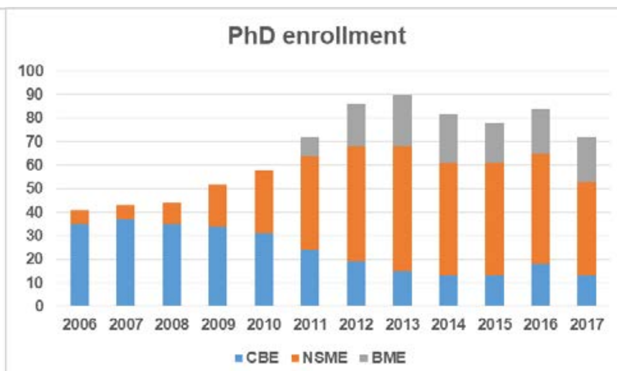


Table 4B.3 Enrollment and Degrees awarded in the Biomedical Engineering Program

M.S. Program Enrollment											
Fa06	Fa07	Fa08	Fa09	Fa10	Fa11	Fa12	Fa13	Fa14	Fa15	Fa16	Fa17
						1	1	2	0	10	22
Ph.D. Program Enrollment											
Fa06	Fa07	Fa08	Fa09	Fa10	Fa11	Fa12	Fa13	Fa14	Fa15	Fa16	Fa17
					8	18	22	21	17	19	19
M.S. Degrees Awarded											
2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
							2	3	2	7	13
Ph.D. Degrees Awarded											
2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
								2	1	1	1

Distribution of students by advisor department. CBE (13 + 19 in the MS program=32, CS 1, ECE 2, NEURO 3, Pathology 2, Pharmacy 1)

Table 4B.4 Enrollment and Degrees awarded in the Nanoscience and Microsystems Engineering Program

M.S. Program Enrollment											
Fa06	Fa07	Fa08	Fa09	Fa10	Fa11	Fa12	Fa13	Fa14	Fa15	Fa16	Fa17
0	3	9	18	23	6	4	2		5	6	5
Ph.D. Program Enrollment											
Fa06	Fa07	Fa08	Fa09	Fa10	Fa11	Fa12	Fa13	Fa14	Fa15	Fa16	Fa17
6	6	9	18	27	40	49	53	48	48	47	40
M.S. Degrees Awarded											
2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
	0	1	1	3	18	13	6	2	5	7	5*
Ph.D. Degrees Awarded											
2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
	0	1	0	0	2	3	5	7	6	7	2*

Distribution of students by advisor department. CBE (22 + 2 MS =24), Chemistry 5, Civil 1, CS 1, ECE 7, Math 1, Mech Engr 1, Pharmacy 3, Physics 2.

4C. Advisement Process

Discuss the unit's advisement process for students, including an explanation of how the unit has attempted to improve or address issues regarding its advising practices (i.e. refer to the outcomes established by the Office of University Advisement, the unit's advising maturity scores—which can be obtained from the unit's designated academic advising, etc.).

At the conclusion of each semester, the Program Advisement Coordinator enters the student performance into a worksheet and reviews the semester's grades for each student. Students with a cumulative UNM GPA below 2.0, semester GPAs below 1.5, grades of D+, D, D-, F, NC, AUD or W in technical courses are identified; records of these students are compiled for review by the Director of Undergraduate Programs. The Program Advisement Coordinator and the Director of Undergraduate Programs determine whether to recommend one of three actions for each student: Academic Improvement Plan (AIP), Probation, or Suspension at the School of Engineering (SOE) Probation and Dismissal meeting that is held every semester.

During the SOE Probation and Dismissal meeting, the case of each student is reviewed by a committee of faculty from across the SOE and the Associate Dean of Academic Affairs. The committee reviews the students' records in depth and then determines whether to place a student on AIP, remove a student from probation, continue the student on probation, or dismiss the student from the SOE.

Following the meeting, students are informed by email of the committee's decision in a letter. The letter also details criteria for release from AIP or probation. All students placed on AIP or probation are required to complete a 5-step Academic Success Plan (see below), which includes two meetings with the student's Faculty Adviser and 3-grade checks during the semester. The Program Advisement Coordinator oversees the entire process and ensures that the students follow through with the Academic Success Plan. After completing all the steps, registration holds are removed for the upcoming semester.

We feel that by closely interacting with and monitoring a struggling student's progress, we provide the student with the support and in-depth advisement that would maximize their chance for improving their academic performance. For the spring 2016 semester, 83% (19 students) of registered students who were put on AIP or probation (23 students) participated in the 5-step Academic Success Plan process. Out of the 19 students who participated, 37% (7 of students) completed all five steps and of these students, 86% (6 of students) showed significant academic improvement and were removed from AIP or probation. Overall, at the end of the spring 2016 semester, 52% of students were removed from AIP or probation, 48% remained on AIP or probation, and 13% (2 students) were suspended.

Based on the above-described outcomes of the Academic Success Plan that we had implemented so far, we feel that the students who participated in the process greatly benefited from the close interaction and mentoring from their faculty advisor and program coordinator as 6 out of 7 students moved out of AIP or probation. However, as the overall rate of participation (83%) and completion (37%) of the Academic Success Plan is below our goal of 85% participation, we are considering to further improve the process. The outcomes of the new Academic Success Plan has been discussed with the Undergraduate Committee and at the 2016 faculty retreat. Inputs from the faculty were taken into consideration and appropriate changes have been be made to the Academic Success Plan that retained features that have been shown to be effective (more frequent face to face meetings with faculty advisers) and streamline steps (3 grade checks) that may hinder participation and compliance.

UNM SCHOOL of ENGINEERING

Department of Chemical and Biological Engineering

ACADEMIC SUCCESS PLAN

Step 2 – First Grade Check

*Complete and turn in this page to Sarah E. Dominguez in the Chemical and Biological Engineering department office by **Monday, February 29, 2016.***

For ____________________________________ UNM ID ______________________________

Meetings with instructors:

	Course	Instructor's Signature	Instructor's Comments	Grade	Date
February					

Additional Instructor Comments:

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UNM SCHOOL of ENGINEERING

Department of Chemical and Biological Engineering

ACADEMIC SUCCESS PLAN

<u>Step 3 – Mid-semester Grade Check</u>

*Complete and turn in this page to Sarah E. Dominguez in the Chemical and Biological Engineering department office by **Friday, March 25, 2016**.*

For ____ UNM ID _________________________________

Meetings with instructors:

	Course	Instructor's Signature	Instructor's Comments	Grade	Date
March					

Additional Instructor Comments:

____

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Farris Engineering Center, Room 209

UNM SCHOOL *of* ENGINEERING

Department of Chemical and Biological Engineering

ACADEMIC SUCCESS PLAN

Step 4 – Advisement Meeting with Faculty Advisor

Complete and turn in this page, along with a completed Undergraduate Advisement Form, to Sarah E. Dominguez in the Chemical and Biological Engineering department office by ***Friday, April 15, 2016*** *.*

For ___________________________________ UNM ID _______________________________

I have improved upon the following obstacles for my academic success during this semester:

	Poor time management		Illness
	Poor study habits		Lack of childcare
	Too many absences		Family/relationship concerns
	Juggling work and school		Transportation
	Course difficulty		Early morning classes
	Lack of communication with instructors		Housing
	Insufficient study time		Lack of motivation
	Lack of career or major focus		Emotional/psychological issues
	Other:		

My greatest obstacles to overcome next semester are:

1	
2	

My primary strategies for success next semester are:

1	
2	
3	

Faculty Advisor comments:

____

____

____

Student Signature Date Faculty Advisor Signature Date

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UNM SCHOOL *of* ENGINEERING

Department of Chemical and Biological Engineering

Undergraduate Advisement Form

Instructions to Student

STEP ONE: Complete the form below using your LoboWeb account, LoboTrax Degree Audit, UNM Catalog and degree requirement forms found at http://cbe.unm.edu/.

STEP TWO: Take your completed form to your assigned faculty advisor for review/approval.

STEP THREE: Take your faculty advisor approved form to Sarah E. Domínguez, CBE Program Advisement Coordinator, in FEC 209. Sarah will then update your file folder, make any necessary edits to your degree audit and will remove your academic advisement hold.

Name:______________________ **UNM ID Number:**______________________

Phone Number:______________________ **UNM Email Address:**______________________

Catalog Year Used:______________________ **Concentration:**______________________

Estimated Graduation (Semester/Year)**:**____________ **Minor (optional):**______________________

Name of Faculty Advisor:______________________

Current Semester Semester/Year:____________			**Next Semester** Semester/Year:____________	
Course	**Credit Hrs**	**Anticipated Grade**	**Course**	**Credit Hrs**

Questions/Comments/Concerns? Include any LoboTrax issues that need to be addressed.

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____

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____

Student Signature:______________________**Date:**____________

Faculty Advisor Signature:______________________**Date:**____________

For Program Advisement Coordinator		
Degree Checklist: ______ Hold Removal: ______ Comments in LoboAchieve: ______	Exceptions requests sent for Degree Audit	Comments

Last Update: 02.29.16

UNM SCHOOL of ENGINEERING

Department of Chemical and Biological Engineering

ACADEMIC SUCCESS PLAN

Step 5 – Final Grade Check

Turn in this page to Sarah E. Dominguez in the Chemical and Biological Engineering department office by ***Friday, April 29, 2016.***

For ___________________________________ UNM ID _____________________________

Meetings with instructors:

	Course	Instructor's Signature	Instructor's Comments	Grade	Date
April					

Additional Instructor Comments:

____

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Farris Engineering Center, Room 209

4D. Student Support Services

Discuss any student support services that are provided by the unit and evaluate the relevancy and impact of these services on students' academic success.

The Department maintains a warm environment to ensure a close relationship between students and faculty and between students and staff. In addition to the broad advisement support provided by faculty and staff, the SOE Engineering Student Success Center (ESS) and UNM Center for Academic Program Support both offer tutoring services. ESS and UNM career Services also provide support in relation to Internships/Co-operative Education Program and employment. The UNM Graduate Resource Center also provides writing, statistics, and research support facilitated by peer consultations and workshops that help graduate students develop strategies to be effective academics, researchers, and professionals.

4E. Student Success and Retention Initiatives

Discuss the success of graduates of the program by addressing the following questions (1) Where graduates are typically placed in the workforce? (2) Are placements consistent with the program's learning goals? (3) What methods are used to measure the success of graduates? (4) What are the results of these measures?

In the recent ABET accreditation visit to the department, the report stated that "The program has strong ties to Sandia National Laboratories, other national laboratories and several local industries. These relationships, along with opportunities within faculty members' laboratories, provide students with research and internship opportunities to augment their educational experiences. This results in a majority of students having a research experience by graduation."

Chemical Engineers find limited employment within the state, the primary employers are the national labs, Intel and and start-up companies. Students go out of state to find jobs. A significant portion of our B.S. degree recipients went on to attend graduate programs in schools like UC Berkeley, UC San Diego, Stanford, MIT, Harvard, Georgia Tech, Purdue and Michigan, to name a few. Our students have also been winning prestigious scholarships. Last year a student won the Goldwater and the Churchill scholarship. Every year, a few undergraduates have been getting the NSF Graduate Research Fellowship.

A large number of our M.S. and Ph.D. recipients find employment in Sandia National Laboratories, Los Alamos National Laboratory, and Air Force Research Laboratory. Many join other government and private sectors upon graduation. Some of our Ph.D. graduates have gone on to become university faculty. The table below lists the placement of recent graduate students from the combined CBE, BME and NSME programs.

Placement of Graduate Students

Experiential Educational Faculty - Albuquerque Academy

Senior Scientist, - Novartis, NJ

Licensing Compliance Adminsitrator - National Renewable Energy Lab

Assoc. Research Scientist - UNM Center for Molecular Discovery

R&D Electronics Eningeer - Sandia National Labs

Purchased Product Engineer - Sandia National Labs

Research Intern - Sandia National Labs

Biomedical Scientist - W.L. Gore & Assoc., Maryland

Faculty member, UNM Health Sciences Center

Postdoc - Iowa State University, Des Moines

Process Engineer - Intel, Portland

Postdoc - Center for Precision Biomedicine, Institute for Molecular Medicine, U. Texas Health

R&D Systems Engineer - Sandia National Labs

Analytical Biochemistry/Mass Spectromtery - Los Alamos Nationa Lab

Manager of Emerging Technologies - Vision Ease (Lotus Leaf Coatings, CTO)

Research Scientist - University of Chicago

Senior Multi-Disciplined Engineer - Raytheon

HOS Quality Manager - Honeywell Aerospace (Post-Doc, Naval Research Lab)

Product Reliability Manager - Global Solar Energy (Post-Doc, University of Massachusetts, Amherst)

Senior Research & Development Engineer - Skinfared

Community Project Manager - Applause, San Francisco

Upstream Process Development Senior Scientist - Pfizer NY

Los Alamos National Laboratory

Post-doc - Oak Ridge National Lab

Post-doc, UNM (Dr. Sang M. Han)

Post-doc, Sandia National Lab

Post-doc - CIC-BiomaGUNE in Donostia, Spain

XRD Lab Manager/Senior Research Scientist -UNM Earth & Planetary Sciences

Sr. Product Development Engineer - TriLumina Corp

Data Scientist I - Broad Institute

Process Engineer - Intel ABQ

Sandia National Labs - Electrochemist

Research Engineer - Intel, Portland

Post-Doctoral Research Associate - US Naval Research Laboratory

Air Force Research Laboratory

President & CEO - BioSafe Technologies LLC

Engineer - Intel ABQ

Postdoc – UNM HSC

Engineer - Vista Therapeutics

Postdoc - University of New South Wales, Aust.

Process Engineer - Intel, Portland

4F. Student Strategic Planning

Discuss the unit's strategic planning efforts going forward to improve, strengthen and/or sustain its structures, processes, and/or rates for recruiting, retaining, and graduating students.

The department has bi-monthly faculty meetings and hosts an Advisory Council meeting each year. Program improvement is a regular topic at all of these meetings. Student recruitment (at all levels) is currently a top priority as is improving our website, creating a brochure and increasing our PR efforts. We are also working with the SOE administration and the Office of Graduate Studies to coordinate graduate student recruitment efforts. We also focused on enhancing undergraduate recruitment, helping the Engineering Success Center by participating in summer orientations and school visits.

Criterion 5. Faculty

The faculty (i.e., continuing, temporary, and affiliated) associated with any of the unit's degree/certificate program(s) should have appropriate qualifications and credentials. The faculty should be of sufficient number to cover the curricular requirements of each degree/certificate program. Also, the faculty should be able to demonstrate sufficient participation in relevant research and service activities. (If applicable, differentiate for each undergraduate and graduate degree and certificate program offered by the unit.)

5A. Faculty Composition and Credentials

After completing the Faculty Credentials Template discuss the composition of the faculty and their credentials. Include an overall analysis of the percent of time devoted by each faculty to the relevant degree/certificate program(s) and his/her roles and responsibilities.

The completed Faculty Credentials Table is shown in Appendix C. All regular faculty (tenured, tenure-track, and lecturer) in the department have a doctoral degree in engineering or a closely related field and have a record of research/scholarship. Currently all faculty are active in research. The table shows that the CBE department has 15 faculty (1 lecturer, and 3 faculty at 0.5 FTE), and 4 secondary appointments (not listed in this table) of whom only two teach in the department – Vanessa Svihla, from OILS (Organization, Information and Learning Sciences) at 0% FTE who jointly teaches CBE 101 and participates in many of the teaching activities in the department, and Jeremy Edwards (Chemistry) at 10% FTE who teaches CBE 454 Process Control. The other secondary appointments are Rama Gullapalli (Department of Pathology, clinician) and John Grey (Chemistry) who are primarily research collaborators. We also have 3 national lab professor appointments, Randy Schunk, Hongyou Fan and Gary Grest. Randy and Hongyou have grants through the department or one of the centers and serve as advisors for students and post docs. One faculty member, Gabriel Lopez, is the VP for Research hence does not teach in the department, but collaborates on research. The department also has 10 research professors, who generally are only doing research, but on occasion we get them to teach a class as an adjunct. We also have 22 affiliated faculty, those who are either working at national labs or local companies with letters of academic title (LAT). The LAT allows us to bring in collaborators, who have the status of Research Assistant Professor, Research Associate Professor or Research Professor.

As evidence of faculty credentials we provide a partial listing of faculty awards, honors and professional service of distinction:

Award Description	**Faculty member name**
National Academy of Engineering	Jeff Brinker and Gary Grest
National Academy of Inventors	Jeff Brinker and Plamen Atanassov
E O Lawrence Award	Jeff Brinker
MRS Medal	Jeff Brinker
MRS Fred Kavli Distinguished Lectureship Award in Nanoscience	Hongyou Fan
George S Hammond Award from the Inter American Photochemical Society	David Whitten
Fellow of AIChE	Abhaya Datye
Fellow of American Chemical Society	David Whitten
Fellow of the Electrochemical Society	Fernando Garzon and Plamen Atanassov
Fellow of the Royal Society of Chemistry	Abhaya Datye
Fellow of the MRS	Jeff Brinker
Fellow of the American Ceramic Society	Jeff Brinker
Fellow of the APS	Gary Grest
AVS Biomaterials Interface Division Young Investigator Award	Eva Chi
NIH Ruth L. Kirchstein National Research Service Award	Eva Chi
3M Corporation, Untenured Faculty Award	Heather Canavan
NSF Early Career Award	Sang M Han, Dimiter Petsev, Eva Chi Elizabeth Dirk, Sang E Han, Vanessa Svihla
NSF I/UCRC program Excellence Award	Abhaya Datye
ASEE-GSW Section Outstanding Young Faculty Award.	Vanessa Svihla
ASEE outstanding paper award – 2017	Vanessa Svihla
Professional Service of Distinction	
Editor in Chief	David Whitten (Langmuir)
Associate Editor	David Whitten (Applied Materials & Interfaces)
President of Electrochemical Society	Fernando Garzon
Petroleum Research Fund Advisory Board	Abhaya Datye
Editorial Board Members	
Catalysis Letters	Abhaya Datye
ACS Nano	Jeff Brinker
R&D 100 awards	Fernando Garzon Jeff Brinker Hongyou Fan Elizabeth Dirk

5B. Faculty Course-Load

Explain the process that is utilized to determine and assign faculty course-load. Discuss the efficiency of this process (i.e., how does the unit determine faculty assignment to lower division vs. upper division courses). Include an analysis of faculty-to-student ratio and faculty-to-course ratio (based on the total number of credit hours taught).

The School of Engineering adopted a unified Academic Load Policy in May 2014. It accounts for the various roles played by faculty, ie teaching, service, research and administrative responsibilities. Faculty at the Assistant Professor level get a reduced teaching load. The policy is shown in Appendix D. Based on this policy, faculty should teach 3 courses per year if they have a significant research program which includes publications, research expenditures, a research group and a website. This policy provides faculty a balance between teaching and research. Since class sizes vary, so does the workload for core classes versus elective classes, hence the CBE department adopted a policy that specifies how the workload should be distributed to achieve a more equitable allocation. This is listed in Appendix D after the School of Engineering Academic Load Policy. The department encourages every faculty to have a balanced teaching responsibility at undergraduate and graduate levels. We aim to assign teaching based on faculty interests and background. Hence, certain classes will likely have only a few faculty who can teach them. The workload policy adopted by the CBE faculty is designed to distribute teaching more equally and adds to the school wide workload policy. Through this approach, we expect to find roles for faculty to contribute to teaching at all levels, BS, MS, and PhD.

5C. Faculty Professional Development

Discuss and provide evidence of the professional development activities for faculty within the unit including how these activities particularly have been used to sustain research-related activities, quality teaching, and support students learning and professional development at the undergraduate and graduate level.

The department runs a seminar program, on Wednesdays from 4 – 5 PM. While the primary purpose is to invite outstanding researchers in the disciplinary areas where our faculty do research, we also now include faculty doing Engineering Education research, especially targeted towards undergraduate education. When we have such seminars, we invite the speaker to do a faculty development workshop. The workshops are recorded and the video is available to faculty on a private web server. The next page lists our departmental seminars for the 2017-2018 academic year. We have now decided that we will target ~8 seminars each semester, since we also require graduate students to attend 8 seminars, and this ensures adequate attendance. As part of the professional development, the seminar coordinator is a junior faculty member, who is encouraged to invite potential collaborators and future letter writers. The same applies to Associate Professors, who are also encouraged to invite collaborators and future letter writers.

An essential professional development activity is attendance at national and international conferences and workshops, to keep abreast with the frontiers in their respective fields, which is documented on their CVs. The department does not provide any direct support for such attendance, except when it involves junior faculty development, such as the ASEE summer school and for professional development for the lecturer to attend the AIChE and ASEE meetings.

THE UNIVERSITY OF NEW MEXICO SCHOOL of ENGINEERING

Department of Chemical and Biological Engineering

2017 Fall Seminar Series

August 23, 2017 • Safety Training • Fernando Garzon • Professor • Chemical and Biological Engineering • University of New Mexico

September 6, 2017 • Preparation of High Performance MEAs for Low Temperature Fuel Cells • Hasuck Kim • Seoul National University

September 13, 2017 • FexNi1-xOy Nanocatalysts for Alkaline Electrocatalysis and Reactive Water Treatment• Lauren Greenlee • Assistant Professor • Department of Chemical Engineering • University of Arkansas

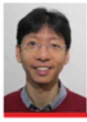
September 20, 2017 • Nanoscale Pattern Formation by (Directed) Self-Assembly: Science, Schema, and Functionality • Jerry Floro • Professor • Department of Material Science & Engineering • University of Virginia

September 27, 2017 • Classical and quantum mechanical calculations of adsorption/desorption and diffusion on surfaces • Hannes Jonsson • Professor • Department of Physical Chemistry • University of Iceland

October 4, 2017 • Flow Cytomety - Four Short Stories • James Jett • Laboratory Fellow • Los Alamos National Laboratory

October 11, 2017 • Designing and Probing Photovoltaic Materials • Jason Baxter • Associate Professor • Chemical & Biological Engineering • Drexel University

October 18, 2017 • On the Reaction Mechanism and the Nature of the Active Site for Standard Selective Catalytic Reduction of NOx on Cu/SSZ-13 Zeolites • Fabio Ribeiro • R. Norris and Eleanor Shreve Professor of Chemical Engineering • Purdue University



November 8, 2017 • Surpassing the Conventional Limit of Response to Heat Radiation by Nanophotonic Structures • Sang Eon Han • Assistant Professor • Chemical and Biological Engineering • University of New Mexico

November 15, 2017 • Soft Materials Engineering in Flatland: 2D Colloid Crystals, and Polymer Lung Surfactants • You-Yeon Won • Professor • Department of Chemical Engineering • Purdue University

November 29, 2017 • Enzymatic and Hybrid Electrocatalysis for Energy Conversion and Electrosynthesis Applications • Shelley Minteer • Professor • Materials Science and Engineering • Chemistry • University of Utah

December 6, 2017 • Li-air batteries: O_2 electrochemistry in Li ion-bearing nonaqueous electrolytes • Bryan D. McCloskey • Assistant Professor • Chemical and Biomolecular Engineering • University of California, Berkeley

CHEMICAL & BIOLOGICAL ENGINEERING

2018 Spring Seminar Series

https://cbe.unm.edu/events/index.html

January 24, 2018 • Reading Analytics When Using an Interactive Textbook • Matthew W. Liberatore • Professor • Chemical Engineering • University of Toledo

February 7, 2018 • Getting Thermodynamics and Heat Transfer Concepts to Stick with Stuents • Margot Vigeant • Rooke Professor • Chemical Engineering • Bucknell University

February 14, 2018 • Nanostructured Materials with Unique Catalytic Properties • Ryan M. Richards • Professor • Chemistry • Colorado School of Mines

March 7, 2018 • Quantitative Assessment of Channelling Mechanisms in Nanoscale Catalytic Architectures • Scott Calabrese Barton • Professor • Chemical Engineering & Material Science • Michigan State University

March 21, 2018 • Block Copolymer/Water/Oil Mesophases • Reza Foudazi • Assistant Professor • Chemical & Materials Engineering • New Mexico State University

March 28, 2018 • Smart Materials and MEMS Applications: from Neural Interfaces to PiezoMEMS • Nathan Jackson • Assistant Professor • New Mexico State University

April 11, 2018 • Computational Design and Prototyping of Organic Catalysts for Photopolymerization and CO2 Reduction • Charles Musgrave • Professor & Chair • Chemical & Biological Engineering • University of Colorado, Boulder

April 18, 2018 • Recent Developments in Computing the Properties of Atoms in Materials • Thomas Manz • Assistant Professor • Chemical & Materials Engineering • New Mexico State University

May 2, 2018 • Stanley S. Chou • Senior Member of Technical Staff • Sandia National Laboratories

As part of FACETS, we have a formal program of faculty development workshops. These are presented by faculty who have done research on education, or have developed innovative pedagogical approaches to teaching. The goal of these workshops is to expose faculty in the chemical & Biological engineering (and more broadly at UNM) to new pedagogical approaches to teaching and to prepare them to engage in the changes being implemented in the department to transform education in the chemical engineering department. The workshops last 2 hours on campus, with the rest of the day devoted to one-on-one meetings with the visitor and group discussions. The mini workshops are done with experts elsewhere over Skype or Zoom, typically for 1 hour.

In recent years, we held the following faculty development workshops featuring expert educators:

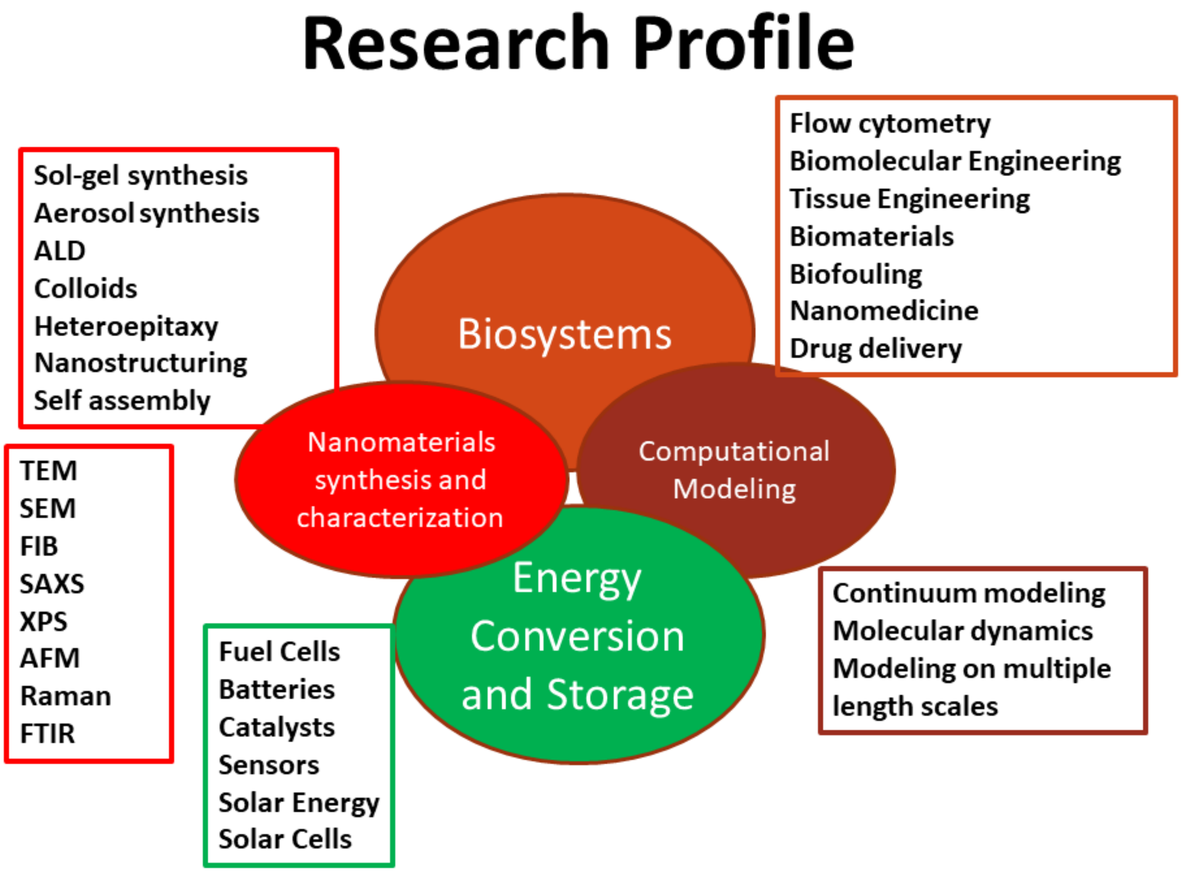
Nov. 2015	Nadia Kellam and Jennifer Bekki, ASU Polytechnic	Additive Innovation
Nov. 2015	Eva Sorensen, University College, London	Towards a scenario- and problem-based chemical engineering curriculum
April 2016	Rick West, BYU	Digital Badging
May 2016	Alex Mejia, UT San Angelo	Funds of Knowledge
Oct 2016	H. Scott Fogler, Michigan	Teaching Creative Problem Solving
Dec 2016	Rick West, BYU	Open Badges
March 2017	Nikolai Kalugin, New Mexico Inst. Of Mining & Technology	Concept Tests for Proficiency Assessment
March 2017	John Falconer, CU Boulder	Active Learning in Chemical Engineering
May 2017	Milo Koretsky, Oregon State University	Conceptual Understanding and Meaningful Consequential Learning
July 2017	Charles Paine, English Department, UNM	Writing to Learn and Learning to Write
January 2018	Aeron Haynie, UNM CTL	Peer Observations
January 2018	Marina Miletic, UNM	How to improve teamwork and assess it
January 2018	Matt Liberatore, Univ. of Toledo	Teaching Large Classes
February 2018	Margot Vigeant, Bucknell University	Problem Based Learning
April 2018	Irene Vasquez & Ricardo Griego	Modeling Success for Underrepresented Students in STEM

There is also institutional support for professional development in the area of teaching at UNM. For example, the Center for Teaching and Learning (CTL) offers both individual and departmental consultations on teaching effectiveness. CTL also offers collaborative peer observations of teaching as well as numerous workshops on diverse aspects of teaching.

5D. Faculty Research and Creative Works

Discuss and provide evidence of the research/creative work and efforts of the faculty within the unit at the undergraduate and graduate level. Explain the adequacy and/or significance of the research/creative work and efforts in supporting the quality of the unit and/or the program(s).

The department research can be summarized in the image below which shows the major research areas and tools used by our faculty. More details can be found on our website.



During the calendar year 2017, total research expenditures for CBE faculty amounted to \$5,051,423 which translates to \$404,114 per FTE faculty member. The faculty published 76 refereed journal articles and 26 conference proceedings. A total of 33 patents were issued to our faculty last year, bringing the total number of patents to >100. Our faculty have created a total of 9 start-up companies. A measure of the impact of our faculty research is the *h-index* which ranges from 9 to 91 with a total of 124,565 citations. The composite *h-index* is 123, ie the number of publications with citations of 123 or more for our faculty as a whole. Another measure of the creative works of our faculty is to have their research featured on the cover of a journal. The next page shows a few of the cover pages of journals where our faculty research was prominently featured.

5E. Faculty Involvement in Student Retention and Academic Success

Explain and provide evidence of the efforts and strategies by the unit to involve faculty in student retention and ensure students' academic success at the undergraduate and graduate level (i.e., advising efforts, student engagement activities, etc.)

As described previously, degree majors are advised by both the staff and faculty. Freshmen and sophomores are seen by the Director of Undergraduate programs. After they are admitted into the department and have selected a concentration, they are assigned a faculty advisor who remains their advisor for the rest of their undergraduate career. During the advisement meeting, the student and advisor discuss the student's academic history, their plans for subsequent semesters, their outside work load, research, internships, etc., and other issues that impact the student's progress through the program. The advisement meeting provides a good opportunity for the faculty member to get to know the students and for the student to discuss academic and career options with a faculty member.

Graduate students choose their own faculty advisor. Advisement is mainly done through direct interaction with the faculty advisor, although the staff advisors assist with processing the all of the paperwork involved and record keeping for graduate students. Students are also encouraged to talk to the Director of Graduate Programs about their academic progress.

5F. Faculty Experience

Provide an abbreviated vita (two pages or less) or summary of the educational background and professional experiences of each faculty member. (If the unit has this information posted on-line, then provide links to the information.)

Faculty CVs, biographical data and google scholar links are posted on the department webpage at https://cbe.unm.edu/faculty-staff/index.html

5G. Faculty Strategic Planning

Discuss the unit's strategic planning efforts going forward to improve, support, and/or optimize its faculty.

The department provides opportunities for faculty to continually improve and refine their teaching skills through professional development opportunities. A healthy start-up package ensures that faculty get off to a good start and have funds to visit program officers, and collaborative visits and to establish their presence in national societies of their choice. The department ensures that teaching loads are commensurate with rank and research group size, so that faculty can continue to progress in their careers. There is continuous discussion within the faculty and centers about large group proposals. Also, we try to encourage peer review of proposals, especially when proposals are rejected, so that the faculty member can be encouraged to be more effective at winning grants. The faculty mentor and the chair play a critical role in this regard.

Criterion 6. Resources and Planning

The unit has sufficient resources and institutional support to carry out its mission and achieve its goals.

6A. Resource Allocation and Planning

Explain how the unit engages in resource allocation and planning that are effective in helping it carry out its mission and achieve its goals. If the unit has an advisory board, describe the membership and charge and discuss how the board's recommendations are incorporated into decision-making. Include a discussion of how faculty research is used to generate revenue or apply for grants. How is the revenue gained from research being distributed to support the unit and its degree/certificate programs?

Resource allocation and planning is conducted primarily by the Department Chair, and in consultation with Associate Chairs, Center Directors, Directors of Graduate and Undergraduate programs, relevant committees and key staff members. The department has an active Advisory Council. As of Fall 2017 the Council consists of 13 members representing government labs, industry and academia. Some of the members are also alumni of our department. The Advisory Council makes programmatic recommendations and provide advice as well as acting as our community advocate, so the Council is rarely involved in resource allocation and planning issues.

As described in other sections, the CBE Department is active in research. The revenue generated by faculty research is directly used for the research endeavor itself, namely graduate research assistant support, post-docs, faculty summer salaries, equipment, professional travel, and other necessary expenditures for conducting the research. A portion of the indirect costs (overhead) generated by external funding is returned to the department. The percentage of the generated indirect costs returning to the department varies from 0 to about 15% in recent quarters since it follows the top slice model. This is the same model used by the VPR, wherein all fixed costs and those important to the administration are covered first, then if money is left over, it trickles down to the department. The PI gets a share of the F&A return in quarters when funds are received by the department. As stated elsewhere, most of the research in CBE is done in centers, so none of that makes it to the department.

6B. Budget and Funding

Provide an analysis of information regarding the unit's budget including support received from the institution and external funding sources. Include a discussion of how alternative avenues (i.e., external and grant funding, summer bridge programs, course fees, differential tuition, etc.) have been explored to generate additional revenue to maintain the quality of the unit's degree/certificate program(s) and courses.

The department receives about $1.72M direct Instruction & General (I&G) funds annually. There have been cuts and mid-year pull-backs over the past two years. The I&G funding is inadequate to cover all salaries (faculty, staff, TA/graders, and adjunct faculty). Some TA/grader, adjunct, faculty and staff support comes from undergraduate and graduate differential tuitions (totaling approximately $108K per year flowing back to the department). The department also receives curriculum fees of about $55K per year. This is our main source for upgrading and maintaining teaching laboratories, as well as for computer hardware and software purchases.

External research/educational expenditures by our faculty amounted to $5,051,423 in AY 2017. As described in Sec. 6A these funds are used for supporting graduate students, post-docs, faculty summer salaries, equipment, supplies, travel, and miscellaneous research expenses.

6C. Staff Composition and Responsibilities

Discuss the composition of the staff assigned to the unit and their responsibilities (including titles and FTE). Include an overall analysis of the sufficiency and effectiveness of the staff in supporting the mission and vision of the unit.

The departmental staff consists of 7 members (6 - 1.0 FTE and 1 - .25 on-call working retiree). The positions and their main responsibilities are:

- Department Administrator – supervision of staff; administrative processes of hiring, faculty contracts, course scheduling, department office day-to-day operations, etc…
- Administrative Assistant – provide excellent front office customer service and to assist the department chair, faculty, students and staff (shared with NE)
- Coordinator, Program Advisement – undergraduate and graduate advising
- Senior Academic Advisor – undergraduate and graduate advising (shared with NE)
- Accountant – accounting, grant proposals, and other fiscal related matters (shared with NE)
- Graphic Designer – web page, promotional materials, seminars, and special events (.25) (shared with NE)
- Research Engineer – coordinates the undergraduate lab and lab safety for all laboratories

All positions are currently filled. We currently share four staff members with the Nuclear Engineering Department.

6D. Library Resources

Discuss and provide evidence of the adequacy of the library resources that are available and/or utilized to support the unit's academic and research initiatives.

The University Library system at UNM is comprised of four libraries: Centennial Science and Engineering Library, Fine Arts and Design Library, Parish Memorial Library for Business and Economics, and Zimmerman Library. The University Library system is a member of the Association of Research Libraries, an organization of the largest research libraries in North America. We are also members of the Hathi Trust Digital Library, Center for Research Libraries, Greater Western Library Alliance, New Mexico Consortium of Academic Libraries and other consortia. The University Library also serves as the regional depository of federal government publications for the state of New Mexico.

The University Library system has an extensive collection that is adequate to support student and faculty needs. Books, magazines, newspapers, and scholarly journals make up a substantial portion of the collections, but many other formats of information are included. Microforms, maps, DVDs, and posters are vital parts of the research and instructional process at UNM. Many parts of the collections are now available beyond the walls of any library in online digital formats. The acquisition of these materials accelerates with each year, now surpassing print and other tangible formats in terms of the number of titles available. A wide selection of e-journals, e-books, digital music, and streaming video are available to all UNM students, faculty, and staff. The University Library system also leads the nation in developing processes to curate, store, and preserve research data created by UNM faculty and students and make it available to the world.

UNM collaborates with many libraries in the U.S. to expand the availability of information. Cooperative initiatives include interlibrary loan, cooperative purchase of electronic resources, and shared preservation and digitization projects.

6E. Resources and Planning Strategic Planning

Discuss the unit's strategic planning efforts going forward to improve, strengthen, and/or sustain the sufficient allocation of resources and institutional support towards its degree/certificate program(s), faculty, and staff.

As described above, the primary source of funding for the department comes from the university I&G allocations. Those are based historically, and are not on specific performance, ie credit hour production, etc. But enrollments and tuition influence the overall university budget which trickles down to the department. Funding from the state has been constrained in recent years by the low price of oil and gas, which has meant budget cuts and mid-year rescissions. The Dean has made clear that increasing enrollments is essential for enhancing budgets at the departmental level, and we are moving forward with the Dean's office to help in this regard.

A bright spot was the recent establishment of differential tuition for both the undergraduate ($15/cr hour) and graduate students ($100/cr hour). This extra revenue (after retaining 20% for financial aid) comes back to the department and is the only component of the budget that scales with enrollment. Part of the undergraduate differential tuition is now reserved for advising staff, hence the amount that trickles down to the department will be reduced in future years, but it is essential to help pay for peer learning facilitators, undergraduate and graduate TA. All of these payments are on an hourly basis, since the department does not have any TA lines in our budget. There is also a curriculum fee levied on all undergraduate and graduate courses, which helps create a fund for equipment renovation, software license fees (such as Aspen) and even to pay for other curricular enhancements.

At the departmental level, we have a very low level of funding through the UNM foundation, in terms of endowments. This is now a primary focus, especially with the addition of new development staff based in the School of Engineering. Our goal is to increase our visibility with our alumni and attract funds for projects in the department, and for expenses, such as sending undergraduate students to conferences, etc.

Criterion 7. Facilities

The facilities associated with the unit are adequate to support student learning as well as scholarly and research activities.

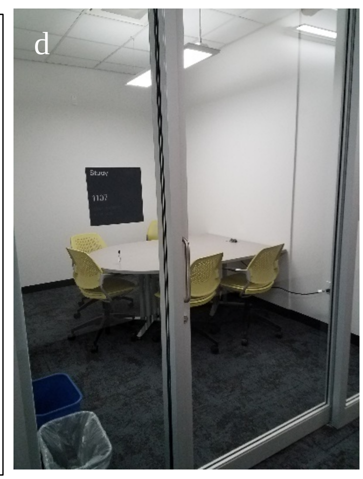
7A. Unit's Allocated Facilities

Provide an updated listing from UNM's current space management system of the spaces assigned to your unit. Discuss the evolution and sufficiency of the amount of space your unit has been assigned by category (e.g., offices, support spaces, conference rooms, classrooms, class laboratories, computing facilities, research space, specialized spaces, etc.). (1) Include an analysis of the square footage-to-student ratio and square footage-to-faculty ratio. (2) Explain if the unit has any spaces outside or in other locations that are not documented in UNM's space management system.

The Chemical & Biological Engineering has offices and laboratories in two buildings on main campus and two buildings on south campus and our faculty are involved in three research centers, the Center for Biomedical Engineering (CBME) the Center for Microengineered Materials (CMEM) housed in the Advanced Materials Laboratory on South Campus. Some faculty also have labs in the Center for High Technology Materials (CHTM) on South Campus and several faculty collaborate with the Health Sciences Center on North Campus and utilize laboratory facilities in the UNM Cancer Center and elsewhere. Please see Appendix E for the individual floor plans in each of these buildings.

Farris Engineering Center Building # 119	Area (sq. ft.)	
Administrative Space (includes conference rooms)	2,677	
Faculty Offices	1,428	
Student / Collaborative Space (includes computer lab, student office space)	4,555	

With the completion of the remodeled **Farris Engineering Center** in January 2018, we now have excellent office space with a nice sitting area for students who are waiting to see advisors, and a small conference room for discussions as well as spaces for undergraduate student use on the 1st floor as shown in the images on the next page. The new student lounge is equipped with whiteboard walls suitable for writing on, a large screen and projector for holding meetings, for example with recruiters, or for the student chapters. In addition, we have two dedicated student conference rooms with 4K 65 inch LCD monitors. There is also one study room for discussions and a similar one for faculty-student meetings. There is a nice kitchen, a break area and lockers for the AICHE student chapter use.



Undergraduate student spaces on the 1st floor of the remodeled Farris Engineering Center

a) Student lounge

b) conference room

c) conference room

d) study room

This is a beautiful new building with electrochromic windows (ie no window shades) creating a very open feeling, and is already having a very positive impact on our students who use these spaces for studying, for practicing their presentations and for design project discussions, etc. On the 2nd floor students also have a 800 sq. ft computer lab with a 75” 4K monitor for presentations, 12 computer work stations and space for students to use laptops. The workstations are equipped with the software students need, such as ASPEN, but this can also be installed on student owned laptops. A large conference room is available for department use on the 2nd floor with a 84” 4K LCD monitor, two PTZ cameras (for Skype, Zoom, etc..), AirMedia system (to allow presentation over WiFi), and a state of the art sound system (microphones and speakers).

The undergraduate Laboratories in the Department of Chemical & Biological Engineering are located in the **Centennial Engineering Center** (CEC) along with the Center for Biomedical Engineering and the Nanomedicine Laboratory.

Centennial Engineering Center Building # 112	Area (sq. ft.)
CBE Undergraduate Laboratory (1st flr)	2,750
Laboratory Space (basement)	6,419
Center for Biomedical Engineering (CBME) 2nd floor	
Administration	1,752
CBE Faculty Offices	1,130
Laboratory Space	11,721
Nanomedicine Laboratory (3rd floor)	
Laboratory Space	3,224
Office space	1,332

Some of the CBE faculty have offices in the Advanced Materials Laboratory on South Campus where the Center for Microengineered Materials (CMEM) is located. The equipment available in the research laboratories and the shared equipment accessed by our faculty is listed on our website.

Advanced Materials Laboratory (AML) Building # 337	Area (sq. ft.)
CBE Faculty Offices	629
Center for Micro-Engineered Materials (CMEM)	
Administration/offices	3,796
Classroom	741
Laboratory Space	6,797

7B. Ability to Meet Academic Requirements with Facilities

Discuss the unit's ability to meet academic requirements with the current facilities. Explain the unit's unmet facility needs. If applicable, describe the facility issues that were raised or noted in the last APR. What were the outcomes, if any?

The undergraduate laboratories are in good condition, but getting crowded due to our increasing enrollments. Students in the Junior and Senior lab courses are divided into sections so they use the space on different days. The lab space for the undergraduate lab courses is considered adequate at this time but may become a problem in the future with growing enrollment and as we add new experiments. This will require rethinking how we organize the lab classes since they are intensive on faculty time, as currently organized.

Undergraduate Laboratory

7C. Space Management Planning Efforts

Discuss any recent space management planning efforts of the unit relative to the teaching, scholarly, and research activities of the faculty associated with the unit. Include an explanation of any proposed new initiatives that will require new or renovated facilities.

The department's research laboratories are distributed over three buildings, the CEC with labs in the basement, on the 2nd floor and the 3rd floor. The CMEM is housed in the AML and some faculty are located in CHTM. A major concern is that facilities on south campus are charged rent. This has used up some of the precious F&A resources available to the centers. Also, the move of CMEM labs from Farris Engr (before remodeling) to the AML has necessitated major expenses for remodeling the facilities in the AML.

7D. Unit Facility Goals and Strategic Planning

Discuss the unit's facility goals and priorities for the future and the timelines associated with them. Include a description of short-term goals (1 – 3 years) (e.g. renovation requests) and long-term goals (4 – 10 years) (e.g. new facilities) and how they align with UNM's strategic planning initiatives. Explain the funding strategies associated with any of the unit's facility goals.

At this time we do not have any plans for creating any new spaces, since we just moved into new labs and offices.

Criterion 8. Peer Comparisons

The degree/certificate program(s) within the unit are of sufficient quality compared to relevant peers. (If applicable, differentiate for each undergraduate and graduate degree and certificate program offered by the unit.)

8A. Unit's Distinguishing Characteristics

Discuss the distinguishing characteristics of the degree/certificate program(s) within the unit after completing the Peer Comparison Template provided as Appendix F (i.e., examination of student enrollment rates, degrees/certificates offered, number of tenure-track faculty, research/creative work of faculty, etc.). Include an analysis of the unit's degree/certificate program(s) based on comparisons with similar or parallel programs: (1) at any of UNM's 22 peer institutions; (2) at other peer institutions identified by the unit; and (3) designated by relevant regional, national, and/or professional agencies.

Appendix F lists the comparison of our department with other Chemical Engineering departments at UNM's peer institutions. All three research universities in New Mexico are included but UNM is the only one that is ranked (#72) in the U.S. News and World Report survey. We listed departments according to size of faculty, which is relevant in the rankings, but another strong correlator is the size of the graduate program, namely the number of PhD students. The schools in the top 20 all have PhD enrollments in excess of 100. If we compare the rankings of similar sized departments, with faculty size of 15±1, we find there are a few departments that are ranked higher than UNM's CBE. These have similar sized graduate programs. It will take sustained effort to move up to the top 50, since these rankings are reputational and hence there is a lag time associated with peer perceptions. The department faculty are aware of this and moving forward, as described below.

8B. Strategic Planning in Relation to Peer Institutions

Discuss the unit's strategic planning efforts going forward to improve, strengthen, and/or sustain the quality of its degree/certificate program(s) in relation to peer institutions.

UNM's chemical engineering program has moved up in rankings from unranked (RNP) in 2014 to #72 in the rankings published in 2018. The US News and World Report rankings are reputational, based on a survey of department heads. Our faculty discussed the rankings during our advisory board meeting in fall 2014. It was clear that the department needed to work on enhancing our reputation and image, because our metrics such as citation impact, publications and size our graduate program should help us get better ranked. We have since worked on many aspects, an improved website, newsletters emailed to all department heads, sending out lists of our seminar speakers, inviting department heads for seminars and making effective use of our invited seminars at other departments to spread the message. Since our faculty and graduate students belong to different centers and graduate programs, which have their own identities, we have worked hard to bring everyone together, a common seminar series and common recruiting for graduate students. We plan to continue these efforts, with a brochure planned for the summer, and more frequent newsletters and mailings to department heads and alumni.

Appendix A

APR report from April 2009

Report of the Academic Program Review Team for the Department of Chemical and Nuclear Engineering at the University of New Mexico

Summary

The Academic Program Review (APR) team was favorably impressed with the accomplishments of the Department of Chemical and Nuclear Engineering given their relatively limited resources. The department has a number of excellent faculty members who have established well-funded, productive research programs. Each faculty member publishes on average more than 4 papers per year and their work is highly cited. A distinguishing feature of this department is the extremely productive research centers that have been established by faculty in the department. The centers have helped create a first rate research environment with excellent facilities and equipment. Another distinguishing feature of the department is the emphasis and impressive results in achieving diversity in their program.

While the APR team was very impressed with the Department, several challenges were identified during the visit that the department should address to improve its undergraduate and graduate programs. First, a balance must be established between enabling the centers to thrive, and simultaneously, maintaining a vibrant department. The department budget, aside from salaries, has shrunk dramatically in the last few years to the point where it is difficult to see how the department can function, much less provide a quality education. This is due to a number of policy decisions, including the F&A split between centers and the department. The F&A apportionment is critical and must be addressed. Although the centers are an integral part of the department, they have created a culture where "Let's Make a Deal" appears to have become the operational standard in the departmental and university negotiations. This culture has led to an appearance of separation between the elite faculty and center directors and the other faculty in the department. Further, this has created the potential for scenarios where individuals may have a tendency to consider themselves above the organizational structure of the department.

The department needs to devote significantly more effort and resources to graduate recruiting. The departmental advisory board has not met since 2004 and we strongly suggest that this board meet on a more regular basis for ABET accreditation and for facilitating ongoing improvements in the department. The department currently does not have a strategic plan and the faculty needs to develop one that has a clear focus, goals, set of priorities, and establishes a common "branding" for the department. The process of establishing a strategic plan, possibly through a long overdue departmental retreat, will also help to create more cohesion within the department and will assure that all faculty members are "on board" with a commonly accepted plan.

A consistent faculty-mentoring program across the entire department is lacking. A department mentoring program including both direct and indirect mentoring, with accountability, should be instituted.

We will now address the specific questions that the APR team was requested to address (note: for some questions, separate responses will be given for the chemical and nuclear engineering programs).

Question 1a. How does the undergraduate program for chemical and nuclear engineering compare with other well-respected programs across the country?

Chemical Engineering Response: The committee had a very favorable impression of the undergraduate students. Obviously, a lot of thought has gone into creating a broad educational experience for the undergraduate chemical engineers. Almost all the seniors came to the meeting with the APR team. The students appeared to be very intelligent and enthusiastic and we were impressed with how many undergraduates are involved in research (more than half of the seniors). Six or seven students went to the national AIChE meeting and presented posters on their research. In addition, half of the seniors were continuing on to graduate school, which is significantly higher than in most chemical engineering departments. The students indicated they were satisfied with the education they had received. The diversity of the students was impressive and admirable. There were a large number of women in the program, a significant number of foreign-born undergraduate students and a significant number of under-represented minorities. We note that the tuition is quite low and that a quality undergraduate education is provided at a bargain.

Specific Comments:

1. The senior seminar is an excellent idea and presenting ethics in the seminar is commendable. However, some students complained that others copied solutions for homework assignments from solution manuals and that some of the faculty were aware of this and did nothing about it. Given the seminar content, this certainly sends mixed messages about ethics to the students and this situation should be addressed.
2. Some students complained that grading was not strict enough and that grades were curved so that everyone did well, even if they did not perform well on exams. This clearly bothered students who had worked hard to master the material. Moreover, grade inflation appears to be an issue in the chemical engineering program. The average GPA of juniors and seniors is 3.4/4.0, with only one student having below 3.0. It also appears that some courses could be taught more rigorously. This issue raises concerns about how well the students are being prepared for graduate school or industry.
3. In some courses, faculty missed a significant number of classes. In one course, the instructor was gone for half the classes during the semester. Either a TA taught the course or the class was canceled. Clearly, this affects the quality of the educational experience. Expectations of faculty teaching responsibilities should be made clear.
4. Some of the high-performing faculty in research do not teach undergraduate classes so the students do not get to benefit from their expertise and experience.
5. Even though many students are going to graduate school, the students could be better informed about what the benefits of graduate school are. For example, while many of the juniors we met with were interested in graduate school, they seemed to believe that a master's degree in Chemical Engineering improved career opportunities more than it actually does.
6. The chemical engineering program offers five concentration areas, but each of these only requires two courses to satisfy the area requirement. Further, at present it appears that most of the students select the bio option. The APR team recommends that the curriculum should be modified so that each concentration area has more specialized courses or that the number of concentration areas be reduced.

7. Some additional smaller issues were raised such as not getting homework back on time for one course and a lack of communication between faculty teaching lectures and faculty teaching labs on the same topics. There appears to have been some inconsistency with different professors teaching the labs each year concerning different assumptions about students' background knowledge for the labs. The students were not impressed with the technical writing course, and perhaps more writing emphasis needs to be integrated into the other classes. Finally, the students could use more help with finding jobs, at present it does not appear that the faculty are actively helping with this.
8. The undergraduate program is smaller than most programs at other universities as is the number of students per faculty member. It appears that this number is relatively constant. However, the APR team does not view this as a problem, in that it enables the faculty to continue to develop their research programs and the undergraduates to have more undergraduate research experience.

Nuclear Engineering Response: The program must take leadership responsibility and play a significant role on the national stage so that it becomes well known for their visible leadership and research successes. It is suggested that a faculty representative become actively involved in the Nuclear Engineering Department Heads Organization (NEDHO) and strive for a visible leadership role, including taking a turn serving as Chair of NEDHO. While USN&WR rankings are nothing more than a "beauty contest" (where deans and department heads/chairs vote based upon how well they know the faculty, undergraduates, and research programs at each of the country's nuclear engineering programs), if they know more about UNM's program, they might be favorably inclined to vote for a higher position. In addition, there is a clear and direct correlation between faculty size and ranking in nuclear engineering – the larger the faculty size, the higher the ranking. More faculty means more research, more graduate students, more postdocs, more publications, more students graduating, and greater visibility resulting in higher rankings.

Specific comments:

1. The juniors were unanimous in their praise for the professors of the NE program. They feel that the professors care for them, they are generally very good lecturers, have an open door policy, and are well rounded in their knowledge of the nuclear industry.
2. The seniors indicated that they felt unprepared for the senior level Monte Carlo course in the area of probability theory. In addition, the course instructor indicated his disappointment with the knowledge and motivation of the students taking his course. A comprise might be to replace this course with one designed to provide hands on experience in developing input for and implementing the industry standard code, MCNP, which seems more appropriate at this level.
3. Students feel that when they provide feedback to faculty that they are honestly listened to and their input is considered when improvements to the program are made.
4. The ChNE 101 course is especially effective as an introductory course in nuclear engineering since it includes a simple experiment and exposure to faculty research activities. This introductory freshman course is viewed by the students as a very positive experience that initially attracted them to the nuclear engineering major.

Question 1b. How does the graduate program for chemical engineering and nuclear engineering compare with other well-respected programs across the country?

Chemical Engineering Response: Most of the faculty members appear to be active in research. Although some faculty are extremely productive (three faculty members have h-indices above 30) and are well known, the graduate program is not considered a top department. The graduate student enrollment is much smaller than other departments of comparable size, and the department has more of an emphasis on master's students as compared to other Chemical Engineering Departments. The number of PhD students per faculty is low, and this is a problem since this is an important criterion used to compare graduate programs. Moreover, many of the graduate students were undergraduate students at UNM. A significant fraction of the research is carried out not by graduate students but by postdocs and research faculty. In addition, only six of the ChE faculty members have degrees in chemical engineering and it is not clear how active the faculty are in the AIChE (the chemical engineering professional society). This is important since visibility in the AIChE affects department standing, graduate recruiting, and faculty recruiting.

Some of the graduate courses in the department could be more rigorous with grading that is reflective of students' performance. At present, the average GPA of master's students (the only data available) is 3.84/4.0. The faculty appear to want to not lose students from the program, and thus a significant question is raised about the quality of the students. This may be reflected in the concern by Sandia about hiring UNM students.

Nuclear Engineering Response: The research areas of the six research active faculty are well defined and for all but the recent hire, are well established, but seem not to overlap. All six nuclear engineering research active faculty members have a generally accepted teaching load while maintaining an active research program. Some consideration should be given to meshing the various programs of transport methods development, computational strategies in multiphysics and transport theory, space nuclear applications, nuclear instrumentation and plasma physics, to make a more cohesive departmental research footprint.

The department should have more interactions and participation with the New Mexico national laboratories. There is a need to innovate to find a creative way to make this happen. This could come in the form of making a UNM education more accessible to those at national laboratories. This would include allowing double counting undergraduate and graduate credits. In addition, support could come from the establishment of Endowed or Governor's chairs to grow the nuclear engineering program in conjunction with the laboratories missions.

Question 2. Are the undergraduate laboratory facilities and experiments adequate and competitive with other strong programs? Do you have suggestions for improvements in this regard?

Chemical Engineering Response: The undergraduate laboratory facilities and experiments are excellent and are certainly competitive with other ChE programs. The ChE undergraduates take 4 semesters of undergraduate labs, which appears to be an excellent educational experience. The interface between the labs and the courses is an innovative approach. The undergraduate laboratory has much more space than other ChE departments with two to three times as many students. Further, it has a staff person to help run the lab (note: this is unusual for programs with such a small number of students who take the lab). Some safety issues that should be addressed were observed during the walk-through. Finally, it would be useful to include new experiments that reflect the cutting-edge research in the department in the undergraduate lab experience.

Nuclear Engineering Response: Overall, the committee felt that the nuclear engineering laboratories and experiments were competitive and similar to those used in other nuclear engineering programs. The NE students gain valuable laboratory experience on a well-maintained AGN nuclear reactor including decay counting experiments designed by their most recent hire, Adam Hecht. It is clear that Dr. Bob Busch is a significant element of the NE teaching mission. His teaching of 6 NE courses per year and maintenance of the reactor laboratory enables the research faculty to perform their research without an excessive teaching load. His service should be recognized as necessary to departmental operation and the present and future accomplishments of the NE program. Since Bob is nearing retirement, some serious thought should be given to his replacement. Additionally, some students felt rushed in the detector laboratory and felt that they would have been better served if more time had been available to them to perform their laboratory experiments.

Question 3. What strategies might help use to improve the success of our graduate student recruiting?

Chemical and Nuclear Engineering Response: The low number of PhD students is one of the most pressing problems in the department. The graduate recruiting and acceptance approach needs to be fundamentally changed if the graduate recruiting is to improve. The present policy of making offers only to students to work with specific faculty on an individual basis (based on available research funding) is untenable if the graduate program is to grow. The department must be able to accept graduate students as early as possible without the students committing to work on a specific project. The number accepted should be based on how many projects are available, and allowance made for many of the students not accepting the offers. The department may also want to re-visit an earlier policy where graduate students were not assigned to a research project until after the fall semester started. The department, college, and university should consider fund raising for graduate fellowships or identifying other resources to support graduate students in the first part of their (uncommitted) graduate study. Improved graduate student recruiting is critical for new faculty to be successful.

Better visibility is needed to increase the number of graduate student applicants. The department should also strongly consider bringing in potential students for visits. The excellent facilities and the nice location should help in this regard. A decreased emphasis on the masters program should also occur as the number of PhD students grows. The department might want to consider recruiting undergraduates whose majors are not in chemical or nuclear engineering. The graduate student stipend is low compared to other engineering programs, and the department should consider raising it.

Questions 4: Do we have enough faculty to compete effectively for funding opportunities in the various research focus areas that we have targeted. If adding faculty were possible, what research areas would you recommend strengthening?

Chemical and Nuclear Engineering Response: The total number of engineering faculty has stayed the same for 20 years. While stagnant faculty numbers makes it difficult to advance, the department's approach of using centers, research professors, and affiliated researchers from Sandia National Labs has created an environment where it can compete effectively for funding in chemical engineering, as indicated by the $6 million expenditures last year. The next hire in the department should probably be in the nuclear engineering program.

New hires in nuclear engineering need to be strategically chosen based upon the distinct focus areas for the program. One possibility would be to hire in the chemical-nuclear area with an emphasis in nuclear non-proliferation. More faculty in nuclear engineering would make it easier for the department to be recognized in the national rankings of nuclear engineering programs. With this in mind, the hiring of Adam Hecht into Nuclear Engineering was a visionary hire in light of the choice of a non-proliferation research focus. His knowledge of instrumentation will enhance this research focus and every effort to encourage his participation should be made.

Finally, it is important that new hires be adequately and appropriately mentored, both formally, and informally, to ensure their success – in a small program, it is critical that junior faculty be carefully recruited to fit within the agreed-upon focus areas of the program, and then be completely supported by all faculty and staff, but especially by the department chair, program lead, senior faculty, etc. This is especially important, since there was evidence that was brought up (concerning ChE) during the APR visit that some actions by senior faculty may have undermined the success of some junior faculty.

Question 5: What are best or suggested practices for effective coordination of departmental administration and the administration of affiliated centers in order to maximize the positive impacts of these centers? Specific issues that are of interest include financial coordination and cooperation, balancing of faculty workload expectation and duties, and reporting/credit for productivity.

Chemical and Nuclear Engineering Response: The department budget, aside from salaries, has shrunk dramatically in the last few years to the point where it is difficult to see how the department can adequately function, much less provide a quality education. Clearly, something has to be done to enable the department to continue to function productively. This problem should be addressed at the university, school, and department levels. The centers contribute tremendously to the department by creating opportunities for first-rate interdisciplinary research, outstanding equipment, and an infrastructure for competing at the national/international levels. However, this presents some unique challenges within the department. The challenge is how to maintain the excellence of the centers while assuring the vibrancy of the chemical and nuclear engineering programs. Some suggestions include: F & A policy modification so that the indirect cost recovery of the centers are more equally shared with the department, well-defined release time and workload policies, strategic decisions about how to spend limited resources, clear rules on when proposals are to be submitted through the centers, and well defined policies and procedures related to the identification, selection, administration, and continuance of the centers. The lack of clear guidelines related to the relationship between the centers and the department should be addressed and proper policies be instituted to assure the vibrancy of both the department and the centers.

Question 6: What are the suggested practices for effective administration and coordination of interdisciplinary degree programs that are largely supported or led by department faculty? Specific issues that are of interest include impact on enrollments in department programs, student credit hour generation, and faculty workload credit.

Chemical and Nuclear Engineering Response: While the creation of interdisciplinary degree programs are highly desirable, careful consideration should be given to the impact of these programs on the traditional educational programs in the department. In chemical engineering, half the faculty do not have chemical engineering degrees, which limits who is available to teach the chemical engineering core courses. This problem is exacerbated by the existence of these additional programs. A more formal policy on workload credit is recommended. A strategic plan where the roles of the interdisciplinary degree programs and faculty hiring are discussed in the context of the overall mission of the department is also clearly needed.

The medical physics program does not seem to add much to the national credibility and recognition for the nuclear engineering program – the most important factor in increasing the recognition of the program by its peer institutions, department heads, and faculty. Is this really an important core mission and direction for the department and nuclear engineering program? The question of its continuation should be addressed.

Question 7: Do you see opportunities that either of the programs in the department is not recognizing or capitalizing on?

Chemical and Nuclear Engineering Response: The union of chemical and nuclear engineering is unique in the US. For this reason, the ChENE Department should take full advantage or their unique position. In this regard, the faculty should find ways to use the research strengths of the department synergistically. This would point to developing a research program in fuel cycles. In addition, there is significant potential for increasing the interactions with the national laboratories in New Mexico if such a program were established. For this to occur, however, encouragement through additional resource allocation needs to be made by the upper state administration, university, and the national labs.

Additional Comments from the APR team

Mentoring: A consistent mentoring program across the entire department is lacking. The, expectations are not clear and there is minimal feedback. Lab space was not ready for some of the new faculty and start up funds were not available for retrofitting the labs. Faculty were not given guidance about writing mid promotion packages. Some of the junior faculty have not received adequate mentoring, and some of the senior faculty have not treated junior faculty with the respect they deserve. On the other hand, other junior faculty felt that they had received adequate mentoring. A department mentoring program including both direct and indirect mentoring, with accountability, should be instituted with the realization that the assistant professors are the department's future. This should be done or there is a danger of the department losing its junior faculty. Yearly written reviews of all faculty members should be done.

Effective use of resources: As described above, one necessity is for the university and the college to resolve the distribution of funds between the department and the centers. In addition, it should be determined if it is possible to re-allocate resources within the department. In particular, it appears the department could be more efficient. Some suggestions/comments in this regard: The undergraduate classes are small and some ChE faculty appear to teach little if at all. In addition, the department has two lecturers who only teach. Is it possible to not fill one of those positions when it becomes vacant and use the salary for graduate student recruiting and department expenses? Is it possible to combine some ChE and NE courses? Does the department need to teach a materials science course or is there one in mechanical engineering? Although the 4 UG labs are a good educational experience, what are the priorities of the department? Could 3 lab courses be taught instead to free up faculty time? Is it possible to offer fewer courses for the new biomedical degree or to use some current courses? Teaching graduate courses to 8 students may be an inefficient use of resources.

ABET concerns: Retaining ABET accreditation for engineering programs is an important measure of the externally perceived quality of the programs. It is highly recommended that both programs pay particular attention to preparing for the Fall 2010 visit and place appropriate resources, faculty and staff time to achieve a successful outcome.

The Department claims to use its Advisory Council as an important assessment and evaluation tool; however, the last meeting of the Advisory Council was in 2004. Since the Advisory Council is included in the department's assessment process as shown in Figure 1 of the self-study it appears that the department is not regularly asking the Advisory Council to assess its programs. This is too long between opportunities to receive feedback from the Advisory Council. More regular use of the Council is an important signal to ABET that the programs take the ABET process of continuous improvement seriously. The review team recommends that the Department convenes the Advisory Council at least once, but preferably twice – once in Fall of 2009 and once in late Spring of 2010 - and possibly either right before or right after the ABET team visits campus.

The Program Educational Objectives (PEOs) for both programs appear to be closer to objectives for graduates to achieve at graduation than for objectives to be achieved and assessed by graduates a few years after graduation. The PEOs should be reviewed with this and other new/revised definitions by ABET-EAC, in mind. They should also be reviewed by each program's constituents prior to the ABET visit and self-study preparation.

Additional Suggestions

The department should produce a high quality brochure and a constantly updated web site.

The department should consider having a reception at the AIChE and ANS meetings.

The university should make an effort to create endowed chairs for the top faculty in the department.

The department should undergo its own fund-raising efforts.

A space committee should be established that would re-allocate space so that new faculty members have sufficient space to be successful.

An effort should be made to create endowed positions for graduate students to enable part of their first year to be covered by the university.

Graduate stipends should be increased.
TA lines from central administration should be provided to give the department more flexibility.
An awards committee should be established.
A formal workload for faculty should be established.
The department needs to have a well defined set of policies that are transparent and consistent.

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Appendix B

Departmental response to the APR report from 2009

Department of Chemical and Nuclear Engineering

Response to the Academic Program Review Report

Timothy L. Ward, Chair, Department of Chemical and Nuclear Engineering

The Department of Chemical and Nuclear Engineering (ChNE) underwent a visit with a program review team on April 27-29, 2009 as part of the periodic UNM Academic Program Review process. The department was quite open with the team about strengths and weaknesses, and their report was similarly open and frank. Though, I believe the committee may have made some inappropriate conclusions based on very limited data, their report for the most part provided a valuable outside perspective that the Department use to improve the quality of programs and operations. The Department has already taken action on many of the recommendations of the APR Review Team, and more will follow. Below is a point-by-point response to the APR report, concluding with an and Action Plan that addresses the most critical recommendations.

Summary Points

Department /Center Relationships

The Department is glad that the team recognized the crucial role that the Centers have played in creating the highly-productive research environment that ChNE enjoys. They also noted that we have outstanding and productive faculty. What they might not have fully appreciated is that the Centers have also played a crucial role in our ability to retain our most outstanding faculty. The team also recognized that the department's financial challenges have been exacerbated by the changes in F&A policies, and by the lack of clear institutional policies for splitting or sharing of returned F&A between home departments of faculty and Centers where they may choose to submit their grants. During Fall 2009, the ChNE Chair met with the Directors of all Centers affiliated with ChNE to discuss the financial situation and prognosis of the department, and possible ways for the Centers to help ensure financial sustainability of the department operations. All Center Directors are committed to supporting the department; however no standardized policies have been adopted yet. Ideally, from the department's perspective, clear policies should be implemented at the institutional level. However, in the absence of institutional policies to address this problem, the Department and affiliated Centers have identified several ways to jointly support the department, including partial Center support of department staff, Center contributions to department operational expenses that all share (such as copying and telephone service), and voluntary F&A splits on proposals. These are all band-aid measures – a fair policy at the institutional level would be a much more effective solution to the broad problem of strained department-center relations due to F&A return.

Graduate Recruiting

The department shares concerns about graduate recruiting for both chemical engineering and nuclear engineering. This topic was addressed by a break-out group at the Department retreat held on September 3, 2009. Several strategies were identified to improve graduate recruiting. These included earlier admissions, increasing stipends, exploring National Laboratory fellowships, continuation of recruiting postcards that were first sent out last year, and an improved web page. The department has a web page Committee that is working on improvements to our web page, as well as a strategy for regular updates. We have yet to act on a new stipend policy, but that is under consideration. The APR team also highlighted the need for the department to be able to bring in and support new graduate students without prior assignment to a particular research advisor or grant. This has been discussed by the faculty, and there is agreement about the desirability of such an approach, and recognition that this is what is needed to truly compete with what other chemical and nuclear engineering graduate programs. However, under the current financial situation of the department, we do not have departmental resources to do this. We continue to discuss creative ways to try to implement such a plan, but don't see it being feasible in the near future.

Advisory Council and Strategic Plan

The department Advisory Council has been reconstituted, and met on November 5, 2009. The agenda for this productive meeting included a broad introduction to the department and its associated Centers, and a discussion of the ABET Program Objectives and Program Outcomes of the chemical engineering and nuclear engineering programs. The Advisory Council plays an important role in the continuous improvement process that must be documented for our accreditation under ABET (Accreditation Board for Engineering and Technology). The Advisory Council will tentatively meet again in Fall 2010, with as-needed electronic communications during the interim period.

The department began preliminary discussions about strategic planning at the Department retreat on September 3, 2009. The Chair is fully in agreement on the desirability of a Strategic Plan for each program, and will continue discussions with faculty and the Advisory Council in Spring 2010 about the best way and time to initiate this.

Faculty Mentoring

The APR team pointed out that a consistent faculty mentoring program was lacking in the department. The Chair recognizes and agrees with that need. A dedicated faculty discussion on this topic is planned during Spring 2010. In the meantime, the Chair included the assigned faculty mentor into the Annual Review process in Spring 2009 for all untenured faculty. This new process, which was initiated after consulting with the untenured faculty, added another perspective to the Annual Review and brought the mentor into the loop in terms of performance data for the year. This should make the mentor better informed and more effective.

Specific APR Questions

Question 1a: How does the undergraduate program for chemical and nuclear engineering compare with other well-respected programs across the country?

Chemical Engineering: After a generally complimentary introduction on this question, the APR team reported some rather strong conclusions based on limited information. These were discussed by the faculty at the department retreat on September 3, 2009. We believe that on many of these specific points the APR did not have sufficient data or understanding to support their conclusions or concerns. Nevertheless, the department will keep an eye on these issues. Brief specific responses follow.

1. Senior seminar and ethics: there may well be instances of the use of solution manuals, something that is occurring nationwide with the electronic availability of these documents. Professors in the courses where this has been a problem dispute the allegation that "faculty did nothing about it". In fact, many are utilizing other texts for problems or creating their own homework problems to control this. Faculty are also encouraged to explicitly address academic dishonesty in their syllabi.

2. The department faculty believe the allegation that some courses were not being taught with sufficient rigor, and that this brought into question the preparation of our students, was completely baseless and inappropriate. No course materials were examined by the team, and their allegation appears to be based on their own pre-conceived notion of what the appropriate average GPA should be. We are proud of the record of achievement by our graduates in industry, graduate and professional schools, and we believe that speaks directly to the quality of preparation of our students. The ABET accreditation process, which includes alumni and employer/graduate school surveys on the performance of our students, is yet another quality check.

3. It is the opinion of the Chair that the complaint about faculty missing classes was probably an isolated situation. However, the expectations with regard to teaching will be emphasized to faculty in the annual review process.

4. All of our faculty teach or co-teach at least one class a year, though some do not teach at the undergraduate level each year. We maintain a teaching plan for both programs that extends several years into the future, and allocate teaching based on expertise, overall workload, and the need to cover core courses while offering a reasonable collection of elective classes for both undergraduate and graduate students. Students usually do have opportunities do be exposed to "high-performing" faculty (which the Chair interprets to mean research-intensive) through topical elective classes, though these may not be offered every year.

5. We make an effort to discuss graduate school in the Senior Seminar course. However, graduate school and other career guidance discussion is an area where the department could do more.

6. Our Undergraduate Program Committee, in consultation with the faculty and Advisory Council, will examine the current chemical engineering concentration areas. There has been a shift of interests in recent years, and consolidation of the number of concentrations may be appropriate. There is not currently flexibility to add more specialized courses to the concentrations – the students, in consultation with their advisor, must use their technical electives to achieve this.

7. We are aware of some deficiencies in the lecture-lab connections, and are working on that, especially in thermodynamics which appears the be the main sore spot.

8. We do view the opportunities for undergraduate research experience as one attractive and valuable feature of our undergraduate program.

Nuclear Engineering: We certainly agree with the spirit of the teams suggestions that the NE program stature will be served by faculty exerting themselves on the national stage, by better promotion of our programs, and by growth of the programs and increased visibility. Though we have constraints on number of faculty and budget, the Chair will nevertheless call on the nuclear engineering faculty to develop a plan to move in the direction of these suggestions. Responses to specific comments follow.

1. We are happy to hear the students are generally happy with the program and faculty.

2. We have been aware of the issues associated with the teaching of this course. We anticipate an instructor change for that course starting next year, and suggestions on content modifications will be taken up by the NE Undergraduate Program Committee.

3. We are happy to hear the students feel they are listened to.

4. We are also happy to hear that NE students find the 101 course to be a positive experience. That is consistent with our impression based on carryover enrollments in both programs.

Question 1b. How does the graduate program for chemical engineering and nuclear engineering compare with other well-respected programs across the country?

Chemical Engineering Response: The team identified several things that the chemical engineering faculty have been discussing at some length in the context of improving our graduate recruiting and admission policies. We recognize that the PhD student/faculty ratio is low compared to leading programs (this was highlighted in our Self Study). It is also true that the fraction of post-docs and research faculty may be higher than some places – this is partially coupled to the graduate recruiting problem that we are working on, and partially related to the types of research faculty are engaged in. The chemical engineering graduate program is taking steps to improve quality and quantity of graduate students, and has already seen a sizeable change in Ph.D/M.S. student ratio.

As with the undergraduate program, the team felt compelled to conclude that average GPA indicated a lack of rigor in the graduate courses. Again, this was done without inspection of course materials, or knowledge of our students. We reject this assessment, and believe the team was out of line here.

Nuclear Engineering Response: The team suggestion regarding meshing of the research areas of the faculty is well received. The nuclear engineering faculty will undertake some strategic planning in this regard during Spring 2010 and following semesters in the context of several anticipated faculty openings in the next 5 years.

We are always looking for new ways to expand our interactions with the national laboratories. Some interesting suggestions were made, though many would require higher level action within both the University and the Labs.

Question 2: Are the undergraduate laboratory facilities and experiments adequate and competitive with other strong programs? Do you have suggestions for improvements in this regard?

Chemical Engineering Response:

We appreciate the compliments of our undergraduate laboratories and the 4-semester laboratory experience that we provide. We are implementing new experiments in the laboratory when funding permits, and have plans to incorporate other research-based experiments into the laboratory where they fit the objective of the course.

Nuclear Engineering Response:

We appreciate the positive comments regarding the NE undergraduate laboratory experience. We are very aware of the contributions of Prof. Busch, and will be discussing in Spring 2010 a hiring plan to strategically address his eventual retirement.

Question 3: What strategies might help us to improve the success of our graduate student recruiting?

Chemical and Nuclear Engineering Response:

Both programs are very aware of issues related to recruiting graduate students. This issue was one of several focus group discussions at the Fall 2009 department retreat, and it has been discussed in faculty meetings since that time. The review team made several useful suggestions which we continue to keep under consideration. Our lack of resources prevents implementation of some of their ideas at this time, especially relating to the initial support of graduate students; however we recognize the desirability of this model. Several things have been done to help with graduate student recruiting since the APR visit. Both programs have developed a new postcard for promoting the graduate program, and the chemical engineering program has changed the priority admission deadline for Fall have to January 15 which appears to be increasing to early application pool.

Question 4: Do we have enough faculty to compete effectively for funding opportunities in the various research focus areas that we have targeted? If adding faculty were possible, what research areas would you recommend strengthening?

Chemical and Nuclear Engineering Response:

We concur that the approach of using Centers has helped the Department compete effectively for research funding. As Chair, I also agree with the recommendation that any next hire should be in Nuclear Engineering. This is especially true in light of the developments in the nuclear energy area since the APR visit. NE enrollments are growing, and there are prospects for years of strong demand in nuclear engineering that should continue to drive growth in both enrollments and research funding. With a recently announced resignation in the nuclear program, we are actively planning to hire to fill strategic needs of the program. This will not be a net faculty addition, but will address some strategic holes related to upcoming retirements in the NE program.

Question 5: What are best or suggested practices for effective coordination of departmental administration and the administration of affiliated centers in order to maximize the positive impacts of these centers? Specific issues that are of interest include financial coordination and cooperation, balancing of faculty workload expectation and duties, and reporting/credit for productivity.

Chemical and Nuclear Engineering Response:

The APR team made some useful suggestions related to the challenges associated with the strong presence of Centers in the department, and the financial impacts of an unequitable F&A return policy. Many of these issues were discussed at the Fall 2009 Department Retreat, and a financial summit between the Chair and Center directors in the department was held in Fall 2009, with another planned in Spring 2010. The basic issues related to F&A return, selection and continuance of centers should be dealt with at the institution level, and that is currently happening in an OVPR task force. However, within the department, all parties are committed to maintaining the vibrancy of both the departments and the centers. We are exploring creative ways for the Centers to help sustain the department.

Question 6: What are the suggested practices for effective administration and coordination of interdisciplinary degree programs that are largely supported or led by department faculty? Specific issues that are of interest include impact on enrollments in department programs, student credit hour generation, and faculty workload credit.

Chemical and Nuclear Engineering Response:

We are aware that our chemical engineering faculty is multidisciplinary, but view this as a strength that allows us to integrate cutting edge multidisciplinary research with our traditional course offerings. The chemical engineering program maintains a teaching plan that projects out several years to ensure that we have our core chemical engineering curriculum covered. The suggestion of a more formal workload policy is currently being adopted. Formal strategic planning has not been conducted yet, but the suggestion that this should be done before additional hiring is welcome. The strategic points raised with regard to the medical physics program have been discussed and would certainly be addressed as part of any future strategic planning exercise. At this time the nuclear engineering program finds that the graduates and student credit hours generated are worth the limited investment, and sees strategic value with cultivating ties to the medical school.

Question 7: Do you see opportunities that either of the programs in the department is not recognizing or capitalizing on?

Chemical and Nuclear Engineering Response:

The suggestions with regard to identifying research programs that leverage the union of chemical and nuclear engineering make good strategic sense if significant faculty replacements or additions could occur. At the moment, the department has a relatively young group of faculty and not very much natural overlap in research, so it is difficult to envision much progress in building such programs in the near future.

Additional Comments:

Written annual reviews of all faculty were conducted in Spring 2009 and will be conducted going forward. There has been a mentoring program for many years in the department; however, the quality and uniformity of the mentoring can certainly be improved. The mentoring program processes will be brought up for detailed discussion and modification with the faculty during the 2009-2010 academic year.

The team raised several questions related to use of departmental resources. These are all useful and logical questions that we will be considered as part of our curriculum and strategic planning processes.

The ABET concerns about the lack of regular interaction with the Advisory Council is understandable. We have reinstated an Advisory Council which met in Fall 2009. We tentatively plan a second meeting after the Fall 2010 ABET visit. As a result of input from the APR team, our Advisory Council, and a mock ABET team, we are revising our Program Educational Objectives (as suggested by the APR team).

The additional suggestions made by the team are all acknowledged for their potential value. Many have been considered already, and come up from time to time, and others will be taken up in the future by the faculty. Several are included in the Action Plan

Appendix C

Faculty Credentials

Directions: Please complete the following table by: **1**) listing the full name of each faculty member associated with the designated department/academic program(s); **2)** identifying the faculty appointment of each faculty member, including affiliated faculty (i.e., LT, TTI, TTAP, AD, etc.); **3**) listing the name of the institution(s) and degree(s) earned by each faculty member; **4)** designating the program level(s) at which each faculty member teaches one or more course (i.e., "X"); and **5)** indicating the credential(s) earned by each faculty member that qualifies him/her to teach courses at one or more program levels (i.e., TDD, TDDR, TBO or Other). Please include this template as an appendix in your self-study for Criterion 5A.

Name of Department/Academic Program(s): Department of Chemical & Biological Engineering

NOTE: Please add rows to the table as needed.

Full First and Last Name	Faculty Appointment Continuing • Lecturer (LT) • Probationary/Tenure Track - Instructor (TTI) or Asst. Prof. (TTAP) • Tenured - Assoc. Prof. (TAP), Prof. (TP), or Dist. Prof. (TDP) • Prof. of Practice (PP) Temporary • Adjunct (AD) • Term Teacher (TMT) • Visitor (VR) • Research Faculty (RF)	Institution(s) Attended, Degrees Earned, and/or active Certificate(s)/Licensure(s) (e.g., University of New Mexico—BS in Biology; University of Joe Dane—MS in Anthropology; John Doe University—PhD in Psychology; CPA License—2016-2018)	Program Level(s) (Please leave blank or provide "N/A" for each level(s) the faculty <u>does not</u> teach at least one course.)		Faculty Credentials • Faculty completed a terminal degree in the discipline/field/or related field (TDD); • Faculty completed a terminal degree in the discipline/field /or related field and have a record of research/scholarship in the discipline/field (TDDR); • Faculty completed a terminal degree outside of the discipline/field but earned 18+ graduate credit hours in the discipline/field (TDO); OR • Other (Explain)
1. Plamen Atanassov	TDP	Bulgarian Academy of Sciences – PhD in Chemistry: Physical Chemistry	Undergraduate	X	TDDR
			Graduate	X	
			Doctoral	X	

Full First and Last Name	Faculty Appointment Continuing • Lecturer (LT) • Probationary/Tenure Track - Instructor (TTI) or Asst. Prof. (TTAP) • Tenured - Assoc. Prof. (TAP), Prof. (TP), or Dist. Prof. (TDP) • Prof. of Practice (PP) Temporary • Adjunct (AD) • Term Teacher (TMT) • Visitor (VR) • Research Faculty (RF)	Institution(s) Attended, Degrees Earned, and/or active Certificate(s)/Licensure(s) (e.g., University of New Mexico—BS in Biology; University of Joe Dane—MS in Anthropology; John Doe University—PhD in Psychology; CPA License—2016-2018)	Program Level(s) (Please leave blank or provide "N/A" for each level(s) the faculty <u>does not</u> teach at least one course.)		Faculty Credentials • Faculty completed a terminal degree in the discipline/field/or related field (TDD); • Faculty completed a terminal degree in the discipline/field /or related field and have a record of research/scholarship in the discipline/field (TDDR); • Faculty completed a terminal degree outside of the discipline/field but earned 18+ graduate credit hours in the discipline/field (TDO); OR • Other (Explain)
2. C. Jeffrey Brinker	TDP	Rutgers University – PhD in Ceramic Science and Engineering	Undergraduate	X	TDDR
			Graduate	X	
			Doctoral	X	
3. Heather Canavan	TAP	George Washington University – PhD in Physical Chemistry	Undergraduate	X	TDDR
			Graduate	X	
			Doctoral	X	
4. Nick Carroll	TTAP	University of New Mexico – PhD in Chemical Engineering	Undergraduate	X	TDDR
			Graduate	X	
			Doctoral	X	
5. Eva Chi	TAP	University of Colorado, Boulder – PhD in Chemical Engineering	Undergraduate	X	TDDR
			Graduate	X	
			Doctoral	X	
6. Abhaya Datye	TDP	University of Michigan – PhD in Chemical Engineering	Undergraduate	X	TDDR
			Graduate	X	
			Doctoral	X	
7. Elizabeth Dirk	TAP	Rice University – PhD in Bioengineering	Undergraduate	X	TDDR
			Graduate	X	
			Doctoral	X	
8. Fernando Garzon	TP	University of Pennsylvania – PhD in Materials Science and Engineering	Undergraduate	X	TDDR
			Graduate	X	
			Doctoral	X	

Full First and Last Name	Faculty Appointment Continuing • Lecturer (LT) • Probationary/Tenure Track - Instructor (TTI) or Asst. Prof. (TTAP) • Tenured - Assoc. Prof. (TAP), Prof. (TP), or Dist. Prof. (TDP) • Prof. of Practice (PP) Temporary • Adjunct (AD) • Term Teacher (TMT) • Visitor (VR) • Research Faculty (RF)	Institution(s) Attended, Degrees Earned, and/or active Certificate(s)/Licensure(s) (e.g., University of New Mexico—BS in Biology; University of Joe Dane—MS in Anthropology; John Doe University—PhD in Psychology; CPA License—2016-2018)	Program Level(s) (Please leave blank or provide "N/A" for each level(s) the faculty does not teach at least one course.)		Faculty Credentials • Faculty completed a terminal degree in the discipline/field/or related field (TDD); • Faculty completed a terminal degree in the discipline/field /or related field and have a record of research/scholarship in the discipline/field (TDDR); • Faculty completed a terminal degree outside of the discipline/field but earned 18+ graduate credit hours in the discipline/field (TDO); OR • Other (Explain)
9. Jamie Gomez	LT	Florida A&M University – PhD in Chemical Engineering	Undergraduate	X	TDDR
			Graduate		
			Doctoral		
10. Steven Graves	TP	Pennsylvania State University – PhD in Biochemistry	Undergraduate	X	TDDR
			Graduate	X	
			Doctoral	X	
11. Sang M. Han	TP	University of California, Santa Barbara – PhD in Chemical Engineering	Undergraduate	X	TDDR
			Graduate	X	
			Doctoral	X	
12. Sang Eon Han	TTAP	University of Minnesota – PhD in Chemical Engineering	Undergraduate	X	TDDR
			Graduate	X	
			Doctoral	X	
13. Dimiter Petsev	TP	University of Sofia, Bulgaria – PhD in Chemical Physics and Engineering	Undergraduate	X	TDDR
			Graduate	X	
			Doctoral	X	
14. Andrew Shreve	TP	Cornell University – PhD in Physical Chemistry	Undergraduate	X	TDDR
			Graduate	X	
			Doctoral	X	

Full First and Last Name	Faculty Appointment Continuing • Lecturer (LT) • Probationary/Tenure Track - Instructor (TTI) or Asst. Prof. (TTAP) • Tenured - Assoc. Prof. (TAP), Prof. (TP), or Dist. Prof. (TDP) • Prof. of Practice (PP) Temporary • Adjunct (AD) • Term Teacher (TMT) • Visitor (VR) • Research Faculty (RF)	Institution(s) Attended, Degrees Earned, and/or active Certificate(s)/Licensure(s) (e.g., University of New Mexico—BS in Biology; University of Joe Dane—MS in Anthropology; John Doe University—PhD in Psychology; CPA License—2016-2018)	Program Level(s) (Please leave blank or provide "N/A" for each level(s) the faculty <u>does not</u> teach at least one course.)		Faculty Credentials • Faculty completed a terminal degree in the discipline/field/or related field (TDD); • Faculty completed a terminal degree in the discipline/field /or related field and have a record of research/scholarship in the discipline/field (TDDR); • Faculty completed a terminal degree outside of the discipline/field but earned 18+ graduate credit hours in the discipline/field (TDO); OR • Other (Explain)
15. David Whitten	TP	Johns Hopkins University – PhD in Organic Chemistry	Undergraduate	X	TDDR
			Graduate	X	
			Doctoral	X	

Appendix D

School of Engineering – Academic Load Policy

Academic Load Policy
School of Engineering
University of New Mexico

Passed by vote of the SOE Faculty Assembly, May 9, 2014

1. **Introduction**

Section *C100: Academic Load* of the UNM Faculty Handbook articulates a policy governing the officially recognized duties carried out by faculty. These duties fall into the three familiar categories of teaching, scholarly work, and service. This policy and the closely related *C110: Teaching Assignments* policy wisely provide uniform guidelines across Academic Affairs, while recognizing that the overall academic load can be achieved by different mixes of teaching, research, and service to accommodate the diverse character and needs of individual units. This School of Engineering Academic Load Policy comprises uniform guidelines across the departments within the School, while taking full advantage of the flexibility articulated in Section *C100* to enable the breadth of the School's academic mission.

The SOE Academic Load Policy supersedes the SOE Teaching Load Policy approved by the SOE faculty on November 25, 2011. Among other features, the SOE Academic Load Policy is directed towards:

- enhancing sponsored research activity by SOE faculty
- encouraging the generation and commercialization of intellectual property emanating from research
- giving incentives for faculty to support additional graduate students, particularly at the PhD level
- providing a flexible approach for determining the appropriate teaching load for faculty, in light of their research and service activities
- establishing a mechanism for faculty to decrease their teaching load and increase their research load by using research funding to compensate their departments
- providing flexibility for department chairs to implement this policy in the best interests of their departments

2. **Guidelines and Parameters for Balancing Teaching and Research for Regular Faculty with Full-Time Appointments**

The guidelines and parameters in this section assume a normal university and professional service load, and articulate two faculty categories as follows:

(1) Faculty whose academic activities are centered on teaching, defined as:

- having less than $50k of annual research expenditures (as calculated in Section 5), and
- supervising fewer than 3 PhD students (as established in Section 6), and
- having no issued US patent in the previous two calendar years.

The base teaching load for faculty in this category will be 5 or 6 classes per year, depending on the level of service or other relevant considerations, as determined by the department chair.

(2) Faculty whose academic activities include a significant level of research, defined as:

- having more than $50k or more of annual research expenditures (as calculated in Section 5), or
- supervising 3 or more PhD students (as established according to Section 6), or
- having 1 or more issued US patents in the previous two calendar year, or
- demonstrating scholarly impact through significant peer-reviewed publications in the previous calendar year.

The base teaching load for faculty in this category will normally be 4 classes per year.

A faculty member in this category has the option of reducing his/her base teaching load to 3 courses per year by either:

- supervising 6 or more total graduate students (PhD + MS), or
- having a significant departmental administrative appointment with approval by the department chair, or
- having a significant administrative appointment within SOE with approval by the dean

In all cases, for faculty members with a 0.75 FTE or greater appointment, the base teaching load will not be reduced below 3 courses per year.

A faculty member may reduce his/her teaching load by using research or other funding to compensate his/her department at a level that is normally 15% of the academic year salary for each unit of course reduction. Such "release time" funds will remain in the faculty member's department to be managed by the department chair.

A faculty member who wishes to reduce his/her teaching load below 1 course/year must have approval of the department chair.

3. **Guidelines and Parameters for Balancing Teaching and Research for Regular Faculty with less than Full-Time Appointments**

For faculty members with less than full-time appointments, the base teaching loads in Section 2 will be adjusted in proportion to the fraction of the appointment. For example, faculty members having 0.5 FTE appointments within the School or having a 50% administrative appointment within the School would have base teaching loads that are one half of those in Section 2.

Administrative appointments within the School that are at the level of 50% include:

- Department chair
- Associate Dean for Academic Affairs
- Associate Dean for Research

In all cases in which the base teaching load is reduced for a reduced FTE or administrative appointment, the guidelines for further course load reduction through release time funding remain the same as those in Section 2.

University policies on parental and medical leave take precedence over the School's Academic Load Policy.

4. **Procedure for Establishing Faculty Base Teaching Load**

The base teaching load for each faculty member will normally be established by the department chair each January for the following academic year. For example, for calendar year 2015, the determination will be made in January 2015 for the 2015-16 academic year, which will start in August, 2015. The determination of the faculty member's research expenditures and graduate student supervision will follow the procedures in Sections 5 and 6, respectively.

It is in the interests of the School to implement this Academic Load Policy in academic year 2014-15, to the extent possible. With this in mind, the base teaching load for each faculty member will be established by the department chair as soon as possible after the Policy goes into effect. It is recognized that teaching assignments will have already been made by that time for the fall 2014 semester and may be difficult to change in many cases. Department chairs are encouraged to take advantage of whatever flexibility they may have to follow the new policy, with full implementation coming in the spring 2015 semester.

5. **Determination of Annual Research Expenditures**

For the purposes of Section 2, annual research expenditures will be determined from research expenditure reports provided by the School to each department based on research expenditures made in a faculty member's "org code" as the greater of:

- research expenditures for the previous calendar year, or
- the average of research expenditures for the previous 2 calendar years.

6. **Determination of Graduate Student Supervision**

For the purposes of Section 2, the number of graduate students supervised will be the number of graduate students (PhD or PhD + MS, depending on the criteria in Section 2) supervised at the end of the fall semester of the previous calendar year, plus any additional supervised students who have graduated during the previous calendar year. This determination will be made by the department chair.

7. **Further Guidelines**

In addition to what is articulated above, other circumstances may occur wherein it is in the interests of a department to reduce a faculty member's teaching load. For example, a reduced teaching load is often part of a new faculty member's startup package or part of "matching funds." All such cases will require approval by the department chair. As well, there may be additional circumstances in which it is in the interests of the School to reduce a faculty member's teaching load. Cases that fall into this category will require approval by the dean.

Each case will be decided on the basis of its own merits, with attention to the goals articulated in Section 1, and consistent with the spirit of the overall policy.

Department of Chemical & Biological Engineering

Equitable Allocation of Teaching Assignment
Discussed and voted by CBE Faculty on 2/6/2018

Goal: Our aim is for a departmental culture that values effective teaching. The workload associated with each class varies, hence it is appropriate to consider these differences. The goal is to create a more equitable allocation of teaching assignments. Additionally, this allocation will also help us to determine our capacity to offer new courses, allowing faculty to develop new courses.

SOE Workload Policy: The SOE base load is 5 - 6 courses a year for a full-time faculty member. For those faculty with a research program (research expenditures averaging $50K per year over a 3-year period or 1 issued patent over two calendar years or 3 PhD students or significant peer reviewed publications), the SOE policy drops the teaching load to 4 courses per year. An additional one course reduction is provided for a significant level of research (6 or more graduate students supervised).

For CBE, we adopt a more flexible definition of a substantial research program. Scholarly publications, presentations, mentoring of graduate and undergraduate students, post-docs and research faculty, maintaining a research web page and holding regular research group meetings would constitute a substantial research program. For CBE, we therefore aim to have a teaching load of 3 courses/year. ***Any further reduction requires a buyout per the SOE workload policy***. Substantial service commitments could provide one additional course release beyond the SOE policy, for example, the Director of Undergraduate programs.

CBE Course Categories: Courses taught by CBE faculty are broadly placed into 3 categories based on the workload requirements. ***To achieve equity in faculty workload, each faculty member should teach at least one course in category 1***. Category 3 courses are considered as part of faculty research and will not count towards meeting faculty teaching workload assignments since the SOE policy already considers them (i.e. reducing loads from 6 to 3 courses/yr). **Co-teaching** should be considered on a case-by-case basis, after considering the workload for each faculty member. For example, when both instructors attend each class and fully participate, then each faculty member should count the class in their workload. However, there are other situations where a fractional workload assignment is more appropriate.

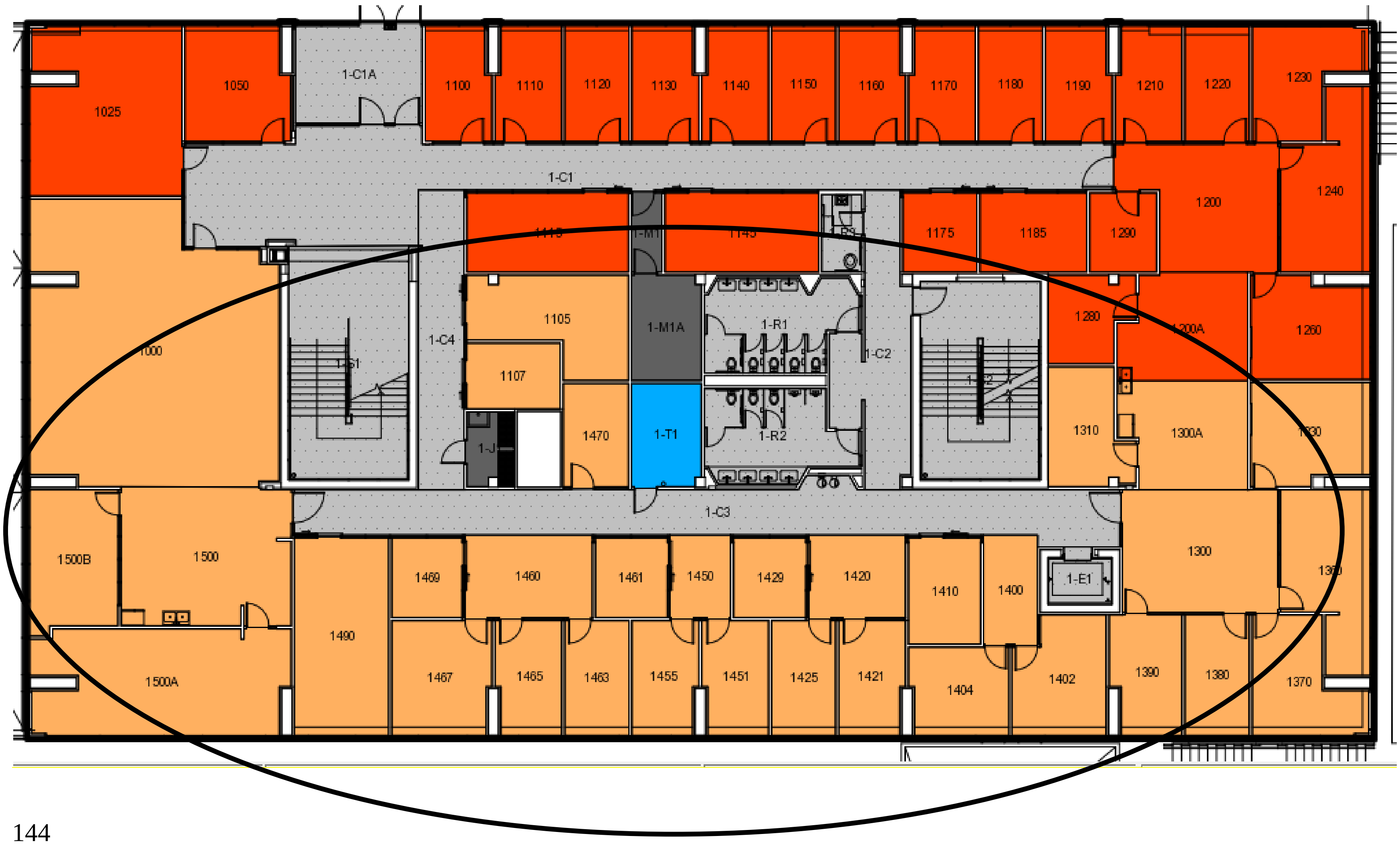
Category	Credit hours	Nature of course
1a	Core undergraduate class	Core undergraduate class, with enrollments of ~60, 2-3 contact hours, plus recitations, office hours, etc.
1b	Core graduate class	Core graduate class which in some cases may also serve as an undergraduate elective class. Typical enrollment 30-40 students, 3 contact hours per week.
1c	Undergraduate laboratory class	Contact hours generally 6 or more per week, with heavy grading responsibilities.
2a	Undergraduate seminar class	Minimal class preparation and grading requirements, 3 contact hours per week. CBE 101 could count as 0.5 since it has only 1 contact hour per week.
2b	Elective class	Elective for both graduate and undergraduate programs. Typical enrollment ~15-20 students
3	Seminar courses, group meetings, independent study, topical courses developed as part of a research program	This could be considered service (for example CBE 501 seminar) or research, such as group meetings or specialized courses related to a grant

Appendix E

Floor Plans

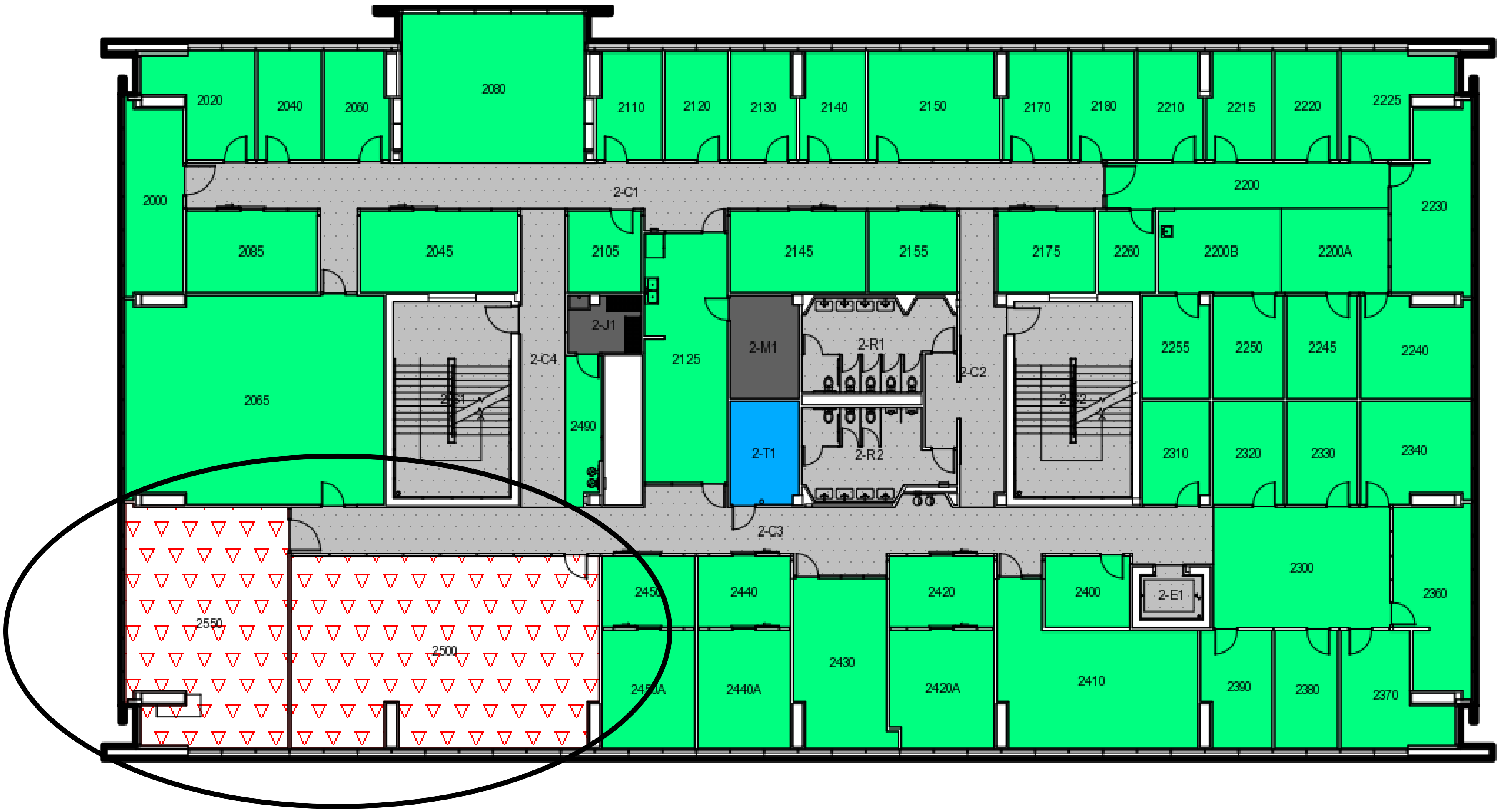
Farris Engineering – 1st Floor

CBE allocated space (6996 sq. ft.)



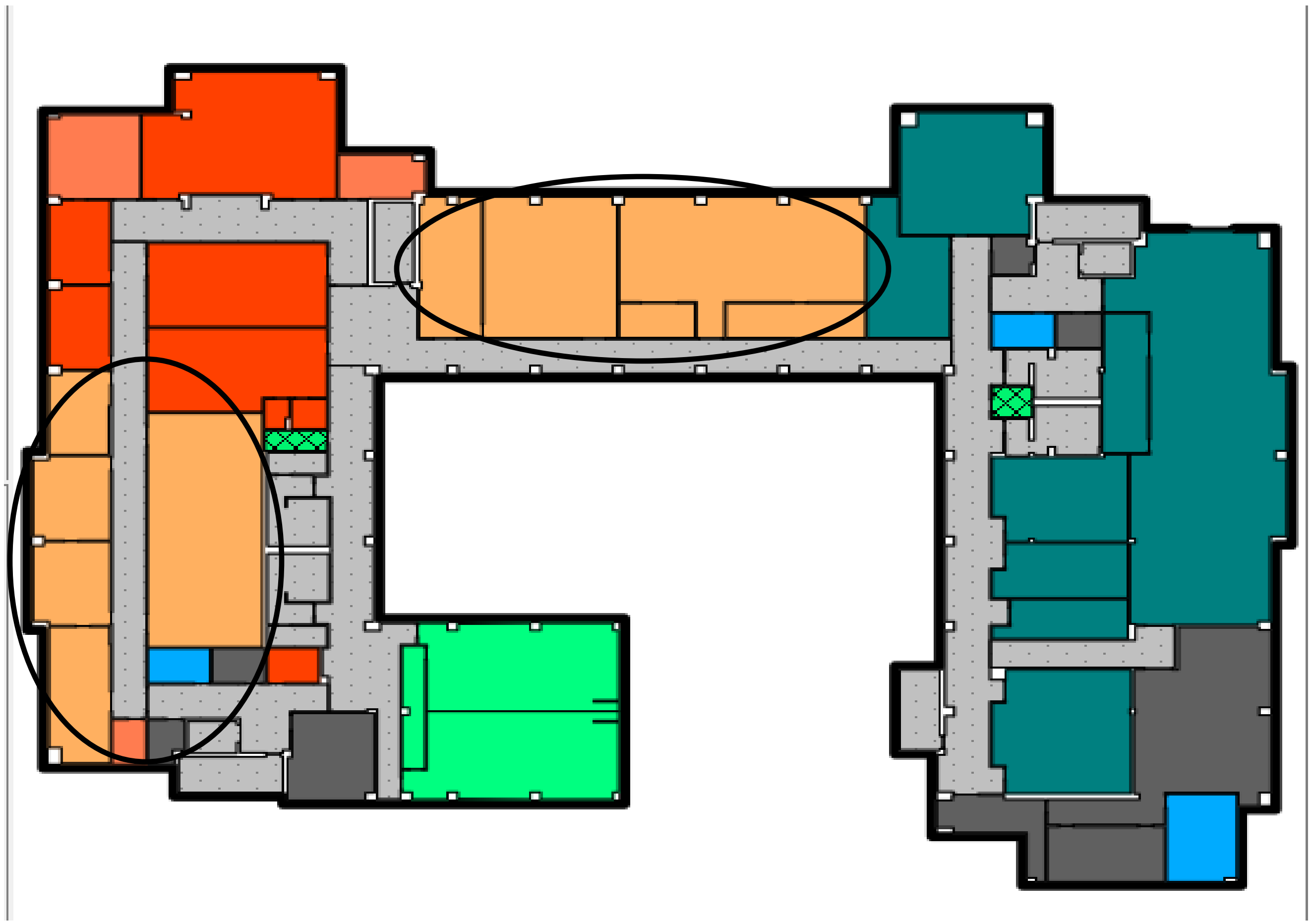
Farris Engineering Center – 2nd Floor

Rooms 2500 & 2550 – shared space w/ NE (1732 sq. ft.)



Centennial Engineering Center – basement

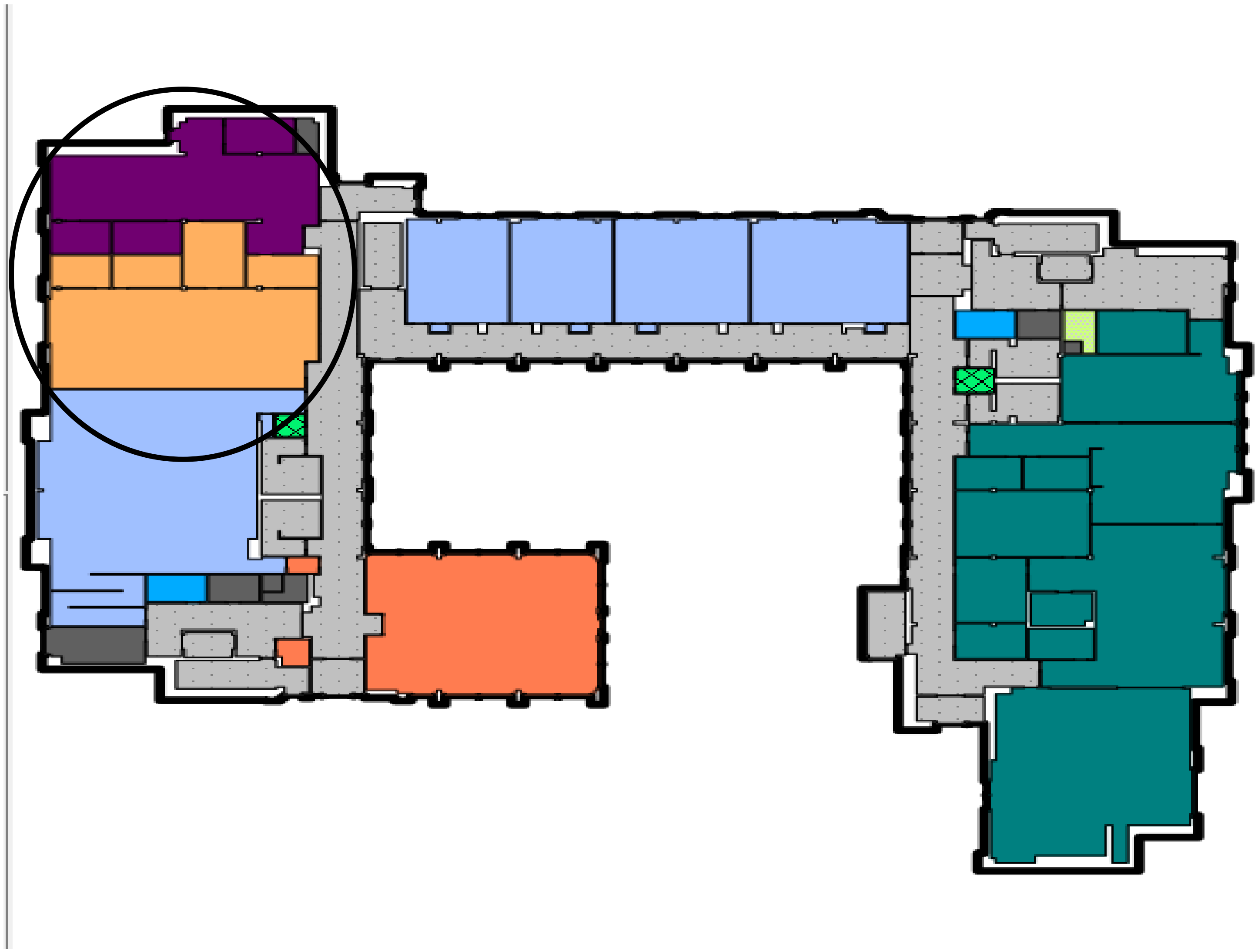
CBE Laboratory Space & Researcher/Student office space (6419 sq. ft.)



Centennial Engineering Center – 1st Floor

CBE Undergraduate Laboratory (in yellow) - 2750 sq. ft.

BME Laboratory Space (in purple) – 2,061 sq. ft.

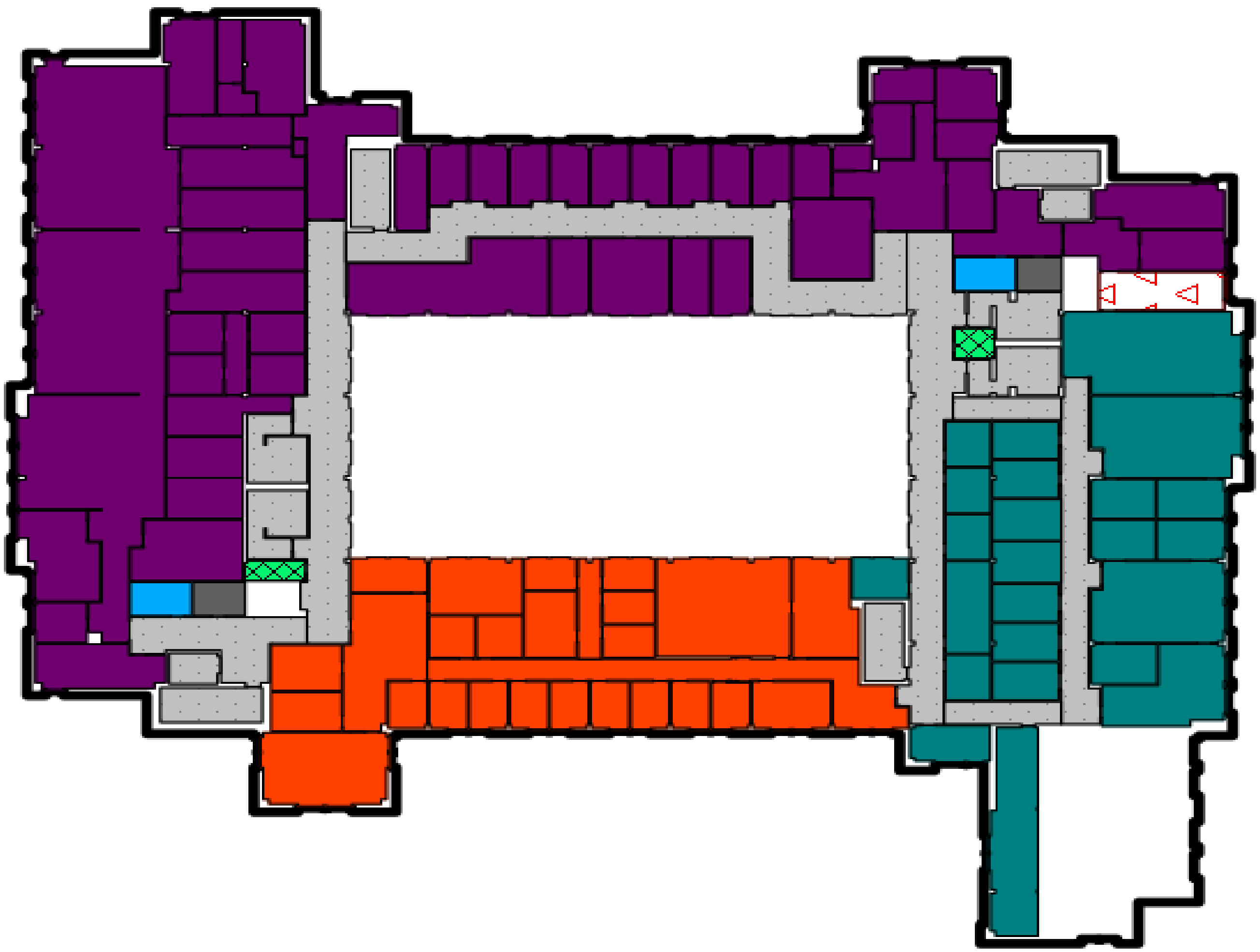


Centennial Engineering Center – 2nd floor (in purple)

CBE Faculty Offices – 8 offices (1130 sq. ft.)

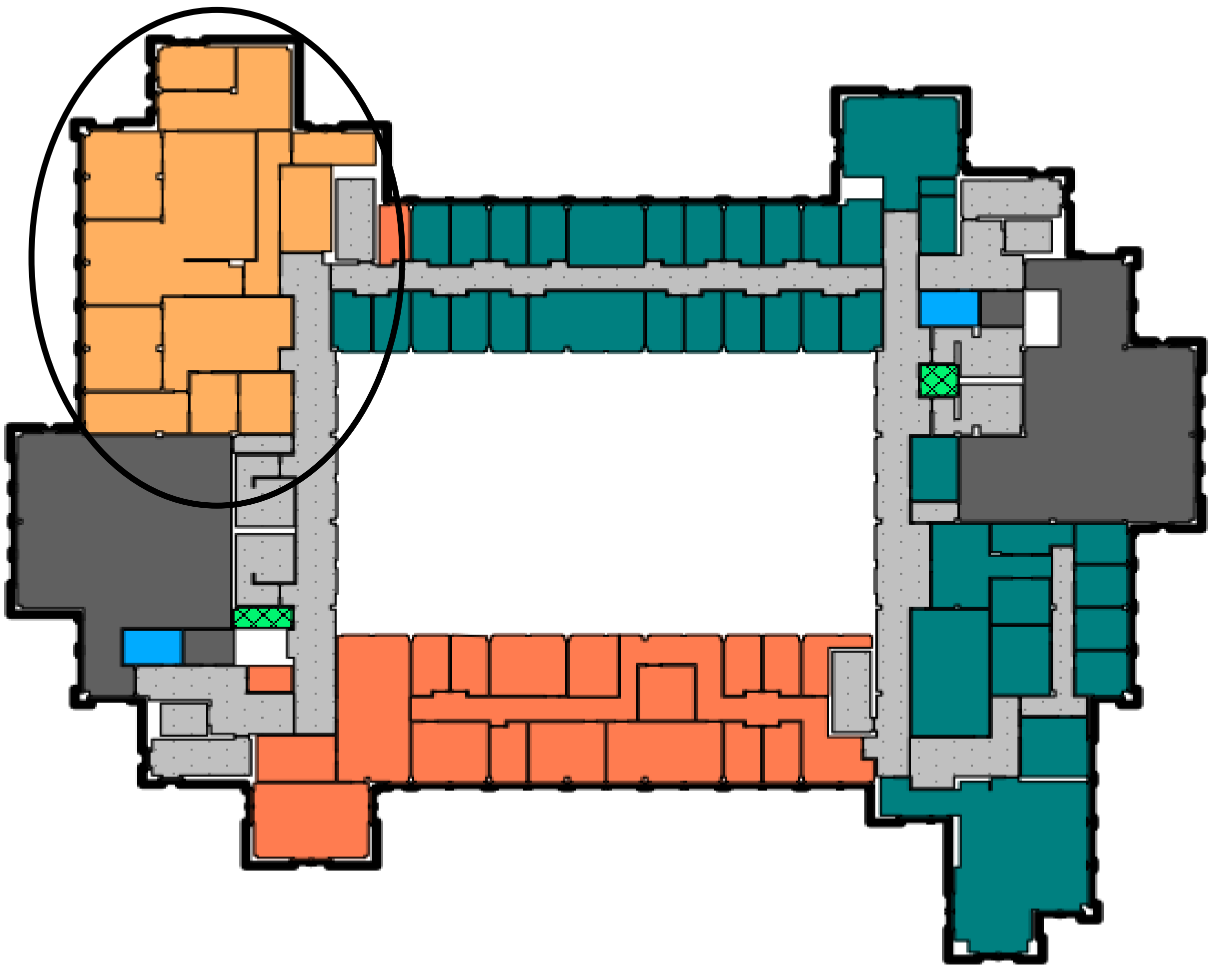
CBME Administration – 1,752 sq. ft.

CBME Laboratory Space – 9,660 sq. ft.



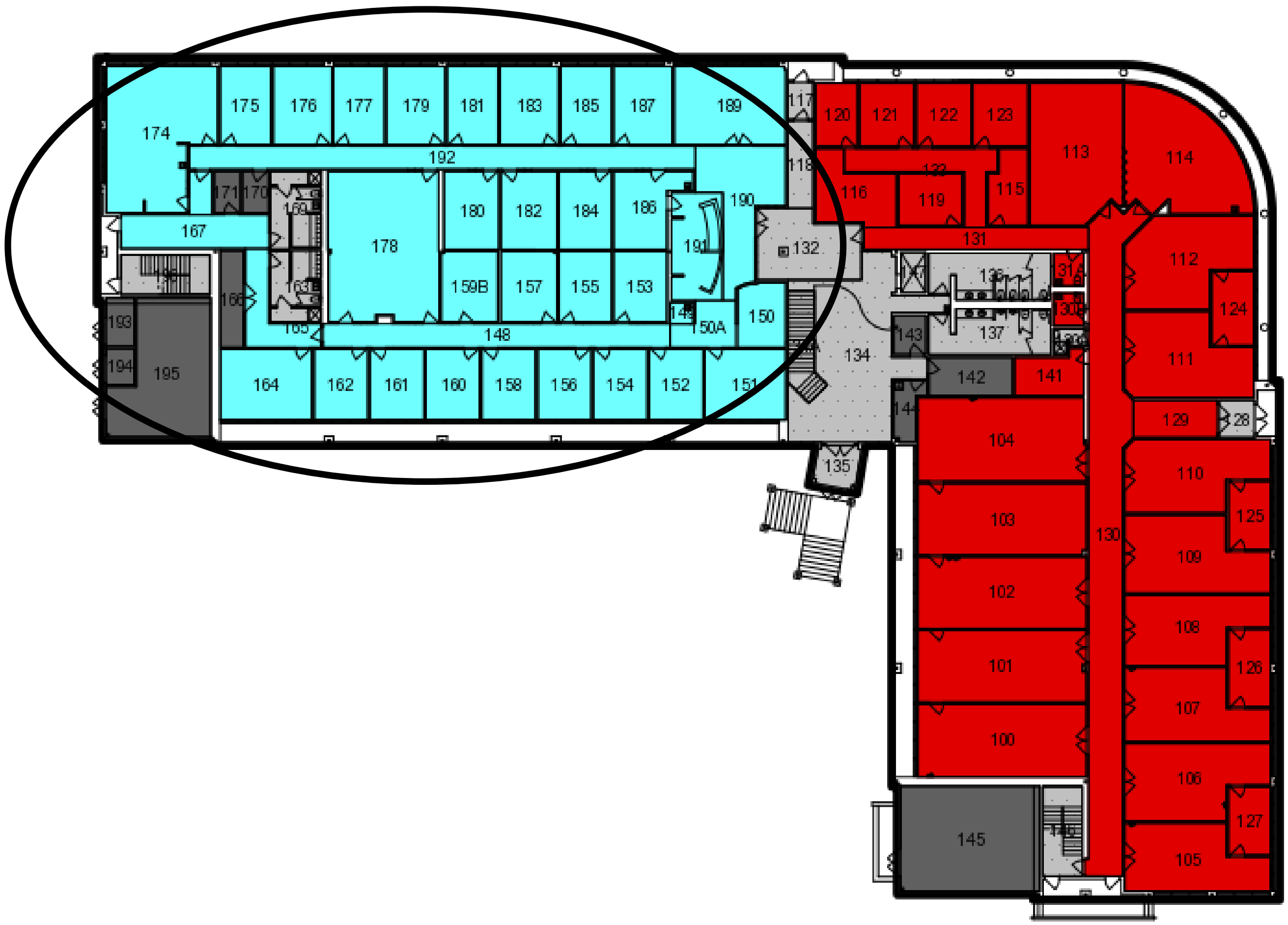
Centennial Engineering Center – 3rd Floor

Nanomedicine Research Laboratory (4556 sq. ft.)



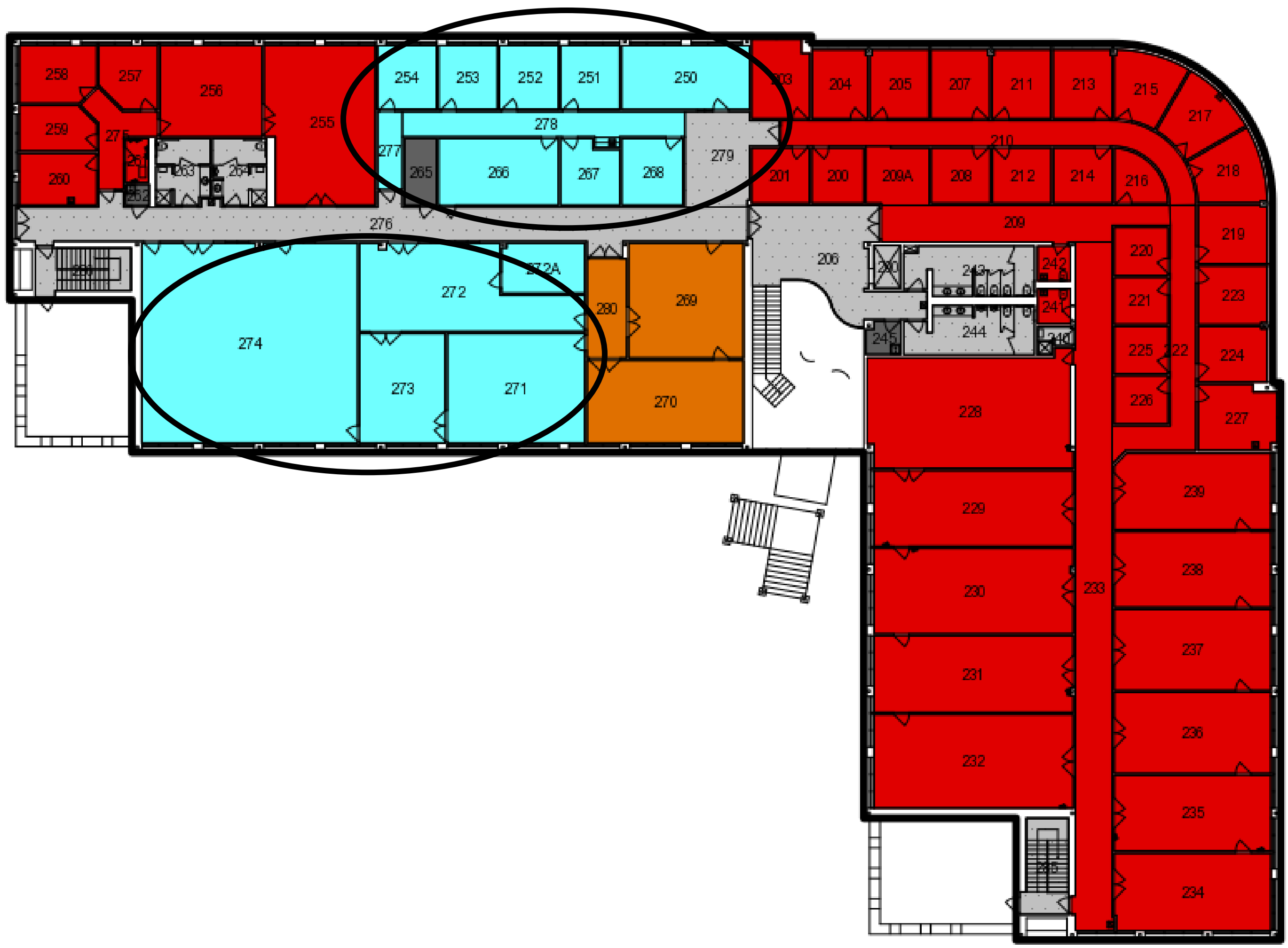
Advanced Materials Laboratory (AML 1st floor)

Laboratory Space – 1,359 sq. ft.
Classroom space – 741 sq. ft.
Administration & Faculty Offices – 4,425 sq. ft.



Advanced Materials Laboratory (AML) 2nd Floor

Laboratory Space – 5,438 sq. ft.



Appendix F

Peer Comparison Table

We have included 15 designated peer institutions from the UNM peer institution list and added the New Mexico Institute of Mining and Technology (since it has a Chemical Engineering Department) to the list so all three research universities in New Mexico are included. We have ordered them in by the number of full time faculty in their department.

	Total University Enrollment	Unit Undergraduate Degrees/Certificates Offered	Unit Undergraduate Student Enrollment	Unit Graduate Degrees/Certificates Offered	Unit Graduate Student Enrollment	Total # of Unit Faculty	US News 2018 Ranking – Best Graduate – Chemical Engineering	Engineering School Rank
University of Texas - Austin	40,168	BS	747 BS	MS PhD	0 MS 171 PhD	27	6	10
Texas A&M University	50,735	BS	793 BS	MS PhD	121 MS 140 PhD	26	21	12
University of Colorado-Boulder	27,846	BS	337 BS	MS PhD	7 MS 124 PhD	23	17	32
University of Kansas	19,262	BS	437 BS	MS PhD	4 MS 38 PhD	26	72	95
University of Utah	23,789	BS	413 BS	MS PhD	22 MS 63 PhD	21	61	58
University of California - Riverside	19,799	BS	334 BS	MS PhD	8 MS 87 PhD	19	43	61
Arizona State University	51,869	BS	783 BS	MS PhD	48 MS 40 PhD	19	47	45
University of Houston	35,871	BS	584 BS	MS PhD	36 MS 100 PhD	19	34	69
University of Nevada – Reno	18,191	BS	194 BS	MS PhD	3 MS 6 PhD	19	Unranked	132

	Total University Enrollment	Unit Undergraduate Degrees/Certificates Offered	Unit Undergraduate Student Enrollment	Unit Graduate Degrees/Certificates Offered	Unit Graduate Student Enrollment	Total # of Unit Faculty	US News 2018 Ranking – Best Graduate – Chemical Engineering	Engineering School Rank
Arizona State University	51,869	BS	783 BS	MS PhD	48 MS 40 PhD	19	47	45
The University of Tennessee	22,139	BS	443 BS	MS PhD	3 MS 51 PhD	17	61	61
Texas Tech University	29,963	BS	283 BS	MS PhD	8 MS 79 PhD	16	58	91
University of Arizona	34,072	BS	243 BS	MS PhD	20 MS 24 PhD	16	72	58
University of New Mexico	26,278	BS	293 BS	MS PhD	44 MS 52 PhD	15	72	83
Colorado State	25,177	BS	303 BS	MS PhD	16 MS PhD 16	12	58	56
New Mexico State University	14,852	BS	203 BS	MS PhD	15 MS 24 PhD	10	Unranked	145
University of Missouri-Columbia	25,898	BS	170 BS	MS PhD	13 MS 24 PhD	7	Unranked	99
New Mexico Institute of Mining and Technology	2,135	BS	115 BS	none	N/A	5	Unranked	145