Electrical & Computer Engineering Spring 2018

Academic Program Review

03/10/2018

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MAPPING OF APR CRITERION TO REPORT CHAPTERS

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1 Executive Summary

1.1 Department Overview

The Department of Electrical and Computer Engineering (ECE) dates to 1904. The popularity of electrical engineering courses, coupled with the demand for programs in engineering fields other than electrical, led to the creation of the College of Engineering in 1906, which changed its name to the School of Engineering in 1997. Historically, ECE has responded to the community's needs and demands for higher education in engineering, from implementing a Doctor of Science degree in 1956, to developing active and productive research programs, and to recently introducing innovative online degrees.

The Department of Electrical and Computer Engineering strives to provide excellent undergraduate and graduate programs, so that its students are broadly grounded in the fundamentals of engineering, have experience with interdisciplinary approaches, are able to communicate effectively, are prepared for life-long learning, and are imbued with a strong sense of public responsibility. In the current environment of shrinking resources, stiff competition, and increasing focus on the bottom line, the department recognizes the need to be committed to and instrumental in creating a culture of quality and service.

The department has been following a strategic plan that was initiated in the year 2000-2001. As part of that strategic plan, the department defined its vision to provide a world-class educational and research experience. The strategic plan has since been periodically updated and revisited to reflect changes in the department's direction.

The department currently has 28 tenured or tenure-track faculty members: 18 in EE, and 10 in Computer Engineering. Also, the ECE Department utilizes 5 lecturers to help fulfill its teaching mission.

Among our tenured faculty members, we have the UNM President, SOE Dean, and two Associate Deans. While beneficial to the UNM institutions and the departmental research and service missions, having so many ECE faculty members serving outside the department, has resulted in a stressed situation with respect to covering the teaching and service loads.

It should be noted that the FTE numbers of faculty have been constant for the last 25 years, despite the large increase in the breadth and depth of the electrical and computer engineering field, the introduction of new degrees and sub-disciplines, and the increase in the overall number of students served. The ECE department is the largest department of the School of Engineering (SOE) and by most measures, one of the most productive departments of UNM. This includes in the year 2016-2017, the generation of credit hours per faculty (especially graduate at 60 student credit hours per faculty and dissertation student credit hours at 34 per faculty), funded research (about $400,000 per faculty), and scholarly publications (about 6 Journal publications and 6 conference publications per faculty).

The department also employs 10 permanent staff and 6 student workers in our administration. Since 2015, our total staff FTE has been reduced from 13 to 9.5.

Despite challenges in funding and staffing, the department prides itself on maintaining its high professionalism and service culture as one of the flagship departments at UNM. This is demonstrated in example by winning the Group Work Provost Staff award in 2016. We have at various times initiated in the last 2 years external and internal reviews for our computer services and staff.

Our faculty continues to receive competitive funding, including three active NSF CAREER awards, various MURI awards as well as NIH grants. The department faculty members, including those affiliated with centers like CHTM, The MIND, and COSMIAC, generate around $20 Million per year in funded research. The ECE department strongly supports interdisciplinary research and programs. This poses challenges within UNM, where the establishment of such programs has been organic, relying on the existing programs and departments resources.

As an example, about a third of our faculty supports the Optical Science and Engineering (OSE) graduate program, and a large number of them also support the Nano Science and Micro Systems Engineering (NSMS) program. The department faculty is also involved in the Integrated Film and Digital Media (IFDM) program with the UNM college of fine arts. While the research components of all of these programs are strong and self-sustaining, the educational component remains largely unfunded.

The department reputation within the university is very strong, as evidenced by a large number of faculty from other departments who have requested (and been granted) a secondary appointment with ECE. This is also evidenced by our faculty members serving as dean of the school of engineering and both associate deans of engineering. Our faculty members have been recipients of the UNM-wide teaching awards, and three faculty members are currently UNM distinguished professors, the highest rank bestowed by the university to any faculty member.

The department currently counts 10 fellows of their respective professional societies amongst its 29 regular faculty members. The ECE faculty members have and continue to serve on various UNM committees such as the university-wide faculty senate, academic freedom committees, and curriculum committees. In addition, our ECE staff serves on several committees on a regular basis.

The department is always responsive to calls for assistance from UNM and SOE. There have been partnerships formed across the UNM community, the Albuquerque community, the Central New Mexico College (CNM), the Southwestern Indian Polytechnic Institute (SIPI), and Northern New Mexico Community College to support students and programs at UNM.

The department is very active in leading and participating in education and recruiting events for elementary, middle and high school students. The ECE department has taken the lead in establishing international collaborations that have culminated in dual graduate degrees with international universities. We currently have a very active exchange program with leading universities in India, China, and Mexico, and dual degrees with UNICAMP of Brazil and Concepcion of Chile. We are always in active negotiations to establish dual and joint degrees with more universities from countries like Argentina, Spain, Italy, and France.

Where does the department want to be in five years? The ECE department would like to establish the following goals for the next 5 years:

Increase our graduate ranking to the top 50 for the EE program, and the top 50 for the CompE program.
We strongly believe based on our objective metrics (such as research and scholarly activity) that we should be able to achieve that goal. We were already much closer to that target before all the instability in the chair, and dean offices set the department back significantly in presence and visibility. In order to reach this goal, however, we will require more resources (faculty FTE) and coordination with Engineering in actions promoting our rankings. In the past years, several faculty members have left and accepted offers from Institutions such as Georgia Tech, UCLA, the University of Arizona, Virginia Tech and Ohio State.

During the same time, we have been successful in hiring excellent faculty. This flow of faculty in both directions also has a positive effect on awareness of our qualities and appreciation of our strengths nationally.

Increase our undergraduate enrollment to 600 and our self-paying Masters enrollment to 200.
Size matters tremendously in terms of relevance to the market, rankings, income and overall impact. We are working with SOE to overcome geographical and socio-economic challenges in New Mexico and bring in a significant number of new undergraduate students. A key part of the strategy is to look outside the State, for prospective students from Arizona, Colorado, Texas and also from California. We believe our value proposition combining great education, research relevance and an amazing climate and physical locale, make us very attractive, especially to students from places like Southern California with large populations and expensive cost of living. Regarding Masters students, UNM appears currently to be the exception in a general trend in North America with typical ECE departments host hundreds of international self-paying terminal Masters students. A significant number of self-paying Masters, combined with our recently approved differential tuition, would make a tremendous impact on our finances as well as our overall presence in the market. The overall tuition and living costs in Albuquerque are still so affordable, that we should be very attractive at least to the second tier of Indian prospects and similar large student-exporting countries.

Establish closer relations with the national laboratories.
While we enjoy a very good working relationship with Sandia National Laboratories (SNL), Los Alamos National Laboratory (LANL) and the Air Force Research Laboratory (AFRL), we need to become the department of choice for members of these laboratories as well as to align our strengths and interests with theirs. As an example, we are currently working closely with AFRL to accommodate the educational and research needs of a large group that focuses on space weather and that will be moving from Boston to Albuquerque. We are also collaborating with AFRL on establishing strong research efforts in the areas of reconfigurable systems, and with SNL on establishing emerging energy tracks and courses. In particular with SNL, there is finally some advanced negotiations regarding the establishment of "National lab professorships" and a more systematic relationship.

Establish a larger and more stable funding stream to support our graduate and undergraduate students.
While the department currently supports around 25 graduate students (graduate teaching assistants), and more than 60 research assistants, we believe that our faculty can supervise around 60 more graduate students given the appropriate funding. The I&G funds support approximately 25 graduate assistants with the remainder being supported from research overhead. We already have an excellent pool of international students, and our efforts to focus on Latin America and personal recruitment by the faculty have been widely successful. Various initiatives within the department and the university, as well as the state of New Mexico, may actually open the door to many more graduate students.

At the undergraduate level, the department has been aggressively recruiting High School students and awarding them departmental scholarships. While New Mexico high school students enjoy (lottery-funded) state-wide scholarships, to recruit the top students into ECE, the department is spending around $25,000 per year on supplementary Academic scholarships. An infusion of funds in this area will allow to recruit more students as well as to help preparing incoming students for careers in science and engineering.

Make a strategic impact in the area of modern online education. As an immediate extension of goal #4, for both financial independence but also for national and international relevance, we have been working on putting together and launching (in 2018) two new online concentrations for our CompE and EE

Masters, namely a concentration on the "Internet of Things" and a concentration on "Space Systems Engineering", respectively. We have already officially launched the IoT concentration for the Summer/Fall of 2018, and working through the last stages of Senate approvals. Similarly, for the Space Systems degree, where are in the late stages of approvals and of identifying adjunct faculty in the Air Force and the Labs to help make our offerings attractive and relevant to practitioners around the world.

Increase the number of women and minority faculty members. The ECE department culture is rich and diverse. More than 20 languages are spoken by our faculty and staff. The department faculty currently include ten minority faculty members (33%) and five women faculty (16.5%), which we feel are low in relation to our student population. One of our goals would be to attract more women and minority faculty into ECE.

Reach our Alumni. The ECE department has (since 1920) graduated more than 5,500 students. We have done a poor job in reaching our Alumni. During the last few years, however, we have initiated an outreach campaign that is starting to bear fruit. We have asked the UNM foundation to contact our graduate and to request some data on their whereabouts and professional careers. The responses continue to come in at the rate of 10 or so per day. The UNM Foundation people in SOE have been very helpful and active recently, and we have high hopes for increasing our reach and the financial impact in the Alumni relations area.

1.2 Questions for Review Team:

In recent years, more diverse interdisciplinary programs have been established across departments, and even across colleges and schools. While the research problem and interests of our faculty have supported the creation of such programs, the current institutional structure is built around the departments. Resource allocation and teaching credits (funds and positions) focus on departments rather than on cross-cutting multidisciplinary programs. This issue was highlighted in a National Research Council (NRC) study where a number of our faculty, their PhD students, their funding, and their papers were not counted for ECE but rather under the Optical Sciences and Engineering (OSE) program (which happened to be listed under the Physics department). Given the need and desire to offer multidisciplinary programs, how do we handle the increasing demands of Academic multidisciplinary programs?

While recent economic woes have affected universities everywhere, UNM's fiscal concerns started two years earlier with an audit of the research office. In recent years, the UNM administration has instituted various policies to address the fiscal crisis. Some of these policies have impacted the teaching mission of the ECE department since they reduced the amount of overhead funds that are returned to the department. The ECE department relied heavily on the overhead generated in order to attract and support graduate students, as well as to recruit undergraduates. Most importantly, however, the squeeze on the state and overhead funds has affected our ability to attract new faculty. Under the current funding constraints, how can we come up with creative and sustainable faculty hiring plans and graduate student recruiting?

With the National Academy of Engineering publication of their report on Educating the Engineer of 2020, engineering educators have scrambled to expand the education of students to include a knowledge of innovation, entrepreneurship, IP development, tech transfer, etc. The ECE curriculum, already cramped with all the required courses is being massaged to include such new concepts. There is a general feeling that a basic body of knowledge needs to be included but reasonable people have different notions of what

is basic. Nationwide, many institutions are responding to the need to increase the number of scientists in STEM disciplines and to improve the quality and number of scientist and engineers to supply the ever-increasing demand for these professionals. Its importance is well stated in the "America Competes Act" (2007) signed by Congress and the President and this Act should be viewed as a mandate to boost Math, Science, and Engineering at all levels. Today, we do not see strong evidence of UNM responding to this in a significant manner. Any successful initiative in our department, for the most part, has to be self-sustained. How do we design our undergraduate programs to respond to the competing pressures of depth versus breadth? How do we reward faculty members who are involved in IP generation and tech transfer activities? And how do we ultimately impress upon the institution the importance of supporting and funding and increasing initiatives that will increase the number of students studying engineering?

While our faculty are aware of their own achievements and of the quality of our program, the window through which potential students and faculty members see us remain clouded by our rankings (US News). How to develop concrete steps to improve our rankings?

The ECE department received $6 million in grants in the year 2016-17. While the UNM research office has recently undergone various positive re-organizations, the department faculty and staff remain concerned about the level of support from the university research administration both in terms of returns as well as the ability of the research administration staff to respond in a timely fashion to the changing funding landscape. Moreover, and due to the changing nature of funding (more industry-based) Intellectual Property (IP) issues are consuming a larger chunk of the faculty and departmental time. How can we streamline the research office/faculty interactions to help focus the faculty's efforts on securing the funds and doing the research?

2 Department of Electrical & Computer Engineering Self-study

2.1 General Program Characteristics

2.1.1 History

The ECE department dates to 1904, with graduate degrees awarded (MS and Doctor of Science) in 1956. The program has had an incredibly strong track record, in particular with the graduate program. The enrollment in ECE graduate programs exceeded that of any other UNM department during both the fall and spring semesters of 1956. The growth of the graduate program resulted in the expansion of research by EE professors and their students and in 1961, the department was already receiving more than $500,000 in funded research. Instituted in 1959, the Sandia Technical Development Program had a profound impact on the growth of the EE graduate program. When it terminated on June 30, 1969, the Sandia Technical Development Program had both greatly increased graduate enrollment in EE and improved the overall quality of the Department's graduate education. During the first semester of 1956, 128 students, excluding freshmen, were enrolled in EE while 121 were enrolled in the second semester of that year. The implementation of the Navy Enlisted Scientific Education Program (NESEP) Navy Program was another factor in increasing undergraduate enrollment in EE during this period. Beginning in September of 1961 and continuing in the years that followed, twenty-five representatives of the U.S. Navy began the EE undergraduate program each fall. In 1963, forty-one students received undergraduate or graduate degrees in EE. By 1966, increasing EE enrollment made the UNM Department of Electrical Engineering one of the largest in the western United States.

By 1969, the Department consisted of four professors, ten associate professors, two assistant professors, and one visiting professor. In addition to the consolidation of new graduate and undergraduate training programs, the growth years proved particularly important in distance education. The Department of Electrical Engineering became the first University department to use television to teach required undergraduate courses. Television lectures, Department officials argued, would allow students to record lectures and discussion sections for future reference and therefore increase their ability to study difficult material. This new teaching strategy continued to be an important departmental practice in the decades that followed, until it was later complemented and largely replaced by web-delivered courses. With the June 1966 commencement, the College of Engineering administrators made the decision to change the Doctor of Science degree-granting program (ScD) to one that offered a Doctor of Philosophy (PhD).

Throughout the 1950s and 1960s, the Electrical Engineering Department was plagued by a shortage of space, laboratory equipment, and a high rate of faculty turnover due to low salaries. Furthermore, the explosion in graduate education and research brought to light serious inadequacies in the University library's collection on science and engineering. In the late 1960s, many members of the Department of Electrical Engineering faculty developed a sincere interest in computers, the most recent sub-field of EE. At the end of the decade, EE instituted a computer committee to design courses in computer science and provide advice as to how to best start a computer-training program within the Department. Because of the profound interest in computers demonstrated by the EE faculty and student body, the Department of Electrical Engineering officially changed its name to the Department of Electrical Engineering and Computer Science in 1970. In 1970, the Electrical Engineering and Computer Science Department continued to offer programs leading to advanced degrees in all the major areas of EE but, according to UNM reports, placed an emphasis on computers. Interestingly, the Electrical Engineering Department was not the only UNM division interested in promoting the study of computers. In 1976, UNM instituted a new academic department called the Department of Computing and Information Science (CIS). Originating in

the Mathematics Department, Computing and Information Science, like the Department of Electrical Engineering and Computer Science, demonstrated a profound interest in the academic study of computers. In 1979, the Department of Computing and Information Science became the Department of Computer Science. At the same time, the Department of Electrical Engineering and Computer Science officially changed its name to the Department of Electrical and Computer Engineering, or EECE.
The creation of the EECE Department led to the establishment of two new degree-granting programs. In 1979, University officials approved a BS in computer engineering (formerly a degree in Engineering with a computer science option) as well as a PhD concentration in that area. In the late 1970s and early 1980s the Department's faculty demonstrated interest both in computer engineering and microelectronics. Two years later, in 1983, the EECE Department decided to establish an Endowed Chair in Microelectronics with the financial backing of the city of Albuquerque and, at the same time, established the Institute for Microelectronics and Thin Films. Soon after its inception, however, the Institute was reorganized into the Center for High Technology Materials, or CHTM, and removed from the immediate jurisdiction of the EECE Department. During this period, the EECE Department also began a PhD program in optical science and an option in computer engineering, two additions which expanded the graduate-level training available to students in the Department.

The rapid adoption of computer-training programs within the Department caused the problem of space to resurface once again. In the 1970s, the addition of computer equipment, supplies, and instructors as well as the need for more classrooms and laboratories to train computer engineering students resulted in a drastic space shortage within the Department. Although the EECE seat was still located in the Electrical Engineering Building, then known as Tapy Hall, the EECE Department was essentially spread out over several campus buildings in 1980. In that year, elements of the Department occupied the Farris Engineering Center, the Mechanical Engineering Building, the Old Lecture Hall, and Tapy Hall. Unfortunately, all of these buildings, including Tapy Hall, were filled to capacity with electrical laboratories, classrooms, offices, and other educational equipment and facilities. In order to meet the desperate need for more space, the New Mexico State Legislature's approved a new building in 1982. The much-needed structure was completed in the summer of 1986 and continues to house the EECE Department to this day.

One year later, William Streifer became the first recipient of the Endowed Chair in Microelectronics and the first director of the Center for High Technology Materials, or CHTM. In the latter part of the decade, the Department began an undergraduate program for prospective Los Alamos National Laboratory employees, instituted pulsed power as a new area of concentration in the Department, expanded on the Instructional Television or ITV method of teaching, made moves towards affirmative action in its hiring faculty and staff members, and demonstrated a newfound research interest in the area of robotics. In the 1990s, the research areas of the Department could be roughly divided into three distinct EECE sub-fields: computers, electro-physics, and systems.

In 1995 the college of engineering sought a School designation for the University's engineering program. On February 15, 1995, UNM officials signed an act that changed the College of Engineering into the School of Engineering. The department changed its acronym from EECE to ECE in 2001. The ECE department today offers ABET-accredited BS degrees in electrical engineering and in computer engineering, MS degrees in electrical engineering, computer engineering and optical science and engineering, and PhD degrees in engineering as well as PhD degrees in optical science and engineering. The department also offers an online MS degree in electrical engineering.

Student Engineering Societies: The expansion of the Electrical Engineering Department and, for that matter, the entire College of Engineering, mandated that organizations continue to be available to meet the needs of EE students. Between 1955 and 1969, the Engineers' Society continued to sponsor the annual Engineering Day, the Open House, engineering balls and dances, the publication of an engineering issue of the student newspaper, and spirited competitions with members of the College of Arts and Sciences. As had been the case since the 1920s, the Engineers' Society continued to promote a sense of camaraderie among all engineers, regardless of their discipline. In 1957, the Engineers' Society obtained a formal, administrative component with the addition of the Engineers' Joint Council to the UNM campus. This organization, the official UNM counterpart of the National Engineers' Joint Council, was designed to coordinate and supervise activities involving all branches of engineering at the University. Members of the Council included representatives from each engineering department, a faculty advisor, and four officers. The Engineers' Joint Council's primary function was to plan and organize Engineering Day and the Engineering Open House, two events which had by then become UNM traditions. In addition to participating in the Engineers' Society, Electrical Engineering students continued to attend regular meetings of their own organization, the UNM chapter of the American Institute of Electrical Engineers (AEE). In January of 1963, AEE officially merged with another student organization, the Institute of Radio Engineers (IRE), to form the UNM student branch of the world's largest professional organization in the field of EE – the Institute of Electrical and Electronic Engineers (IEEE). The UNM student branch of IEEE, commonly referred to simply as IEEE, was, according to its first officers, designed "to further the development of the electrical engineering student and to promote interests in the theory and practice of all aspects of electrical engineering and allied fields." On April 8, 1962, the University of New Mexico officially acquired Delta Omicron Chapter of Eta Kappa NU, the national electrical engineering honor fraternity.

Apart from these ECE based student societies, students are also part of SOE societies as well. These include the society of women engineers (SWE), the Hispanic Engineering and Science Organization (HESO), the American Indian Science and Engineering Society (AISES) and the Native Americans in Science, Technology, Engineering and Mathematics (NASTEM). The societies also reflect the changing demographics of Electrical and Computer Engineering students with improved enrollment and retention of women and underrepresented minorities.

The department believes that the active participation of students in professional societies is critical to the professional and societal success. The department chair and the associate chair along with the undergraduate and graduate directors play a key advisory role in these organizations.

2.1.2 Statement of mission.

UNM Mission.

The mission of the University of New Mexico is to serve as New Mexico's flagship institution of higher learning through demonstrated and growing excellence in teaching, research, patient care, and community service.

UNM's ongoing commitment to these cornerstones of purpose serves to:

- Educate and encourage students to develop the values, habits of mind, knowledge, and skills that they need to be enlightened citizens, contribute to the state and national economies, and lead satisfying lives.
- Discover and disseminate new knowledge and creative endeavors that will enhance the overall well-being of society.
- Deliver health care of the highest quality to all who depend on us to keep them healthy or restore them to wellness.
- Actively support social, cultural, and economic development in our communities to enhance the quality of life for all New Mexicans.

UNM Vision.

UNM's vision describes the future state to which we, as an institution, aspire. Our aim is for this to be a vision that is "alive," serving to inform and align all of our goals, activities, decisions, and resources, as well as inspiring and encouraging initiative, innovation, and collaboration. We aspire to a future in which we are known for:

- **Strength through Diversity.** We lift up our cultural and ethnic diversity as the unique strategic advantage it is, providing the environment in which our students learn with one another to generate new knowledge that helps the world's people leverage and celebrate the value of difference.
- **Student Success through Collaboration.** We are seen as committed partners with those whose mission it is to educate New Mexico's citizens, helping to assure that each individual has the opportunity and resources to develop the confidence and skills that open the door to higher learning.
- **Vital Academic Climate.** We are known for our dynamic, interactive, and passionate academic climate, punctuated by the virtue of academic freedom that is a hallmark of all the world's great universities.
- **Excellence through Relevance.** We are seen as the university of choice for the brightest students, offering nationally-recognized programs at the undergraduate, graduate, and professional levels that will remain relevant throughout the 21st century and beyond.
- **Research for a Better World.** We utilize the geography of our southwestern landscape and culture, as well as our expansive international connections, as important platforms for research that lead to economic development and improved quality of life; from sources of sustainable energy to cures for disease; from state-of the art digital and film technologies to nanotechnologies.
- **Health and Wellness Leadership.** We are an unmatched health and wellness resource in New Mexico, ensuring access to all, providing state-of-the-art facilities and care, and engaging in research that leads to new ways to preserve wellness, as well as treat and cure disease. **International Engagement.** We recognize and maximize the value of our location in the United States and the western hemisphere and are seen as a hub for international initiatives that touch all parts of the globe.

ECE Department Mission.

The ECE department has identified a three-fold mission:

- Education — Curriculum development to enhance the relevance, attractiveness, and integration of our programs. ECE is committed to being a model of teaching and learning, to fostering a desire for life-long learning, and to:
    - Provide a nationally recognized first degree, becoming the first-choice department for undergraduate applicants in the southwest region and elsewhere.
    - Continue to achieve international prominence in key programs in graduate studies and research.
    - Provide life-long learning opportunities for ECE alumni.
    - Enhance professional activities and development for students and faculty in the context of a diversified environment.
    - Incorporate dynamic education for industry.
- Research — ECE is committed to:
    - Increasing research programs at national and international levels of excellence, fostering multidisciplinary efforts.
    - Performing basic and applied research with our students to advance the state of our profession, and improving our partnerships with local, regional, national, and international industry and research agencies.
    - Forming alliances with local companies as one of our guiding principles, building on local strengths and synergy.
- Service — ECE is committed to providing quality service to our students and constituents and will:
    - Provide quality advisement to our students.
    - Encourage opportunities for entrepreneurship to our graduates, thus fostering economic development in New Mexico.
    - Provide resources to the community.
    - Promote activities in professional societies among faculty and students on the local, regional, national, and international levels.
    - Alumni to provide mentoring to students.
    - Identify key companies to hire our graduates.
    - Do a needs assessment with these companies to identify the skills they desire in new graduates, and the training classes and re-certification-type classes they could use.
    - Send resumes of faculty to training departments of organizations to let them know which classes faculties are qualified and available to conduct.
    - Develop a portfolio of short courses that faculty can teach on demand.

ECE Department Vision.

The vision of the ECE department is to provide world-class educational and research experiences. This simple vision reaffirms the ECE department's long-standing commitment to provide excellent, "world-class" quality undergraduate and graduate programs in a vibrant academic environment. In doing so, the department directly serves the varied constituents listed above. Furthermore, this vision provides a standard by which the department plans, operates and will evaluate itself moving forward. It is easy to see that the mission of the ECE department directly supports that of UNM, particularly as it pertains to

the education and encouragement of "students to develop the values, habits of mind, knowledge, and skills that they need to be enlightened citizens, contribute to the state and national economies, and lead satisfying lives." Success in the department's mission with respect to education will result in nationally recognized undergraduate and graduate programs, where students receive a solid foundation in the principles of electrical or computer engineering, industry-relevant training, and a desire for life-long learning. Given this preparation, students graduating from our undergraduate programs are well-prepared to compete for jobs in the technology sector at both the local and national levels and students graduating from our graduate programs are able to shine in research, academia and industry. Furthermore, by providing this level of talent, we are helping to fuel the growth of the high-technology industries that are vital to the state and nation. Finally, by fulfilling the ECE vision of operating according to world-class standards, the department will help UNM realize its vision of membership in the Association of American Universities.

2.1.3 Leadership, governance and organization structure.

A chairperson who is appointed by the dean with input from the ECE faculty for a renewable 5-year term leads the ECE department. An associate chair assists the chairperson. The chair selects the associate chair with input from the ECE faculty. The associate chair leads the undergraduate and graduate committees in all academic matters. There are currently 5 standing committees in the ECE department:

1. The undergraduate committee is presided over by the associate chair and contains members selected by the various departmental groups. Its charter is to manage, review, and revise the undergraduate curriculum.

2. The graduate committee is presided over by the associate chair and contains members selected by the various departmental groups. Its charter is to manage, review and revise the graduate curriculum including the PhD qualifying exam.

3. The Teaching Laboratories committee is presided over by the associate chair and includes the ECE chair, the director of laboratories, the departmental senior accountant, and a graduate student. Its charter is to supervise and prioritize the spending of the ECE student activities fees. This committee is the only one allowed to spend the student activities fees.

4. The promotion and tenure committee whose members are elected every year and includes a representative of each ECE group. Its charter is to supervise the promotion and tenure process of the regular, tenure-stream faculty. The committee is an advisory committee to the chair.

5. The Accreditation committee which includes the ECE chair as well as the associate Chair, two staff members involved in the undergraduate curriculum. Its charter is to collect the data needed for accreditation (ABET) as well as to carry out the processes set forth by the undergraduate committee. The department also has various ad-hoc committees (security committee, awards committee, space committee, new programs committee, etc) that serve in advisory fashion to the chair and to the faculty on as needed basis.

The ECE department faculty meets about once a month to discuss and vote on Academic and policy affairs. The ECE chair sets the meeting's agenda and calls for the meetings. In addition, the ECE chair sends periodic alerts and messages to the ECE faculty and staff (about three times a semester) to inform them

about financial as well as organizational changes at the university or school levels. Once a year, the faculty retreats to an off-campus location and meets for 1 day with an advisory board to discuss plans and strategies. The ECE department publishes an annual report that is mailed to all members of the Electrical & Computer Engineering Department Heads Association (ECEDHA) and to colleagues across the world.

2.2 Degrees programs and curricula

The ECE department currently offers two undergraduate programs leading to a Bachelor of Sciences in Electrical Engineering, and to a Bachelor of Sciences in Computer Engineering. The two programs are accredited by ABET, Inc., (last in 2017) the recognized accreditor for college and university programs in applied science, computing, engineering, and technology.

The ECE department offers graduate programs leading to a Master of Science in Electrical Engineering, a Master of Science in Computer Engineering, as well a Master of Science in Optical Sciences & Engineering. Graduate students can also earn a PhD degree in Engineering, as well as a PhD degree in Optical Sciences & Engineering. The graduate programs are periodically reviewed but not officially accredited. The department teaches around 60 courses per semester, divided almost equally between undergraduate and graduate courses. The graduate student enrollment is ~ 250, while the undergraduate student enrollment is 400.

2.3 Accreditation

Both the Computer Engineering and Electrical Engineering undergraduate programs are accredited by the Accreditation Board for Engineering and Technology (ABET). The most recent accreditation was completed in 2016. ECE@UNM has the largest electrical engineering program in New Mexico and the only accredited computer engineering program in New Mexico. ECE@UNM collaborates extensively with the federal laboratories in New Mexico (Sandia National Laboratories, Los Alamos National Laboratory, the Air Force Research Lab) as well as high-tech companies in the Albuquerque area such as Honeywell, Intel, Lockheed Martin, SAIC and Boeing. UNM is also the only university in New Mexico with a Carnegie Foundation designation of research doctoral university "with very high activity," which recognizes the university's exceptional level of funded research and the array of degree programs.
Note: Please see appendix A for the most current ABET accreditation letter.

2.4 External Advisory Council

The current ECE Department advisory council consists of the following members:

David McBride, Chair of the EAC (Constituents represented: Alumni and industry.)
Director Armstrong Flight Research Center NASA.
Former graduate of the Department. He holds a leadership role in NASA in research, development and outreach.

John Hawkings (Constituents represented: local industry.)
Manager, Advanced Technology and Strategy at PNM Resources.
He represents our collaboration with large companies and industry. PNM hires a lot of our students and they have a vested interest in improving our program on a continuous basis.

Casey DeRaad (Constituents represented: Alumni, National lab and students.)
Director, AFRL-NM Institute, Air Force Research Laboratory
She is also a graduate of our Department but she is the university programs liaison for the Air Force Philips Research Laboratory and her interests are in attracting female and minority students throughout New Mexico to STEM disciplines.

Dr. Luke Lester (Constituents represented: peer institution.)
Professor and Department Head Electrical and Computer Engineering department, Virginia Tech, VA
Prof. Lester is a former faculty and Department Chair of our Department and has a very good understanding of our programs and student strengths and weaknesses. He can also help us with his experience from a much bigger engineering school as Virginia Tech.

Dr. Kamil Agi (Constituents represented: Alumni and small businesses.)
CEO, K&A Wireless.
He has had an extensive and long-standing interaction with the Department and represents industry and more specifically small businesses.

Dr. Kelly Hahn (Constituents represented: Alumni, National lab and women students.)
Physicist with Sandia National Labs
She is a former student from the department and contributes with her previous experience as a female student in the Department and also represents Sandia National Laboratories in the council.

Dr. Jesse Mee (Constituents represented: Alumni and national lab.)
Program Manager/Researcher with the Air Force Philips Research Laboratory.
A graduate from ECE, he represents the Air Force Research Labs in the council.

Dr. Divya Thakur (Constituents represented: national lab and women engineers.)
NRC (National Research Council) Fellow, AFRL and adjunct faculty at ECE.

Firas Ayoub (Constituents represented: students.)
PhD student, ECE and the President of ECE Graduate Student Chapter.
Represents ECE students in the advisory council.

3 Undergraduate Program

The ECE department administers two programs at the undergraduate level, one in Computer Engineering, and the other in Electrical Engineering. Both programs successfully achieved ABET accreditation in 2016 – 2017. The undergraduate program is one of the larger programs in the school of engineering enjoying good growth in enrollment. The tables below provide undergraduate enrollment and graduation numbers from 2011-2012 to 2017-2018. Prior to 2016 only the admitted majors were counted as ECE students and were advised at ECE. Since Fall 2016 both majors and pre-majors (students who have declared EE or CompE as their desired major) are considered ECE students and are advised by ECE advisors.

Undergraduate enrollment

	Fall 2011	Fall 2012	Fall 2013	Fall 2014	Fall 2015	Fall 2016*	Fall 2017*
Comp E	60	58	71	80	64	195	189
EE	120	109	128	139	113	243	221
ECE Total	180	167	199	219	177	438	410

Table 3.1: ECE undergraduate enrollment data. (* indicates years when both the majors and pre-majors are included in the count.)

Undergraduate Graduation

	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
Comp E	10	13	18	22	17	28	20	7
EE	28	37	29	34	47	45	47	9
ECE total	**38**	**50**	**47**	**56**	**64**	**73**	**67**	**16**

Table 3.2: ECE undergraduate graduation data.

3.1 Program Educational Objectives

The objectives of each of these programs are shared. More specifically, to fulfill the mission of the ECE department and serve our constituents, the objectives of the ECE undergraduate programs are to educate students to become resourceful practitioners of engineering, who within 3-5 years of graduation:

- are capable of utilizing their engineering skills in industry, non-profit organizations, and national laboratories, or in the pursuit of graduate education;

- are knowledgeable of the professional responsibilities and social context associated with being an engineer; and effectively communicate the results of their work;
- will develop their knowledge and skills throughout their careers; and,
- will function well in a diverse environment.

3.2 Consistency of the Program Educational Objectives with the Mission of the Institution

The Program Educational Objectives of the ECE undergraduate programs are most closely aligned with the educational component of the ECE mission. Specifically, if ECE students are capable of utilizing their skills in the workforce or in pursuit of a graduation education, as described in the first objective, then these programs must be relevant, an item in the ECE mission. Similarly, the second objective, dealing with the professional responsibilities of engineers, and their ability to work in teams, directly addresses the relevance of the department's educational mission. The ability to develop knowledge and skills throughout a career, the third objective, almost certainly implies a desire for life-long learning, as described in the ECE mission. Next, the ability to function well in a diverse environment, the fourth objective, directly addresses what students are increasingly encountering in the workplace with respect to the globalization of industry, and again speaks to the relevance of the program. Finally, achieving excellence in attainment of all of these objectives will only serve to make UNM ECE students more desirable in the workforce (and to graduate programs), thereby enhancing the reputation of the ECE department and UNM in general. This will serve to strengthen the ECE department's standing in the state and region, helping to establish it as the department of choice for students in these areas. The Program Educational Objectives of the ECE undergraduate programs are also consistent with the ABET criteria, particularly as they pertain to satisfying "the needs of constituents in a dynamic and competitive environment." It is easy to see that each of the ECE constituent groups are well-served by the education of students that are prepared to achieve the ECE Educational Objectives described above. Students are more likely to have rewarding and satisfying careers if these objectives are attained, the graduate programs and the industries that employ them are also more likely to find success, and the state as a whole therefore benefits.

UNM Mission	Objective Capable of utilizing engineering skills/Pursue advanced study	Objective Professional and social responsibilities/ effectively communicate work.	Objective Lifelong development of knowledge and skills.	Objective Function in diverse environments.
Teaching	X	X		
Research	X	x		
Patient care	X		X	X
Community service			X	X

Table 3.3 : Relationship between UNM Mission and the Electrical Engineering Program Educational Objectives.

3.3 Program Constituencies

The constituents served by the ECE department are –

- our students
- local, national and international industry
- the federal research laboratories
- local, national, and international graduate and professional schools
- our alumni.

The undergraduate students enrolled in our programs are primarily New Mexico residents that enter UNM directly after graduating from a New Mexico high school. The department also serves a smaller number of transfer, out-of-state and international students at the undergraduate level. The local, national and international industries referred to above are assumed to be ones that have some operations related to engineering, and that hire electrical or computer engineers in order to service these operations. Similarly, the constituency at federal research laboratories is assumed to be engineering-related organizations. The graduate programs referred to above are not restricted to engineering, and are assumed to also include other professional areas, such as business and medicine. Finally, the alumni referred to above are the graduates of our program who are afforded the opportunity to continue their professional development through the educational and networking opportunities.

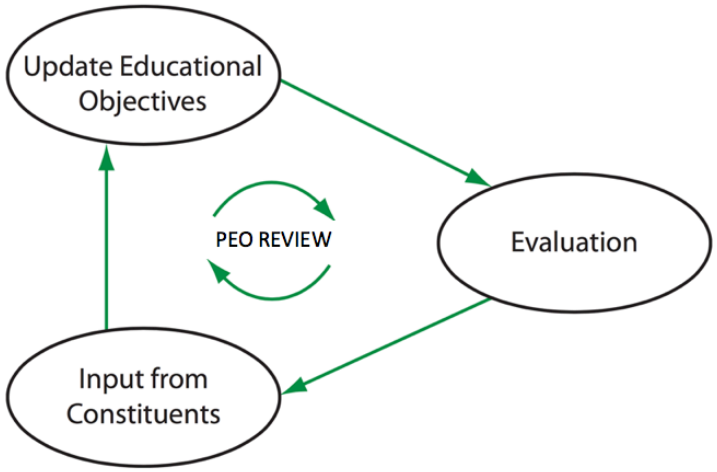


Figure 1: Process of updating the PEOs.

3.4 Process for Review of the Program Educational Objectives

The process shown in Figure 1 provides a high-level overview of the steps taken to periodically document and demonstrate that the objectives of the undergraduate programs in the ECE department are based on the needs of our constituents. The group that is ultimately responsible for determining the Electrical and Computer Engineering programs' objectives, and for ensuring they are consistent with the missions of the university and the department, is the ECE Strategic Planning Committee in consultation

with the Advisory board for the department. The composition of the advisory council is kept such that all constituents of the ECE department are represented in the body.

3.5 Process for Establishment and Revision of the Student outcomes.

The integrated continual improvement processes used by the ECE department to assess and up- date program objectives and outcomes is shown in Figure 2. These processes were established by the leadership of the ECE department, in consultation with the Faculty, ECE Chair's Committee, and the ECE Advisory Committee. The ECE chair's committee typically comprises of the department chair and the two associate chairs. The figure shows the feedback loops that lead to continuous refinement of program objectives and curricular improvements to achieve the standards set for each outcome. The loop shown in "green" is executed less frequently, and its implementation is the primary responsibility of the ECE Chair's Committee. This loop assures periodic evaluation and redefinition (if necessary) of the current program educational objectives and was described in more detail in Criterion 5. The loop shown in "blue" is executed more frequently, and focuses primarily on outcomes assessment, leading to curricular improvements. The implementation of this process is the primary responsibility of the ECE Undergraduate Committee. The red arrow in Figure 2 depicts the activity of relating the degree to which the program educational objectives are being achieved, and how the program outcomes should be adjusted in order ensure their attainment. This activity occurs through discussions at the ECE Advisory Council meeting, with input provided by the ECE Strategic Planning Committee and the ECE Undergraduate Committee.

The data used for making decisions related to improvements associated with the green loop come from a number of sources depending upon the constituency. Surveys are periodically conducted in order to collect information from program graduates (approximately 5 years after graduation) and their employees. In addition, data is collected from the ECE department's graduate program in order to assess to the degree to which program graduates find success in graduate school. Finally, a member of the ECE staff solicits feedback through surveys and direct interactions with the participants in the department's outreach activities that include K-12 students and teachers throughout the state of New Mexico.

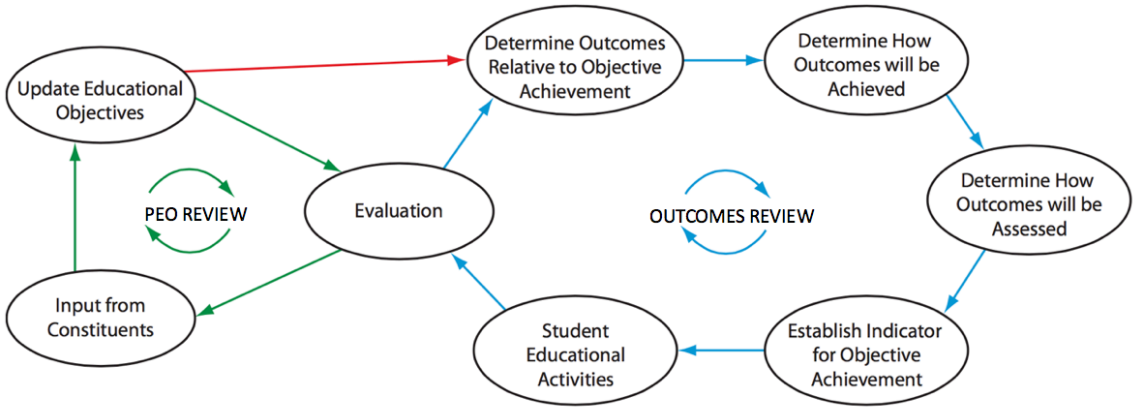


Figure 2: Process for updating student outcomes.

The data used for making decisions related to improvements associated with the blue look primarily come from the knowledge probes that are conducted every semester. In addition, the department Chair and Associate Chair for Undergraduate programs have decided to hold an open forum for under graduate students every semester in which students are given the opportunity to provide feedback regarding any

aspect of their experience at UNM. Any information in these meetings that may relate to program outcomes and the curriculum is provided to the Undergraduate Committee for consideration.

3.6 Student Outcomes (as recommended by ABET).

a. an ability to apply knowledge of mathematics, science, and engineering
b. an ability to design and conduct experiments, as well as to analyze and interpret data
c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and 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 professional and ethical responsibility
g. an ability to communicate effectively
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. a recognition of the need for, and an ability to engage in life-long learning
j. a knowledge of contemporary issues
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

3.7 Continuous improvement.

The integrated continual improvement processes used by the ECE department to assess and up- date program objectives and outcomes is shown in Figure 3. These processes were established by the leadership of the ECE department, in consultation with the Faculty, ECE Chair's Committee, and the ECE Advisory Committee. The chair's committee consists of the department chair and the two associate chairs. The figure shows the feedback loops that lead to continuous refinement of program objectives and curricular improvements to achieve the standards set for each outcome. The loop shown in "green" is executed less frequently, and its implementation is the primary responsibility of the ECE Chair's Committee. This loop assures periodic evaluation and redefinition (if necessary) of the current program educational objective and was described in more detail in Criterion 5. The loop shown in "blue" is executed more frequently, and focuses primarily on outcomes assessment, leading to curricular improvements. The implementation of this process is the primary responsibility of the ECE Undergraduate Committee. The red arrow in Figure 3 depicts the activity of relating the degree to which the program educational objectives are being achieved, and how the program outcomes should be adjusted in order ensure their attainment. This activity occurs through discussions at the ECE Advisory Council meeting, with input provided by the ECE Chair's Committee and the ECE Undergraduate Committee.

The data used for making decisions related to improvements associated with the green loop come from a number of sources depending upon the constituency. At the end of each semester surveys are conducted in order to collect information from the students about every single course taken. The senior design programs also collect information from the sponsors of the student projects. In addition, data is collected from the ECE department's graduate program in order to assess to the degree to which program graduates find success in graduate school. Finally, a member of the ECE staff solicits feedback through surveys and direct interactions with the participants in the department's outreach activities that include K-12 students and teachers throughout the state of New Mexico. These findings are shared with the ECE Chair's Committee.

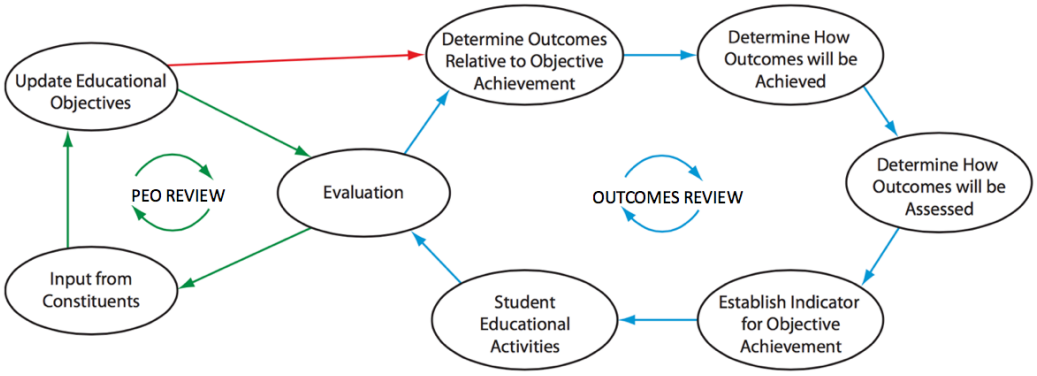


Figure 3: Integrated continuous improvement process for the Electrical Engineering program.

The data used for making decisions related to improvements associated with the blue loop primarily come from the knowledge probes that are conducted every semester. In addition, the department Chair and Associate Chair for Undergraduate programs will start to hold an open forum for undergraduate students every semester in which students will be given the opportunity to provide feedback regarding any aspect of their experience at UNM. Any information in these meetings that may relate to program outcomes and the curriculum is provided to the Undergraduate Committee for consideration.

3.8 UNM Core Curriculum/Electives for ECE Students

UNM adopted a core curriculum in fall 2003 which requires all undergraduate students to complete as part of their baccalaureate program. UNM core requirements for *Writing and Speaking*, *Mathematics*, and *Physical and Natural Sciences* have already been incorporated into the ECE curriculum sequences. ECE students may choose from the following electives for the *Social and Behavioral Sciences, Humanities, Fine Arts and Foreign Language* requirements.

Social and Behavioral Sciences

- Economics 105 or 106
  Plus one course from the following:
- American Studies 182 or 185
- Anthropology 101 or 130
- Economics 105 or 106
- Geography 102
- Linguistics 101
- Political Science 110 or 200
- Psychology 105
- Sociology 101
- Engr-F 200 - Tech in Society

Humanities

Two courses from the following:

- American Studies 186
- Classics 107, 204, or 205
- Comparative Literature and Cultural Studies 223 or 224
- English 150, 292, or 293
- Modern Lang 101

- History 101, 102, 161, or 162
- Philosophy 101, 201, or 202
- Religious Studies 107

Fine Arts

One course chosen from among the following:

- Art History 101, 201, or 202
- Dance 105
- Media Arts 210
- Music 139 or 140
- Theater 122

Students may instead elect to take one three-credit studio course in the departments of Art & Art History, Music, Theater & Dance, or Media Arts to fulfill this requirement.

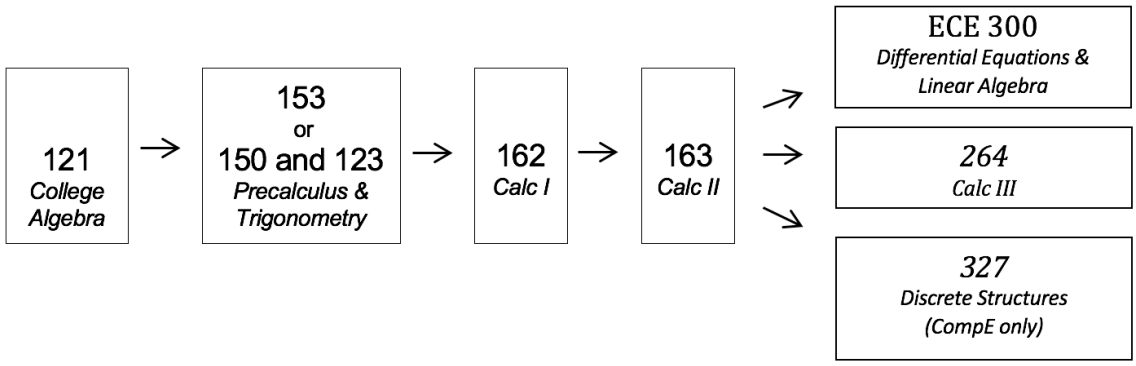
Second Language

One course chosen from any of the lower division non-English-language offerings of the departments of Linguistics, Spanish & Portuguese, and Foreign Languages & Literature. CLEP, AP and Foreign Language Proficiency exams may be used to satisfy this requirement.

Mathematics Placement and Prerequisites

The lowest-level math course in the ECE curriculum is Math 162. Prerequisite courses must be satisfied with a grade of C or better in accordance with UNM's core curriculum. Placement in mathematics courses is determined by the student's ACT and SAT quantitative scores. In general, to enroll in Math 162 (Calculus I) the student must have an ACT math score of 28 or greater or an SAT quantitative score of 640 or greater. If the student has not yet completed Math 123 (trigonometry), which is a prerequisite for Math 162, he/she must pass the COMPASS trigonometry exam offered at the UNM Testing Center or successfully complete Math 123 prior to enrolling in Math 162.

Engineering Mathematics Sequence:



3.9 Track Courses and Technical Electives

Both the Computer Engineering and Electrical Engineering programs offer areas of specialization, or tracks. Students must take two classes from the track of their choice. In addition, technical electives are required by both programs. Technical electives are developed in consultation with your academic advisor and can be taken from ECE, Computer Science, Physics, Math or other engineering-related courses 300-level or above. (ECE 231: Intermediate Programming is the only 200-level exception allowed in the EE program only.) Below is a list of track areas, courses required for each and technical elective credit hours required for by each program.

ELECTRICAL ENGINEERING OPTIONS

- **Systems and Controls:**
  ME 481/581 – Digital Control of Mechanical Systems
  ECE 446 – Design of Feedback Control Systems

- **Energy/Power Systems:**
  ECE 482/582 – Electric Drives and Transformers
  ECE 483/583 – Power Electronics
  ECE 484/584 – Photovoltaics
  ECE 488/588 – Smart Grid Technologies

- **Signals and Communications:**
  ECE 439 – Intro to Digital Signal Processing
  ECE 442 – Intro to Wireless Communications

- **Microelectronics:**
  ECE 471– Materials and Devices II
  ECE 474L/574L/NSMS 574L – Microelectronics Proc
  OR
  ECE 421/523 – Analog Electronics
  ECE 424 – Digital VLSI Design
- **Electromagnetics:**
  ECE 460/560 – Intro to Microwave Engineering
  ECE 469/569 – Antennas for Wireless Com Sys
  ECE 495 – Computational Methods for Electromagnetics
  ECE 495 – Plasma Physics I

- **Digital Systems:**
  ECE 338 – Intermediate Logic Design
  ECE 438 – Design of Computers
  OR
  ECE 231 – Intermediate Programming and Eng Prob Solving
  ECE 331 – Data Structures and Algorithms

- **OptoElectronics:**
  ECE 471– Materials and Devices II
  ECE 475 – Intro to Electro-Optics and Opto-Electronics

Technical Electives are approved 300-level and above courses developed in consultation with a student's academic advisor. These can be taken from ECE, Computer Science, Math, Physics, or other engineering-related courses. ECE 231 - Intermediate Programming is the only 200-level exception allowed for the EE program only. (Electrical Engineering: 3 credits required)

COMPUTER ENGINEERING OPTIONS

- **Hardware Emphasis**
  ECE 338 – Intermediate Logic Design
  ECE 438 – Design of Computers

- **Software Emphasis**
  ECE 335 – Integrated Software Systems
  ECE 435 – Software Engineering

3.10 3+2 B.S./M.B.A

The School of Engineering recognizes that many engineers become managers of engineering programs and projects and thus require training in business methods beyond their engineering training. In cooperation with the Anderson School of Management (ASM) at the University of New Mexico, the School of Engineering offers a "3 + 2" program of studies leading to the B.S. and M.B.A. degrees in five years. This program involves selecting core and technical electives that are compatible with both degree programs and applying to the M.B.A. program at the end of the junior year of engineering studies.

3.11 SHARED CREDIT PROGRAM

The School of Engineering offers a Shared Credit Degrees Program designed to allow students to complete a B.S. and M.S., or a B.S. and M.Eng. 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.

3.12 Electrical Engineering Curriculum

BS Electrical Engineering Curriculum

Effective **Spring 2015** (120 hours)

UNM Core Curriculum, June 2015

FRESHMAN-FIRST YEAR						
FALL SEMESTER				SPRING SEMESTER		
Course #	core	CR		**Course #**	core	CR
ECE 101: Intro to ECE		1		MATH 163: Calculus II		4
ECE 131: Programming Fundamentals		3		ECON 105 or 106* Macro/Microeconomics	SB	3
ENGL 110: Accelerated Composition *(or equivalent based on placement)*	WS	3		ENGL 120: Composition III	WS	3
MATH 162: Calculus I	MTH	4		PHYC 161: General Physics II	PNS	3
PHYC 160: General Physics I	PNS	3		PHYC 161L: General Physics II Lab	PNS	1
		14				14
SOPHOMORE-SECOND YEAR						
FALL SEMESTER				SPRING SEMESTER		
Course #	core	CR		Course #	core	CR
ECE 203: Circuit Analysis I		3		ECE 206L: Instrumentation		2
ECE 238L: Comp. Logic Design		4		ECE 213: Circuit Analysis II		3
MATH 264: Calculus III		4		ECE 300: Advanced Eng. Mathematics		4
PHYC 262: General Physics III		3		Basic Science or Math Elective		3
ENGL 219: Technical Writing	WS	3		Humanities*	HU	3
		17				15
JUNIOR-THIRD YEAR						
FALL SEMESTER				SPRING SEMESTER		
Course #	core	CR		Course #	core	CR
ECE 314: Signals and Systems		3		ECE 322L (ECE Completeness Course) *Spring Only*		4
ECE 321L: Electronics I *Fall Only*		4		ECE 344L: Microprocessors		4
ECE 340: Probabilistic Methods		3		ECE 360 (ECE Completeness Course) *Spring Only*		3
ECE 371 (ECE Completeness Course) *Fall Only*		3		ECE 381 (ECE Completeness Course) *Spring Only*		3
Social/Behavioral Science*	SB	3		Humanities*	HU	3
		16				17
SENIOR -FOURTH YEAR						
FALL SEMESTER				SPRING SEMESTER		
Course #	core	CR		Course #	core	CR
ECE 341 (ECE Completeness Course) *Fall Only*		3		ECE 420: Senior Design II *Spring Only*		3
ECE 345 (ECE Completeness Course) *Fall Only*		3		ECE Track Course**		3
ECE 419: Senior Design I *Fall Only*		3		Technical Elective***		3
ECE Track Course**		3				
Fine Arts*	FA	3		Foreign Language*	FL	3
		15				12

3.13 Computer Engineering Curriculum

BS Computer Engineering Curriculum

Effective **Spring 2015** (120 hours)
UNM Core Curriculum, June 2015

FRESHMAN YEAR

FALL SEMESTER			SPRING SEMESTER		
Course #	**core**	**Cr**	***Course #***	**core**	**Cr**
ECE 101: Intro to ECE		1	ECE 231: Intermediate Programming		3
ECE 131: Programming Fundamentals		3	MATH 163: Calculus II		4
ENGL 110: Accelerated Composition *(or equivalent based on placement)*	WS	3	ENGL 120: Composition III	WS	3
MATH 162: Calculus I	MTH	4	PHYC161: General Physics	PNS	3
PHYC 160: General Physics	PNS	3	PHYC161L: General Physics Lab	PNS	1
Total		**14**	**Total**		**14**

SOPHOMORE YEAR

FALL SEMESTER			SPRING SEMESTER		
Course #	**core**	**Cr**	**Course #**	**core**	**Cr**
ECE 203: Circuit Analysis I		3	ECE 206L: Instrumentation		2
ECE 238L: Computer Logic Design		4	ECE 213: Circuit Analysis II		3
Basic Science with Laboratory		4	ECE 300: Advanced Eng. Mathematics		4
ECON 105 or 106: Macro/Microeconomics	SB	3	ECE 330: Software Design *Spring Only*		3
ENGL 219: Technical Writing	WS	3	MATH 264: Calculus III		4
Total		**17**	**Total**		**16**

JUNIOR YEAR

FALL SEMESTER			SPRING SEMESTER		
Course #	**core**	**Cr**	**Course #**	**core**	**Cr**
ECE 314: Signals and Systems		3	ECE 331: Data Structure Alg. *Spring Only*		3
ECE 321L: Electronics I *Fall Only*		4	ECE 344L: Microprocessors		4
ECE 340: Probabilistic Methods		3	Technical Elective***		3
MATH 327: Discrete Structures		3			
*Foreign Language Core**	*FL	3	*Social/Behavioral Sciences Core Elective**	*SB	3
Total		**16**	**Total**		**13**

SENIOR YEAR

FALL SEMESTER			SPRING SEMESTER		
Course #	**core**	**Cr**	**Course #**	**core**	**Cr**
ECE 419: Senior Design I *Fall Only*		3	ECE 420: Senior Design II *Spring Only*		3
ECE 437: Operating Systems		3	ECE 440: Comp. Networks		3
ECE Track Course**		3	ECE Track Course**		3
Technical Elective***		3	*Fine Arts Core Elective**	*HU	3
*Humanities Core Elective**	*HU	3	*Humanities Core Elective**	*FA	3
Total		**15**	**Total**		**15**

4 Graduate Programs

The ECE Department offers graduate courses leading to the M.S. and Ph.D. degrees: M.S. in Electrical Engineering (MSEE); M.S. in Computer Engineering (MSCompE); M.S. in Optical Science and Engineering (MSOSE); Ph.D. in Engineering with concentrations in Electrical Engineering or Computer Engineering, and a Ph.D. in Optical Science and Engineering (Ph.D. in OSE). The master's degree program requires 31 semester credit hours, while the Ph.D. program requires 19 graduate credit hours beyond the M.S. degree completed at UNM (48 coursework credits, plus two credits of ECE Graduate seminar ECE 590).
As a potential candidate for the Ph.D. program, each student must pass the Ph.D. qualifying examination (an ECE department requirement) to establish levels and areas of scholastic capabilities. Historically, the ECE department offered M.S. degrees in EE for all students in EE or in Computer Engineering. By 2004, as the number of M.S. students in Computer Engineering increased and, in order to better advertise the Computer Engineering program, the ECE department proposed a new degree for M.S. in Computer Engineering. The new degree was approved by the state of New Mexico in 2005. Since that time, the ECE department has offered two separate M.S. degrees: MSEE and MSCompE. The ECE department together with the Department of Physics and Astronomy jointly administer a graduate program in Optical Science and Engineering. The Ph.D. degree in OSE had been offered for more than two decades. In 2004, the M.S. in Optical Science and Engineering (MSOSE) program was established.

4.1 Graduate Curriculum

We recruit graduate students with diverse backgrounds and encourage them to pursue a wide variety interests and research. We have thus designed and offered a relatively large number of emphases in our graduate program. An emphasis is defined by three core courses (at 500 level) and is associated with a group of faculty with similar research interests. A graduate student in the ECE department is required to choose a research emphasis and to take the corresponding three core courses (some emphases may require up to four specific courses). While emphasis areas within Computer Engineering are identified generally, students are allowed to select their own emphasis area courses, in consultation with their faculty advisor. These courses are chosen from two lists (A and B) of possible courses.
Students are requested to identify his/her choice of emphasis in the application to the ECE department. During the initial stage of the program of study, a student may modify his/her research emphasis. Switching of research emphases after one year from the enrollment either as a M.S. student or as a Ph.D. student is discouraged but may be allowed in special and rare cases. The major core courses for different emphases in the ECE Department are outlined below.

4.1.1 Research Emphases in Electrical Engineering (EE)

- Applied Electromagnetics
  - ECE561 Electrodynamics
  - ECE560 Intro. to Microwave Engineering
  - ECE534 Plasma Physics I or ECE569 Antennas
- Bioengineering with EE
  - ECE510 Medical Imaging
  - ECE533 Digital Image Processing
  - ECE500 or ECE539 or ECE561
- Communications

  - ECE500 Theory of Linear Systems
  - ECE541 Probability Theory & Stochastic Processes
    ECE542 Digital Communications Theory
- Image Processing
  - ECE539 Digital Signal Processing
  - ECE541 Probability Theory & Stochastic Processes
    ECE533 Digital Image Processing
- Microelectronics
  - ECE520 VLSI Design
  - ECE523 Analog Electronics
  - ECE576 Modern VLSI Devices
- Optoelectronics
  - ECE561 Electrodynamics
  - ECE570 Optoelectronic Semiconductor Materials & Devices
    ECE572 Physics of Semiconductors
- Power and Energy
  - ECE583 Power Electronics
  - ECE584 Photovoltaics
  - ECE588 Smart Grid Technologies
- Signal Processing
  - ECE500 Theory of Linear Systems
  - ECE541 Probability Theory & Stochastic Processes
  - ECE539 Digital Signal Processing
- Systems & Controls
  - ECE500 Theory of Linear Systems
  - ECE541 Probability Theory & Stochastic Processes
  - ECE546 Multivariable Control Theory

4.1.2 Research Emphases in Computer Engineering (CompE)

<table>
<tr><th></th><th>Emphases</th><th>Major Core Courses</th></tr>
<tr><td rowspan="5">Computer Engineering</td><td>Bioengineering with CompE</td><td rowspan="5">List A: Select at-least two core courses from: ECE 520, ECE 533, ECE 536, ECE 537, ECE 538, ECE 540, ECE 542, ECE 549.

List B: Select at-most one core course from: ECE 506, ECE 510, ECE 512, ECE 516, ECE 517, ECE 522, ECE 539, ECE 541, ECE 633.

On the Qualifying exam, students will be tested on the 3 major core courses. Additionally, students can select any ECE core course as the 4th minor core course, including courses on Lists A or B above.</td></tr>
<tr><td>Computer Architecture & VLSI Design</td></tr>
<tr><td>Computer Systems and Networks</td></tr>
<tr><td>Computer Vision and Image Processing</td></tr>
<tr><td>Information Systems</td></tr>
</table>

Together with EE and CompE, we have 16 research emphases in total. With our current 30 tenured or tenure-track faculty members (19 EE and 11 CompE), there are two faculty members per emphasis area. However, many ECE faculty members work in more than one emphasis area. Note that many core courses are shared by multiple emphases. With 19 total EE core courses, each EE faculty member is responsible

for approximately one core course. In CompE, there are 10 core course that are different from EE (i.e. a EE and CompE share a number of core courses), which is one per CompE faculty.
In general, the ECE department gradually changes or modifies these research emphases to reflect new and emerging research focus in order to respond to the needs of students, and to better support new faculty members' research initiatives. In 2007, the ECE department initiated an interdisciplinary emphasis in BioEngineering, which is flexibly enabled across EE & CompE areas. In 2010, an emphasis was added in Power and Energy.
Three options for the M.S. degree are available to ECE students: **Plan I** (thesis option) requires 24 hours of graduate course credits, 6 hours of M.S. thesis, one credit of ECE Graduate Seminar (ECE 590), and the successful completion and defense of an M.S. thesis. **Plan III** (Coursework-only M.S.) requires 30 hours of graduate course credits, plus one credit of ECE Graduate Seminar (ECE 590). We eliminated Plan II since Plan III provides essentially the same options to the students.
All three M.S. plans require at least 12 hours of ECE core courses, among which 9 hours are required by the emphasis as 3 major core courses, and the other 3 hours are selected from another emphasis as a minor core course. Note that in addition to the three major core courses, some emphases require a fourth course. The remaining credits are made up from free (technical) electives. All M.S. students are required to pass a master exit exam. Plan I students are examined over the thesis material by the thesis committee. Plan II students are examined on their M.S. project, based on a technical report and an oral presentation. The exam for Plan III students consists of an audit of the student's academic record by the student's faculty advisor and the ECE Graduate Advisor.
For Ph.D. degrees, a minimum of 50 semester hours (excluding the 18 hours of dissertation hours) beyond the bachelor's degree is required. Under certain conditions, a maximum of 30 hours can be transferred from another accredited graduate school. A minimum of 25 hours must be completed at UNM, of which 18 hours must be at the 500 level or above.
All Ph.D. candidates are expected to take the ECE Qualifying Examination. A student has no more than two opportunities to pass the exam. Passing levels are determined by the ECE faculty, according to the recommendations of the corresponding emphasis group and the ECE graduate committee. Students are notified as to when they must take the Qualifying Exam in their admission acceptance letter. The exam date is set so that the student will have adequate time (3 semesters) to complete all required course work (4 core courses corresponding to 3 courses in the emphasis and 1 course in a different emphasis) and to study for the exam. Students are allowed to petition, in extenuating circumstances, for a later test date. The qualifying exam is given twice a year: In January and in August on the Thursday before the first day of the Spring or Fall semesters. Students are required to sign up for this exam four weeks in advance through the ECE Graduate office. During the two weeks following the written exam, students are required to be physically present to attend an oral exam if necessary. The results of the Qualifying Exam are available to students within three weeks of the written exam. In 2008, the Progressive passing rule was adopted, which allows students to pass at the subject level. Students are allowed 2 consecutive opportunities to pass the three subject (3 core courses) areas. Students are evaluated as having passed or failed in each individual subject area.

4.2 Graduate Student Enrollment

The graduate enrollment has been approximately steady over the past ten years, accounting for year to year fluctuations. Fall semester enrollment numbers for the last five consecutive years (2012-2017) are presented in Table 2. This table shows the number of active graduate students for the Fall semesters. The column labeled as *New%* indicates the number of students who entered the program within the same

calendar year. For example, for Fall 2012 row, new students are those who entered into the program in Spring, summer, or Fall of 2012.

Table 3 shows the ECE domestic graduate student demographic distribution. On average, approximately 70% of the M.S. students are domestic students (include US citizens and green card holders). Many such students take 2 courses per semester and are employed full time. The minority student population among the domestic M.S. students is approximately 25%, with significant year-to-year fluctuations. Among Ph.D. students, the domestic student proportion is around 50%. The minority population among domestic Ph.D. students is roughly 15%, again with large year-to-year fluctuations, which is an increase from around 5% a decade ago. In the M.S. and Ph.D. total, approximately 50% are known to be domestic students. The female student population is around 15%, with some year-to-year variation, for both M.S. and Ph.D.

Table 2: ECE Active Graduate Students Enrollments

ECE Active Graduate Students (2012-2017)									
Year	M.S.				Ph.D.				Total
	M.S. total	Woman%	Minority%	New%	Ph.D. total	Woman%	Minority%	New%	M.S. & Ph.D.
Fall 2017	94	14%	26%	26%	105	16%	19%	13%	199
Fall 2016	123	14%	17%	17%	110	13%	15%	15%	233
Fall 2015	121	15%	15%	15%	111	13%	12%	12%	232
Fall 2014	114	14%	25%	25%	119	18%	8%	8%	233
Fall 2013	111	16%	33%	33%	128	19%	12%	12%	239
Fall 2012	102	20%	34%	34%	107	22%	12%	12%	209

Table 3: ECE Active Graduate Students Demographics

ECE Active Graduate Students - Domestic									
Year	M.S.				Ph.D.			Total	
	M. S. Total	M.S. Domestic	M.S. Domestic %	M.S. Minority%	Ph.D. Total	Ph.D. Domestic	Ph.D. Domestic %	Ph.D. Minority %	Domestic %
Fall 2017	94	68	72%	26%	105	58	55%	19%	63%
Fall 2016	123	75	61%	17%	110	53	48%	16%	55%
Fall 2015	121	75	62%	15%	111	58	52%	14%	57%
Fall 2014	114	74	65%	25%	119	64	54%	14%	59%
Fall 2013	111	81	73%	33%	128	70	55%	17%	63%
Fall 2012	102	73	72%	34%	107	52	49%	14%	60%

4.3 Advisement and Assessment

Each ECE graduate student is required to meet with his/her advisor on a regular basis. Since advisement is considered an important part of the educational process, each student has an academic HOLD placed every semester on his/her registration. Students must obtain academic advisement each semester before the hold is removed.

ECE590, a Graduate Seminar course, is required of every ECE graduate student. All M.S. students are required to complete one credit hour (1 semester worth) of ECE 590, and all Ph.D. students are required to complete two credit hours (2 semesters worth) of ECE 590. The grading is CR/NC and the credits do not apply toward the required number of degree hours in the program. This seminar course is intended to broaden the ECE graduate student's education by exposing them to areas beyond their own specialties (emphases). The seminar is held on a weekly basis, and speakers from academia (within or outside UNM), as well as industry leaders and practicing engineers, are invited. The seminar also provides a place and time to gather our graduate students from all research groups. Once a semester, the director of the graduate program holds an overall advisement meeting for all graduate students, to discuss updates of the graduate curriculum, reminders of various deadlines, explanation of procedures to graduate, etc. In addition, an open forum is held once a semester or a year to collect and listen to feedback, comments, and suggestions from the current students.

4.3.1 ECE Graduate Office and Graduate Affairs Committee

The ECE department has its graduate office operating on a daily basis to help all graduate students and coordinate activities with faculty as well other staff members. The department graduate office is staffed by Ms. Yvoné Nelson as the graduate coordinator and assisted by a part time administrator who oversees the administration of admission.

The Graduate Program is overseen by three ECE faculty. 1) The Graduate Program Director (Prof. Mark Gilmore) chairs the ECE Graduate Committee, and oversees graduate academic matters, such as changes to the ECE graduate program, administration of the Ph.D. qualifying exam, approval of M.S. and Ph.D. thesis committees, etc. 2) The Associate Chair (Prof. Marios Pattichis) oversees hiring of Teaching Assistances, new graduate student orientation, and course scheduling. 3) The Graduate Admissions and Recruiting Director (Prof. Balu Santhanam) oversees graduate admissions and recruiting.

The Graduate Committee consists of the Director of the Graduate Program and faculty members from the various research emphases (area/group). The Director of Graduate Program who reports to the Department Chair and Associate Chair, coordinates all activities of the Graduate Committee and is responsible for all academic aspects of the graduate program, including:

- Interaction with the Graduate Studies and Global Education Office (GEO).
- Probation/enrollment matters and exit requirements.
- Administration of the Ph.D. qualifying exam, and approval of student exam results.
- Approval of the awarding of M.S. and Ph.D. distinction.
- Approval of new academic programs within ECE, including online courses and determination of core courses, as well as shared-credit and joint degree programs.
- Approval of new course offerings, including Special Topics courses.

The graduate committee meets regularly to listen to feedback from students & faculty, and to address and vote on all academic ECE graduate affairs. The graduate committee maintains minutes of all such meetings.

4.3.2 Graduate program outcomes assessment

For students receiving a Ph.D. or an M.S. with a thesis option, a general assessment form is filled by every committee member after the thesis or dissertation defense. The assessment form is designed and

required by UNM's Graduate Studies, named as Report on Thesis or Dissertation. Every committee member is requested to assess the thesis or dissertation in the five areas listed below.

- Substance
- Methodology
- Originality
- Style
- Evaluation of the work as a whole

The assessment is measured on a scale of Excellent, Very Good, Good, Fair, or Inferior. The forms are submitted to OGS, as well as recorded by our department graduate office. The ECE graduate office considers nomination of thesis or dissertation distinction partially based on these forms filled by the committee members. However, the assessment is designed for specifically evaluating the theses and dissertations. In order to establish assessment as well as feedback of our overall graduate curricula, the graduate committee of the UNM School of Engineering (SOE) implemented a plan in 2008 for assessing the outcomes of all SOE M.S. and Ph.D. programs. The outcomes of the SOE Graduate Degree Programs are listed as follows:

Ph.D. Programs Students receiving the Ph.D. in Engineering will:

1. Exhibit knowledge of engineering and science fundamentals appropriate for the 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.

M.S. programs Students receiving Master's degrees from the School of Engineering will:

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

The assessment rubric is categorized at level of exceptional, acceptable, marginal, and unacceptable. Starting in 2009, for students receiving a Ph.D. or M.S. from the ECE department, the student's exam committee assesses whether the student has achieved the SOE outcomes based on the student's thesis/dissertation and defense. This will be documented on a rubric that has been developed for this purpose, to be filled out by a consensus of the committee instead of by each individual member of the committee. The evaluations will be reported to the SOE graduate committee for analysis, discussion, feedback, and any necessary action. The corresponding curricular changes will be incorporated into our graduate programs in order to improve student performance in the areas specified by the expected program outcomes. (sample rubrics have been provided in appendix B)

Table 4: ECE Graduate Applications and Admissions

ECE Graduate Applications and Admissions											
Year	Domestic			International			Total				
	App#	Accept%	Joined#	App#	Accept%	Joined#	App#	Accept%	M.S.#	Ph.D.#	Total
2017	64	89%	44	170	40%	20	234	27%	45	19	64
2016	76	84%	45	217	28%	34	293	27%	52	27	79
2015	82	80%	49	294	37%	38	376	23%	66	21	87
2014	111	68%	34	248	29%	27	359	17%	48	13	61
2013	126	56%	51	136	38%	22	262	28%	50	23	73
2012	115	51%	47	179	52%	23	294	52%	52	18	70

4.4 Applicants and Admission

Recruiting and retaining an active population of graduate students are some of the ECE department's main goals as expressed in our strategic plan. This is supported by a well-designed curriculum, a newly invigorated recruitment effort, and a good supply of newly admitted students. Fortunately, the department has been able to recruit a large number of qualified applicants, both domestic and international. Table 4 shows the number of M.S./Ph.D. applicants as well as admission data for the past ten years. Acceptance as a regular graduate student in the ECE Department will normally require a Bachelor's degree in Computer Engineering, Computer Science, Electrical Engineering, or a related field from an ABET accredited program in United States or its equivalent in another country. Admission into the ECE Graduate Program for both M.S. and Ph.D. degrees are decided on a case-by-case basis. Many factors are taken into account for admission decisions, including, but not limited to, previous academic degree(s) and coursework, GRE scores, letters of recommendation, etc. The ECE graduate program has two types of assistantships: Graduate Assistantships (GA) and Research Assistantships (RA). The GAs are awarded by the ECE department for exceptional students who are generally recruited by non-tenured faculty. On the other hand, RAs are chosen and administered completely by faculty members using their own research grants. In addition to the GA and RA assistantships there are some other fellowships available to graduate students.

4.5 Graduate Course Credits Data

The ECE department offers around 30 graduate courses per semester that include 3-6 special topics courses (ECE 595). Moreover, the ECE faculty members may offer special problems courses (ECE 551, ECE 651) and many choose to do so. Graduate students also register for Master's thesis (ECE 599) and Ph.D. dissertation (ECE 699).

4.6 Graduate Degrees Awarded

Table 5 shows the number of M.S./Ph.D. degrees awarded for each year, where each calendar year includes the Spring, Summer, and Fall semesters. On average, there are about 48 M.S. degrees awarded every year. This number is increasing due to the new Plan III (coursework only) M.S. option. Half of these M.S. degrees are domestic graduates, employed by local industry and government laboratories; and the other half are international graduates. The average time period to obtain an M.S. degree is just under 3 years. Considering that a large portion (75%) of our M.S. students are part-time students, we consider

this average length to be healthy. For both M.S. and Ph.D. degrees awarded, the percentages of women and minorities correlates well with the percentages from the active enrollment figures.

Table 5: ECE Graduate Degrees 2012-2017

ECE Degrees Awarded (M.S. & Ph.D.)									
Year	M.S. Degrees				Ph.D. Degrees				Total
	M.S.#	Woman%	Minority%	Domestic%	Ph.D.#	Woman%	Minority%	Domestic%	
2017	66	11%	18%	58%	15	27%	7%	33%	81
2016	54	17%	17%	57%	18	17%	6%	28%	72
2015	50	16%	26%	58%	15	13%	20%	60%	65
2014	42	17%	26%	60%	21	29%	10%	48%	63
2013	40	25%	35%	55%	16	25%	0%	31%	56
2012	41	20%	29%	14%	22	14%	14%	23%	63

Table 6: Time to Degree 2012-2017 (in years)

	2013	2014	2015	2016	2017
PhD	5.13	5.39	6.07	5.61	5.94
MS	2.3	2.48	2.21	2.05	1.78

4.7 Globalization of Education

The UNM global education office as part of its global outreach and in an effort to make UNM more competitive in the global market and as part of its recruitment efforts, has partnered with several institutions around the world. These include programs such as : (a) a joint MS program, where the student completed one year in their home university and one year at UNM, (b) a shared credit 4+1 program as part of the UNM global and national engineering scholars program which enables students with a B. S. degree from other universities to count 9 credit hours from their B. S. degree towards their degree at UNM, and (c) joint PhD degrees. The list of Universities that UNM collaborates with includes Amrita University in India (since 2015), Universidad Carlos III, De Madrid (since 2015), and other institutions from China, Latin America, and Pakistan.

To earn degrees from UNM and a collaborating University, the Students have to satisfy the academic standards and degree requirements of both programs. To further facilitate the partnerships, UNM has waived the GRE requirements for students applying to the global and national engineering scholars program. To strengthen cultural ties with these universities and to provide the students a rich experience at UNM, these agreements also provide for discounted tuition rates for international graduate and undergraduate students. Many international students from the partnership agreements have joined and continue to enroll in the department and SOE and have been successful in obtaining their M.S. degree. Several of them have also chosen to pursue a PhD in ECE, mostly in the areas of VLSI and computer hardware, machine learning, and signal processing and communications.

4.8 Online Courses and Online Degree Programs

A large fraction of both our M.S. students and Ph.D. students are part-time students, a trend that has remained largely constant for the past fifteen years. We have always had offered many of our courses online. More recently, we are working on a new model, termed Managed Online Programs (MOP). We want to offer one in Space Systems and another one in Internet of Things.

Our hope is that MOP model will allow us to grow our graduate program. Growth will be supported through a return of a large portion of the student fees to the department. Ultimately, our hope is to establish a sustainable growth model that will allow us to maintain quality while hiring more faculty to offer more options to our students.
The MOP courses follow an intensive 8-week course format. Over an academic year, MOP courses can be offered up to five times: (i) first half of the Spring semester, (ii) second half of the Spring semester, (iii) Summer, (iv) first half of the Fall semester, and (v) second half of the Fall semester.
Students will be admitted at any point during the year. Then, ideally, we would like to see the students to complete the MOP program within a year. Thus, we will offer each at-least two new courses each term. Furthermore, to make sure that we always have enough students, every MOP course is also offered online to the regular UNM students.
The MOPs are separate from the rest of the University courses. Students registered in an MOP will not have access to non-MOP courses. Furthermore, international students who register for an MOP will not qualify for US Visas to come to UNM.

4.8.1 M.Sc. in Computer Engineering with Emphasis on Internet Of Things (IoT)

The Master of Computer Engineering in Internet of Things (IoT) was introduced in the Fall 2017. It was designed to accommodate students with interest in computing and the emerging problems associated with IoT. Students can also take a course that will count towards degree completion. An initial set of 8-week course offerings will be available in Spring 2018 and the program will be fully launched in Fall 2018.

Prospective students need to have an undergraduate degree in Electrical Engineering, Computer Engineering, Computer Science, or a related field. All applicants are expected to have college-level proficiency in English (reading and writing), programming, and mathematics.

The degree consists of five required courses plus an additional six elective courses. The courses can be taken in any order and can be currently completed in as little as 18 months. We are working to reduce the minimum duration to 12 months, with the introduction of 8-week, carousel style courses that will be rolled out in Spring 2018.

The required courses cover 13 credit hours are based on:

- ECE 595 Introduction to Internet of Things
- ECE 517 Machine Learning
- ECE 537 Foundations of Computing
- ECE 540 Advanced Networking
- ECE 590 Graduate Seminar (1 credit hour)

The students will then select from our optional list of courses given by:

- ECE 500 Theory of Linear Systems
- ECE 514 Nonlinear and Adaptive Control
- ECE 522 Hardware Software Codesign with FPGAs
- ECE 525 Hardware-Oriented Security and Trust
- ECE 530 Introduction to Cloud Computing

- ECE 595 Introduction to Cyber Security
- ECE 595 Web Architecture & Cloud Computing

For second half of the Spring 2018 semester, we are currently offering: ECE 595 Introduction to Internet of Things. In addition, the Computer Engineering program is offering the following online courses that will soon be converted to the MOP format:

- ECE 530 Introduction to Cloud Computing
- ECE 595 Networking Services: Quality of Service and Signaling
- ECE 595 Introduction to Cyber Security

4.8.2 M.Sc. in Electrical Engineering with Emphasis on Space Systems Engineering

The Department is currently in the early stages of offering a second online degree in Space Systems Engineering. This degree will be offered jointly with the Department of Mechanical Engineering at UNM. The degree will support the strong space interest in the state of New Mexico.

The proposed Space Systems Engineering concentration includes 19 credit hours selected from:

- ECE 533 Digital Image Processing
- ECE 535 Satellite Communications
- ME 594 Space Situational Awareness
- ME 595 Orbital Mechanics
- ME 596 Spacecraft Attitude Dynamics and Controls
- ME 597 Spacecraft Design I
- ECE 590/ME 591/ME 592 Graduate Seminar in Space Systems

We then have 12 credit hours of core courses in Electrical Engineering that include:

- ECE 500 Theory of Linear Systems
- ECE 514 Nonlinear and Adaptive Control
- ECE 541 Probability Theory and Stochastic Processes
- ECE 546 Multivariate Control Theory

5 Faculty

5.1 Overview

The department of Electrical and Computer Engineering has 33 full-time faculty members. Currently, ECE has 17 full professors, 7 associate professors, 4 assistant professors and 5 lecturers. Because of the large number of courses offered by the ECE department, approximately 10-13 adjunct professors per semester are used to help cover departmental courses. Among the ECE Faculty there are:

- 4 Distinguished Professors (3 regular faculty and 1 research faculty)
- 8 IEEE Fellows (regular faculty)
- 3 OSA Fellows (regular faculty)
- 2 SPIE Fellows (regular faculty)
- 1 APS fellow (regular faculty)
- 1 Direct Energy Society Fellow (regular faculty)
- 1 Endowed Chairs:
  - Manel Martinez Ramon— IST-Prince of Asturias Endowed Chair

Many faculty members participate in professional activities such as chairing and presenting talks at local, national and international conferences, serving as chairs of sessions for such conferences, and serving as the members of the editorial boards for professional publications. Some of the faculty members are also involved in consulting and establishing start-up companies.

The ECE department has always maintained a strong commitment to quality education and research. During the past decade, the department attracted many outstanding and dedicated faculty members. These additions have resulted in several positive changes with respect to the quality of teaching and the number of courses available to ECE students. All of these new faculty members are involved in state-of-the art research and several have achieved national and international reputation. We have also hired 3 new lecturers since 2016 to help with the teaching of our undergraduate courses.

Table 5-1. Faculty Qualification Summary - Electrical and Computer Engineering Program.

Faculty Name	Highest Degree Earned- Field and Year	Rank [1]	Type of Academic Appointment [2]	FT or PT	Govt./Ind. Practice (years)	Teaching (years)	This Institution (years)	Professional Organizations (high, low and medium)	Professional Development	Consulting/summer work in industry
Abdallah, Chaouki	PhD, EE, 1988	P	T	FT		30	20	L	H	L
Balakrishnan, Ganesh	PhD, EE, 2006	ASC	T	FT	0	8	8	H	H	L
Cavallo, Francesca	PhD, ECE, 2009	AST	TT	FT	0	3	3	M	M	L
Christodoulou, Christos	PhD, EE, 1985	P	T	FT	0	30	18	H	H	L
Calhoun, Vince	PhD, EECS, 2002	P	T	FT	0	26	12	H	H	L
Devetsikiotis, Michael	PhD, EE, 1993	P	T	FT	0	23	3	H	H	M
Elshafiey, Tarief	PhD, EE, 1996	I	NTT	FT	20	19	5	H	H	L
Feezell, Daniel	PhD, ECE, 2005	ASC	TT	FT	4	6	5	H	M	L
Fierro, Rafael	PhD, EE, 1997	P	T	FT	0	16	10	H	H	L
Fleddermann, Charles	PhD, EE, 1985	P	T	FT	7	33	33	H	H	L
Gilmore, Mark	PhD, Engineering, 1999	P	T	FT	5	16	14	H	L	L
Hayat, Majeed	PhD, ECE, 1992	P	T	FT	0	25	15	H	M	M
Hossein-Zadeh, Mani	PhD, EE, 2004	ASC	T	FT	0	9	9	L	H	M
Jain, Ravi	PhD, EE	P	T	FT				M	M	L
Jayaweera, Sudharman	PhD, EE, 2003	P	T	FT	2	13	10	H	H	M
Jordan, Ramiro	PhD, ECE, 1987	P	T	FT	5	24	24	H	H	L
Lehr, Jane	PhD, EE, 1996	P	T	FT	17	4	4	H	H	L
Martinez-Ramon, Manel	PhD, EE, 1999	P	T	FT	0	21	4	L	L	L

Nava, Edward	PhD, CompE, 2015	I	NTT	FT	35 +	8	5	L	H	L
Oishi, Meeko	PhD, ME w/ EE PhD minor, 2004	ASC	T	FT	0	6	6	H	M	H
Osiński, Marek	PhD, Physical Sciences, 1979	P	T	FT	0	31	32	H	M	L
Palacios, Jose	PhD, EE	I	NTT	FT				L	L	L
Pattichis, Marios	PhD, CompE, 1998	P	T	FT	0	19	17	H	H	L
Peng, Zhen	PhD, EE, 2008	AST	TT	FT	0	6	4	H	H	L
Plusquellic, Jim	PhD, CS, 1997	P	T	FT	0	20	9	H	H	L
Santhanam, Balu	PhD, EE, 1998	ASC	T	FT	0	17	16	M	M	L
Schamiloglu, Edl	PhD, Engineering, 1988	P	T	FT	0	30	30	H	H	L
Sharma, Ashwani	PhD, EE, 1993	I	NTT	PT				H	H	M
Shu, Wennie	PhD, CompE, 1990	ASC	T	FT	0	25	15	H	H	L
Tsiropoulou, Eirini Eleni	PhD, 2008	AST	TT	FT	0	9	1	H	H	L
West, Jonathan	PhD, 2017	I	NTT	FT	0	0	0	L	L	L
Yang, Yin	PhD, CS, 2013	AST	TT	FT	0	7	3	H	H	L
Zarkesh-Ha, Payman	PhD, ECE, 2001	ASC	T	FT	5	10	10	H	M	H

1. Code: P = Professor ASC = Associate Professor AST = Assistant Professor I = Instructor A = Adjunct O = Other

2. Code: TT = Tenure Track T = Tenured NTT = Non Tenure Track

5.2 Faculty Development

The typical course load in the ECE department for research-active faculty is four courses per year. In addition to teaching in the classroom, all faculty members supervise graduate and undergraduate students in such courses as individual studies, research, thesis and dissertation. New faculty members typically do not teach any courses the first semester they are hired and one course during the second semester. The idea is to give time to new faculty to establish their research programs and adapt themselves to the new setting. Many faculty buy-out from one course a year and they end up teaching one course per semester. In the last five years the department has used roughly 10-13 adjunct professors per semester in order to help cover the department's course load. The department has made a decision to use adjunct professors to offer more courses to our students rather than just cut the number of adjunct professors and the number of choices available to our students. The department has also hired four full-time lecturers and one part-time lecturer (all PhD holders) who teach 3 courses per person per semester. Lecturers are also involved in advising graduate students. Each faculty member maintains at least three hours of office hours per week.

At the end of each semester, faculty members are responsible for providing the course portfolios, along with the assessment reports, to the Associate Chair and Director of undergraduate program for further review and recommendation by the committee members. Each semester, the ECE department conducts the student teaching evaluations for every course. The evaluations play a major role in determining salary increases and promotions. Adjunct professors follow the same rules. They have office hours and they are also expected to meet with students for consultation. All adjunct faculty are evaluated by students in the same manner as regular faculty. Adjunct professors work with the coordinator of the course to assess the course they teach at the end of each semester.

Faculty performance evaluation is conducted every calendar year. The evaluation is a critical element in the assessment of the success of the program in meeting its educational objectives and in the determination of future objectives. The primary purpose of faculty evaluation is to assess faculty members' contributions to the program, and more broadly to the mission of the university. The process is vitally important for tenure-track faculty. The performance evaluation constitutes one consideration in the determination of salary increases should they be authorized, but other factors such as alleviating salary compression and relative inequity and departmental effectiveness, may also contribute to the determination of merit increases.

New faculty are given start-up funds, space for their laboratory, and are not required to teach during the first semester of service. During the second semester, they only have to teach one course. After that the load becomes four courses per year. The idea behind the light load during the first year is to give the opportunity to the new faculty to establish their new laboratory and get used to the new environment. Their first three months during the summer are supported by the department. We also assign a mentor to the new assistant professors upon hiring, but most of them will later gravitate towards a mentor of their choice after their first year. Also, non-tenured new faculty (not associated with any centers) are provided with one or two graduate assistants (GA), to help them with their research until they achieve tenure. Limited travel funds are also available (mostly from soft money sources) to assistant professors and occasionally to more senior faculty.

The ECE department supports about 20 graduate assistants (GA's) a semester and about 5-10 Project assistants (PA's) that help faculty with running the laboratories and grading.

Table 5-2: Faculty productivity numbers for 2011 to 2015.

Productivity measure	2011	2012	2013	2014	2015
Refereed journal papers	108	104	91	99	125
Conference papers	185	181	151	210	157
Books	2	2	1	3	3
Book chapters	7	8	7	4	5
Patents/Patent disclosures	31	32	37	43	40
Research Expenditures	$12,631,503	12,033,345	12,734,412	12,191,285	11,458,823

5.3 Tenure-track/Tenured Faculty and Their Research Interests

Chaouki T. Abdallah, Professor and Provost, Ph.D., Georgia Institute of Technology, Interests: Control systems.

Ganesh Balakrishnan, Associate Professor, Ph.D., University of New Mexico, Interests: Semi- conductor device development including epitaxy and characterization, high power vertical external cavity surface emitting lasers and novel semiconductor material development for Mid-Infrared lasers.

Vincent D. Calhoun, Professor and Director, Image Analysis and MRI Research, The MIND Institute, Ph.D., University of Maryland-Baltimore County, Interests: Biomedical engineering, psychiatric neuroimaging, functional and structural magnetic resonance imaging (MRI), multimodal data fusion, medical image analysis.

Francesca Cavallo, Assistant Professor, Ph.D., Technical University of Chemnitz, Interests: interface between nanotechnology and biology based on the use of inorganic nanomembranes to achieve a successful integration of biological cells and solid-state devices.

Christos G. Christodoulou, Distinguished Professor, Ph.D., North Carolina State University, Interests: Modeling of electromagnetic systems, smart antennas, reconfigurable systems, machine learning applications in electromagnetics, high power microwave antennas and cognitive radio.

Michael Devetsikiotis, Professor and Department Chair, Ph.D., North Carolina State University, Interests: high-speed network modeling, performance evaluation and efficient simulation; and optimization techniques applied to the analysis and design of communication systems.

Daniel Feezell, Associate Professor, Ph.D., University of California-Santa Barbara, Interests: III-nitride materials and devices, nanoscale epitaxial growth, semiconductor lasers, LEDs, and detectors, power electronics.

Rafael Fierro, Professor, University of Texas at Arlington, Interests: Hybrid and embedded systems, heterogeneous multivehicle coordination, cooperative and distributed control of multi-agent systems, mobile sensor networks, and robotics.

Charles B. Fleddermann, Professor and Associate Dean-Academic Affairs, School of Engineering, Ph.D., University of Illinois at Urbana-Champaign, Interests: Plasma processing, physical electronics, photovoltaics.

Mark A. Gilmore, Associate Professor, Ph.D., University of California-Los Angeles, Interests: Plasma physics, plasma diagnostics, magnetic confinement fusion, microwave engineering.

Majeed M. Hayat, Professor, Ph.D., University of Wisconsin-Madison, Interests: Statistical communication theory, signal and image processing, algorithms for infrared spectral sensors and imagers, novel avalanche photodiodes, optical communication, cooperative distributed sensing and computing, applied probability and stochastic processes.

Mani Hossein-Zadeh, Associate Professor, Ph.D., University of Southern California, Interests: Electro-optics, microwave-photonic devices and systems, ultra high-Q optical microresonators, optomechanical interaction in UH-Q optical resonators, optical communication, photonic sensors, optofluidics and plasmonics.

Ravinder K. Jain, Professor, Ph.D., University of California at Berkeley, Interests: Quantum electronics, optoelectronics, electro-optics, experimental solid-state physics.

Sudharman K. Jayaweera, Professor, Ph.D., Princeton University, Interests: Wireless communications, statistical signal processing, information theory, wireless sensor net- works, image processing, quantum information processing, distributed signal processing.

Ramiro Jordan, Professor, Ph.D., Kansas State University, Interests: Data communications, multidimensional signal processors, software engineering.

Jane Lehr, Professor, Ph.D., New York University's Polytechnic Institute, Interests: high power component development, high power electromagnetics and effects, compact pulsed power, exploding wires and shock wave formation, and the physics and application of electrical breakdown in vacuum, gases and liquids.

Manel Martinez-Ramon, Professor, Ph.D., Universidad Carlos III de Madrid, Interests: Kernel methods and statistical learning theory applied to smart grid, antenna array processing and magnetic resonance imaging.

Meeko Oishi, Associate Professor, Ph.D., Stanford University, Interests: Hybrid systems and control, cyberphysical systems, collaborative control of semi-automated systems, motor performance and control in Parkinson's disease.

Marek Osinski, Professor, Ph.D., Institute of Physics, Polish Academy of Sciences, Interests: Semiconductor lasers, optoelectronic devices and materials, group-III nitrides, degradation mechanisms and reliability, computer simulation.

Marios S. Pattichis, Professor, Ph.D., University of Texas-Austin, Interests: Digital image and video processing and communication, medical imaging and statistical methods for image processing, reconfigurable image-processing systems.

Zhen Peng, Assistant Professor, Ph.D., Chinese Academy of Sciences, Interests: Computational electromagnetics and multi-physics analysis, power integrity (PI) and signal integrity (SI) analyses of integrated circuits (ICs), simulation-based design of multi-scale metamaterials and reconfigurable antennas.

James F. Plusquellic, Professor, Ph.D., University of Pittsburgh, Interests: IC Trust, design for manufacturability, defect-based and data-driven VLSI test, small delay fault test, model-to-hardware correlation and IC fabrication process monitors.

Balu Santhanam, Associate Professor, Ph.D., Georgia Institute of Technology, Interests: Digital signal processing, statistical communication theory adaptive filtering, time-frequency analysis and representation, imaging interferometric lithography, AM-FM modeling, nonstationary signal analysis.

Edl Schamiloglu, Professor, Ph.D., Cornell University, Interests: Physics and technology of charged particle beam generation and propagation, high power microwave sources and effects, pulsed power science and technologies, plasma physics and diagnostics, electromagnetics and wave propagation infrastructure surety and complex systems.

Wei Wennie Shu, Associate Professor, Ph.D., University of Illinois at Urbana-Champaign, Interests: Distributed systems, multimedia networking, mobile ad-hoc and sensor networks, overlay network services, biomed modeling and simulation.

Eirini Tsiropoulou, Assistant Professor, Ph.D., National Technical University of Athens, Intrests: Resource Allocation & Optimization in Heterogeneous Wireless Networks, Distributed Optimization and Game Theory.

Yin Yang, Assistant Professor, Ph.D., University of Texas at Dallas, Interests: Graphics, Physics-based simulation, visualization.

Payman Zarkesh-Ha, Associate Professor, Ph.D., Georgia Tech, Interests: Statistical modeling of VLSI systems, design for manufacturability, low-power and high-performance VLSI design.

5.4 Authority and Responsibility of Faculty

The ECE department which houses both the Electrical and Computer Engineering undergraduate programs is headed by a chairperson (Professor Christos Christodoulou) who is assisted by an associate chair of graduate affairs (Professor Mark Gilmore) and an associate chair of undergraduate affairs (Professor Ganesh Balakrishnan). The ECE chair has ultimate responsibilities over the budget and facilities, as well as being the hiring officer for all faculty and staff members.

The associate chair for graduate affairs heads the standing graduate committee which manages all aspects of the graduate program, including the academic part (courses, student admissions, academic policies, course scheduling) as well as the financial part (GA and TA contracts) and interfaces with the office of graduate studies of UNM. The associate chair also manages the PhD qualifying exam and, with the help of the graduate coordinator (a staff member), helps the graduate students navigate the university system from the time of application to their ultimate graduation and awarding of degrees.

The associate chair for undergraduate affairs is assisted by an undergraduate adviser and heads the undergraduate office. The associate chair heads the standing undergraduate committee which has ultimate responsibilities for reviewing and approving any changes in the undergraduate program, including major course and catalogue changes. The associate chair also manages the admission process into the ECE department and the undergraduate adviser assists in monitoring the progress of all undergraduate students. Note that the academic advisement is the responsibility of all faculty members but is managed by the undergraduate office. The undergraduate office interfaces with the UNM admission office and other Academic departments (Math, Physics, etc).

The ECE chair and associate chair of undergraduate affairs are assisted in managing the under- graduate programs by an elected undergraduate committee. This committee has representatives from each technical area that is responsible for a set of courses in the undergraduate programs. The undergraduate committee monitors the quality and content of the undergraduate program and is the first committee to approve changes to the undergraduate programs as described next. The ECE faculty (who teach both EE and CE courses) have the responsibility and power to create, modify, and evaluate all courses in the ECE department. Individual faculty members work through their technical emphasis areas (technical groups) to propose changes to courses or to the program, then to shepherd the changes through their group representatives on the elected ECE undergraduate committee. If approved by that committee, the changes are then voted on by the full ECE faculty members. The undergraduate office then has the responsibility to start the process to make those changes effective though the university system. Depending on the level of changes, they may be approved by the school of engineering undergraduate committee, then by the faculty senate committee on curriculum. The ECE chair, the SOE dean, and the provost office play no role in affecting the content of any course (except as voting faculty members in some cases). They may however, decide on the offering of some non-required courses (especially during the summer term) based on budgetary considerations.

Each undergraduate course has a course coordinator (see section below titled Course Coordinators) who is responsible for making sure that the approved catalogue description and topics are adhered to. The course coordinator may not be the course instructor but is always in charge of making sure that the established evaluation process is followed. The ECE department has a number of standing committees (undergraduate committee, graduate committee, assessment, ABET committee, IT committee, Promotion and Tenure committee, etc.) described in Table 5-3.

Table 5-3: List of ECE committees.

Chair's committee	Chair	Dr. Michael Devetsikiotis (Department Chair)
	Member	Dr. Marios Pattichis (Grad director)
		Dr. Ganesh Balakrishnan (UG director)
Lab Committee	Chair	Dr. Ramiro Jordan
	Member	Dr. Ed Nava
		Dr. Payman Zarkesh-Ha
		David Modisette
		Reiner Martens
IT Committee	Chair	Dr. Ed Nava
		Talia Garcia (Student Member)
		Dr. Ramiro Jordan
		Frank Mercer
		Thomas Sahs
		Reiner Martens
Undergraduate Committee	Chair	Dr. Ganesh Balakrishnan
	Member	Dr. Meeko Oishi
		Dr. Ramiro Jordan
		Dr. Ravinder Jain
		Dr. Daryl Lee
		Dr. Jane Lehr
		Reiner Martens
		Valarie Maestas
Promotion & Tenure Committee	Chair	Dr. Martinez Ramon
	Member	Dr. Marek Osinski
		Dr. Ramiro Jordan
		Dr. Jane Lehr
Awards Committee	Chair	Dr. Balu Santhanam

Space Committee	Chair	Dr. Edl Schamiloglu
	Member	Dr. Balu Santhanam
		David Modisette
		Dr. James Plusquellic
		Dr. Wei Wennie Shu
		Reiner Martens
Assessment Committee	Chair	Dr. Sudharman Jayaweera
		Dr. Balu Santhanam
		Dr. Daniel Feezell
		Dr. Yin Yang
		Reiner Martens
Graduate Committee	Chair	Dr. Marios Pattichis
	Member	Dr. Balu Santhanam
		Dr. Francesca Cavallo
		Dr. Jane Lehr
		Dr. Rafael Fierro
		Dr. Ramiro Jordan
		Dr. Vince Calhoun
		Dr. Wei Wennie Shu
		Reiner Martens
		Yvone Nelson
Security Committee	Chair	David Modisette
		Reiner Martens

6 Resources and planning

6.1 Leadership

The EE program is strongly supported by university leadership including the provost's office and the dean's office. This support extends to both the financial aspects of the program and to critical activities such as accreditation.

6.2 Program budget and financial support

Program budgets are departmental budgets, as departments are the fundamental units for academic budgets. The ECE department budget is submitted every spring semester, then adjusted and approved by the School of Engineering then by the University administration. For the last completed budget (FY 2015-2016), the ECE department's budget was $ 4, 282, 920. This is an increase of 20.1% in comparison to the last report. The Instructional & General (I &G) budget is exclusively dependent on the funds available from the state and is calculated using last year's budget as a base. The I & G budget covers all faculty and staff salaries, as well as small amounts of infrastructure support (phones and communications, laboratories, etc.). It also contains support for graduate students (around 60 TAs, GAs, PAs per academic year).

6.3 Sources of Financial Support

Departmental financial resources come under a variety of budget headings, including:

Expenditures

Faculty salaries (I&G)

Administrative Support salaries (I&G)

Technical Support salaries (I&G and F&A)

GA (Graduate assistants) (I & G and F & A)

Adjunct Professors salaries (F&A)

Maintenance and Operations (I & G and F & A)

Travel Funds (I & G and F & A)

Non I & G Accounts

Overhead Account

Faculty release

Course Fees

Endowments

Donations/Gift Fund

Differential tuition

6.4 Staffing

The staff gets selected by matching adequately their profile to the job profiles of the required positions. Staff gets mandatory trained to obtain all required Banner roles and to ensure the safety of all constituents as voluntary trained on a need / desire basis. These trainings are provided by Employment and Organizational Development UNM. The program grants to its staff the benefit of taking one UNM course during working hours to enhance their professional development if compliance with UNM policy 3700 exists. UNM grants the benefit of paying tuition for up to 8 credit hours in regular semesters. Additionally, staff gets recognized through staff awards on school and university level.

6.5 Faculty Hiring and Retention

The EE program has a strong history of attracting some of the best faculty talent worldwide. The ECE department in conjunction with the SOE does the hiring of the faculty. The process involves the establishment of a faculty search committee with advertises the position in prominent electrical engineering journals and magazines such as IEEE spectrum. The program takes great care in attracting the best talent, in particular women, and underrepresented minorities.

The program also pays close attention to faculty retention. UNM has an annual equity adjustment and compaction process. The effort is spearheaded by the department chair who goes through the faculty salaries on an annual basis and targets salaries that are lower than the department average for the particular faculty rank.

6.6 Support of Faculty Professional Development

The department chair is closely involved in the professional development of faculty. The faculty who are eligible for sabbaticals are required by the department to submit a plan to the chair who then discusses the plan with the faculty and upon sufficient clarifications approves the plans. The department also participates in various professional meetings that faculty may initiate, these include both scientific and educational meetings.

7 FACILITIES

7.1 Offices, Classrooms and Laboratories

The university and the Department maintain an adequate number of classrooms, facilities and computing resources.

Offices (Administrative, Faculty, Clerical, Teaching Assistants): The ECE administrative offices are located on the first floor of the ECE building and are divided into the chair and associate chairs' suite, and the support personnel suite which houses the undergraduate office and the graduate office and their support personnel. In addition, the department administrative offices include those of the accounting department (2 offices). The accounting department includes a senior accountant who assists the chair in keeping track of all financial matters, as well as managing all the research grants and accounts of the ECE faculty. The senior accountant manages an administrative assistant who helps with several financial issues but also the scheduling of rooms and courses. The Department also has an administrative assistant (accounting technician) who handles purchases and refunds, as well as travel request and time sheets for student workers.

Most ECE faculty members have a private office in the ECE department where they receive students during their office hours and conduct other university business. The only exception is that the faculty members affiliated with the Center of High Technology Materials (CHTM) who are also ECE faculty, have offices located in the south campus. The south campus is reachable via a campus bus system. However, the CHTM/ECE faculty members have an office in the ECE building where they may receive students who for one reason or another, may not be able to go to the south campus. The ECE chair and the two associate chairs maintain academic offices (to receive students and engage in research) in addition to their administrative offices.

All regular clerical staff members have private offices. Student helpers and temporary staff may share an office. The receptionist occupies a public office that is accessible by all visitors to the department.

All teaching assistants (TA's) have their own office where they can meet the students during their office hours. In general, and with the exception of senior PhD students who may also be employed as TAs, multiple graduate assistants may share an office.

Undergraduate students have several rooms where they can meet that include the IEEE student lounge, the HKN office, the WISE (Women in Engineering) office and the entire atrium area in the ECE building is available for studying and gathering.

Classrooms: Most of the classrooms used by the ECE Department are either in the ECE building, Dane Smith Hall or the CHTM building. Most of these classrooms are equipped with computer projection equipment and some are used for live transmission of lectures. Many of our courses are offered in the Dane Smith Building, which was completed in 1998. All classrooms in the ECE building are equipped with audiovisual equipment and wired to the Internet.

Laboratories: Since our last review, numerous changes were made to the ECE Department's teaching laboratories. These are documented below.

Several of our laboratories have been upgraded since the last review. The following pages describe all new upgrades and changes in our laboratories.

Computing resources.

Over the past four years the ECE Chair, ECE Computer Use Committee, and ECE Technical Staff have worked diligently to bring the level of computing within the department up several notches. Four areas were looked at quite closely: network infrastructure, server infrastructure, security and, most importantly, student accessibility.

The mission of the Computer Support Group (CSG) is to provide computing and networking resources in support of the mission of the Electrical and Computer Engineering Department at the University of New Mexico. These resources are provided to four main groups consisting of: students, faculty, researchers, and staff. The computer support group staff provides these resources in the form of these basic services: data file storage, software licensing, software installation, operating system installation, patching, and troubleshooting (including Windows and Linux), printing, user data backup, desktop maintenance and repair, and laptop maintenance and repair. Other miscellaneous services are provided on an as needed basis.

ECE has continually worked to improve student accessibility to our computing infrastructure. These improvements include a three-fold increase since the last accreditation visit in the number of computers available to students in course-specific and public labs. Access to course-specific computers is limited to those students taking the course, while all ECE students can access the public labs. We also have a very large wireless network, which has enabled students to continue their work in any part of our building including classrooms, labs, offices, and public areas. We have increased our software repository to include the latest programs from Cadence, Synopsys, Agilent, IBM, and others.

Data File Storage. Data file storage is provided to all users (faculty, students and staff). Typically this is limited to 1 gigabyte for most users. Faculty and researchers contact the CSGif additional storage space is required. Windows users are provided a default mapped network drive (Z:\) to \\nucleus\<username> with Samba based authentication. Linux users are provided with a dynamically accessed NFS share named /research/<pool_name>/<username> with NIS based authentication.

The current data storage host is named nucleus (nucleus.ece.unm.edu, 129.24.24.5). The operating system is Red Hat Enterprise Linux 6.6 with a 1.2TB hardware raid container divided into ten partitions locally referred to as pools. In each pool are two subdirectories and under each subdirectory are the individual user folders.

Software Licensing.

Adobe Acrobat. Adobe Acrobat Pro A simple listing of these software products is sufficient from Adobe Systems Incorporated is installed on an as-needed basis for faculty, researchers, and staff requiring PDF file creation utilities. Acrobat Reader can be installed by a simple download from the internet. For further information on Adobe products please visit the Adobe Systems web site at: http://www.adobe.com.

Agilent. Agilent Test and Development software from Agilent Technologies can be in- stalled on an as-needed basis for academic and research purposes on individual user machines. In order for the software to operate, the user machine must be able to get licensing information from one of the department license servers. For further information on Agilent products please visit the Agilent Systems web site at: http://www.agilent.com.

Ansoft. Ansoft HFSS and Designer software from Ansoft Corporation can be installed on an as-needed basis for academic and research purposes on individual user machines. For further information on Ansoft software products please visit the Ansoft Corporation web site at: http://www.ansoft.com.

Cadence. Cadence Custom IC Design, Digital IC Design, P-Spice, and many other software packages from Cadence Design Systems can be installed on an as-needed basis for academic and research purposes on individual user machines. For further information on Cadence software products please visit the Cadence Design Systems web site at: http://www.cadence.com.

CST. CST Microwave Studio from CST of America, Incorporated can be installed on an as-needed basis for academic and research purposes on individual user machines. For further information on CST software products please visit the CST of America web site at: http://www.cst.com.

LabView. Any LabView software application from National Instruments can be installed on an as-needed basis for academic and research purposes on individual user machines. For further information on National Instruments software products please visit the NI web site at: http://www.ni.com.

MATLAB. MATLAB by MathWorks Incorporated is a complete mathematical analysis, modeling, and simulation software environment. It is currently installed on all Windows 7 and Red Hat Enterprise Linux 7.1 partitions in the computer lab in the ECE department room 216. These installations are primarily used for under-graduate academic purposes and are licensed through a direct network connection to the license server. Research installations of MATLAB can be obtained by contacting the computer support group and obtaining a stand-alone license for research purposes. For further information on MathWorks software products please visit the MathWorks web site at: http://www.mathworks.com.

MentorGraphics. MentorGraphics PCB Design by Mentor Graphics Incorporated is a complete PCB design solution combining schematic definition with powerful layout and simulation tools. For further information on Mentor Graphics software products please visit the Mentor Graphics web site at: http://www.mentor.com.

Microsoft Office. Microsoft Office by Microsoft Incorporated is a complete office productivity suite including Word, Excel, PowerPoint, and Outlook. It is currently installed on all Windows 7 ECE systems. For further information on Microsoft Office software products please visit the Microsoft web site at: http://office.microsoft.com.

Symantec EndPoint Protection. Symantec EndPoint Protection by Symantec Incorporated is a complete anti-virus solution for the Windows desktop environment. It is currently installed on all Windows ECE systems. For further information on Symantec EndPoint Protection software please visit the Symantec web site at: http://www.symantec.com.

Tanner Tools. L-Edit Pro includes L-Edit for layout editing, Interactive DRC for real- time design rule checking during editing, Standard DRC for hierarchical DRC, Standard Extract for netlist extraction, Standard LVS for layout versus schematic, Node High- lighting for highlighting all geometry associated with a node and SPR for standard cell place and route. Visit them at: http://www.mentor.com.

Software Installation. Software installations for academic and research use should be accomplished by the CSG as the ECE central point of contact. Most of the software packages currently in use in ECE have licensing constraints set by the software company. The CSG maintains a list of licenses, license servers, and expiration periods for this software. Graduate students, researchers, and teaching faculty typically have research copies of engineering software packages installed on their office desktops and their laptops for convenience during travel and working at home.

Operating System Installation. Currently we are supporting Windows 7, Red Hat Enterprise Linux 6/7, and Mac OSX operating systems on department computing resources.

User Data Backup. Full user data backup is accomplished by creating compressed tar files of user directories and storing them on one of four portable 4 Terabyte ESATA raid drives. This is accomplished on a weekly basis with a rotating schedule utilizing the five drives. Two full user data backups can be stored on the drives thereby creating a sequential archive of backups for ten weeks. Following the completion of a given backup process the drive is stored offsite in the Computer Science department staff offices and the previous drive is returned to the ECE Department.

In addition to this archiving method of backup the department has a 7.0TB SATA raid array on a Red Hat 7 server named neutron.ece.unm.edu. Every evening, beginning at 5:15pm the user directories from the department file server are synchronized to corresponding directories on Neutron.

Computer Maintenance and Repair. All University of New Mexico-owned desktop and laptop computers in the Electrical and Computer Engineering Department are maintained and repaired by the computer support group. Maintenance includes both hardware and software. This is particularly true for computers which are utilized beyond vendor specific hardware maintenance agreement (warranty period).

Wireless Access. Wireless access is currently provided by UNM IT with 14 access points located thru out the ECE building.

Server Infrastructure. The department server infrastructure is a mixed environment of Red Hat Enterprise Linux 6.5/7 and Windows Server 2012 and 2012R2 operating systems. NIS services are controlled through the master server nis.ece.unm.edu. Backup NIS services are configured on the slave NIS servers nucleus.ece.unm.edu and neutron.ece.unm.edu. NIS services are necessary to control user access to all department Linux workstations. Two SSH servers with full internet access are jetfire.ece.unm.edu and psi.ece.unm.edu. These provide login and interactive computing services for classwork and Linux desktops.

The department currently hosts two Windows Server 2012R2 Active Directory domains operating in native mode. The WIN domain is the primary domain for Windows user authentication. Windows users receive a default home directory assignment via Samba authentication to the department file server nucleus.ece.unm.edu. The ECE domain is for department DNS and software licensing services. Two domain controllers, electron.ece.unm.edu and proton.ece.unm.edu host these services. Linux servers,

running Red Hat Enterprise Linux 6.6/7 operating systems, are utilized in a variety of roles in the department server infrastructure. Jetfire.ece.unm.edu with a canonical name of linux.ece.unm.edu also hosts SSH services for internet access to department resources. Operating system backup services for Linux server hosts are accomplished using AMANDA on ecestore.ece.unm.edu. Nucleus.ece.unm.edu is primary file server for all users and the user directories are replicated to neutron.ece.unm.edu on a daily basis for redundancy purposes. Finally print server services are hosted on nis.ece.unm.edu with a canonical name of printserver.ece.unm.edu.

Networking Infrastructure. The department's networking infrastructure is comprised of a router/switch backbone of Cisco Catalyst layer 2 and layer 3 ethernet and FDDI devices. These devices are housed in five different equipment rooms spread throughout the ECE building on the main campus. The core router/switch is a Cisco Catalyst 3550 12G. This device is located in Room 214B of the ECE building. Fiber optic trunk cables connect the Cisco router/switch to all the Cisco Catalyst 3550 switches. The connection to the department firewall and subsequently UNM IT and the internet is through a FDDI port on the Cisco Catalyst 3550 12G. 1000Base-T connectivity for the local server non-routable backbone is accomplished through a stub network on NetGear switches in Room 214B.

Several VLANs are configured on each of the router/switch devices in transparent mode. The department has 2048 IP addresses allocated in 8 class C subnets ranging from 129.24.24.1 to 129.24.31.255. The eight class C subnets have been broken up into modified class C subnets of varying sizes and assigned to specific VLANs. Computing resources are then logically assigned to a specific VLAN depending on the function of the resource.

Workstation Infrastructure. For local access to computing resources, a wide variety of workstations are available for student, faculty, staff, and research use in the department. Room 211 has twenty-four workstations primarily configured for ECE238 coursework support, but with multiple extra software packages installed. An access controlled laboratory in room 215, hosts sixteen Windows 7 workstations for software engineering coursework purposes. A general purpose research lab with twenty dual boot workstations in Room 216 exists for all personnel with many undergraduate software applications installed. Room 311 contains fourteen workstations configured for general electronics laboratory support.

All faculty and staff with office space in the department have a workstation allocated to them. Many graduate students have workstations for their use but are typically legacy machines retired from one of the laboratories or purchased with a grant for research purposes.

UNM Information Technologies Department. The primary mission of the Information Technologies (IT) Department at UNM is to provide quality and professional service to the UNM community, especially fast response and timely solutions to customer needs and questions. Principles guiding this service include:

Providing access, support, privacy, and security to all of the University's IT customers.

Improving the effectiveness of IT services and sharing IT resources across UNM.

Supporting UNM's mission, goals, and values.

Coordinating IT planning and communication for better use of resources.

Ensuring the development and sustainability of high IT standards for UNM.

Organization. The CIO Office is comprised of the CIO, Deputy CIO, Director of Information Assurance and the Administrative Services Unit. Computing Services and Communications Network Services comprise Information Technologies.

Additional information on IT services at UNM is available at http://it.unm.edu.

7.2 Maintenance and Upgrading of Facilities

Both the undergraduate committee and laboratory committee spend a considerable amount of time on the upgrade and the upkeep of facilities. The upgrade of the facilities is done through two dedicated lines of funding, the student laboratory fees and the differential tuition. These sources of revenue allow for modernization of both classrooms and laboratories.

7.3 Library Services

The school of engineering has a dedicated centennial science and engineering library that houses a vast collection of engineering books and literature. (http://library.unm.edu/about/libraries/csel.php#).

The library also provides numerous online databases to students such as those from IEEE.

7.4 Overall Comments on Facilities

In all laboratory classes, the following information is passed on to the students: You must be aware of safety concerns while working in the ECE lab. These include electrical shock, electrical fires, building fires, evacuation strategies, and explosion. These hazards can cause serious injury, and possibly death. If an injury occurs, immediately notify your T.A. and seek medical attention or call 911. The locations and use of AED (defibrillators) are discussed. For the undergraduates, the circuits constructed are typically low-voltage DC circuits, with low-voltage AC inputs.

The ECE department has a safety officer (Mr. David Modisette) who is responsible for safety training. The Laboratory instructors are made aware of Mr. Modisette's contact information.

The ECE department has also formed a safety committee. The committee has established a variety of safety procedures and protocols and continues to meet to refine them, and to publicize them to all ECE students.

8 Peer Comparison

For the sake of this report we compare our program to the following:

	Total university enrollment	Unit UG degrees offered	Unit UG enrollment	Unit Graduate Degrees offered	Unit Grad student enrollment	Total number of unit faculty
University of New Mexico	27,060	BS EE BS CompE	410	MS/PhD	199	32
University of Utah	31,860	BS EE BS CompE	395	MS/PhD	204	42
UC - Riverside	22,921	BS	~500	MS/PhD	~200	42
University of Houston	43,774	BS EE BS CompE	588	MS/PhD	293	36
UC – Boulder	33,771	BS EE BS CompE	-	MS/PhD	-	59
University of Tennessee	28,052	BS CS BS EE BS CompE	797	MS/PhD	-	39
University of Texas at El Paso	23,922	BS EE BS CompE	470	MS/PhD	82	19
Iowa state university	31,856	BS CS BS EE BS CompE	2001	MS/PhD	387	56
University of Arizona	43,625	BS EE BS CompE	-	MS/PhD	-	28

The University of New Mexcio's ECE program compares very well to the peers indicated in the above table. The department offers very typical degrees compared to our peers with Electrical Engineering and Computer Engineering BS degrees and MS and PhD degrees in the same disciplines.

Comparisons:

Total University enrollment: The unique geographical location and the nature of universities in the state currently limits the university's net population. The university is one of multiples institutions in the state of New Mexico with the prominent schools including the University of New Mexico, New Mexico State

University and New Mexico Tech[1]. For a state with 2 million residents we have numerous higher education institutions. Despite this, we are able to sustain a student body that averages ~27,000 students in the main campus and >30,000 including branch campuses.

Undergraduate enrollment: The undergraduate enrollment at the ECE department is 410 students. This puts us in the middle of the group of peer institutions. The undergraduate enrollment is a key focus of the department and the school of engineering with several initiatives underway to boost this number. While the traditional approach to undergraduate enrollment has been to focus on New Mexican students, of late our efforts have widened to include universities in California, Nevada, Arizona, Utah, Colorado and Texas. One of our key selling points is that UNM is one of the few universities that is listed as a Hispanic Serving Institution but is also an R1 (highest research activity) Carnegie classification institute. With a rich history of educating underrepresented minority students in STEM, we believe the we are uniquely positioned to draw students from a wide range of demographics into our programs in coming years.

Graduate enrollment: The ECE department at UNM has a very well established graduate program with strong instructional and research components. The faculty research expenditure for the department is consistently in the 300 – 500K/year range allowing our faculty to hire numerous students as research assistants. Our current combined graduate enrollment is 199, which is a bit lower that the average for the past decade on account of some reduction in international student admissions in the past years. We are well positioned with respect to our peers in this category. The department also has numerous students who are currently employed with the Sandia National Labs, Los Alamos National Labs and the Air Force Research Labs. The addition of these high caliber and highly skilled graduate students places us in a unique position of advantage compared to our peers. The department is also enacting measures to increase the number of MS students, with an emphasis on course work degrees. With the enactment of the differential tuition, the increased MS student body who would be paying for their tuition could lead to a strong revenue stream for the department.

Faculty count: The faculty count at the ECE department is currently 33 (tenured, tenure-track and lecturers). This number is of some concern since it is a slight decline from previous years and we find ourselves at the tail end of the peer group in terms of faculty size. There is an ongoing effort to hire faculty and to boost this number to be in the vicinity of 40, which we believe is the requirement for the department to operate smoothly. Another issue that the department currently faces is that in some ways it has become a victim of its own success. The ECE department at UNM perhaps contributes more faculty to administrative positions than any other department. In past couple of years, ECE faculty have been – the university president, provost, associate provost, dean of SOE, associate dean for research at SOE, associate dean for education at SOE and the director for the center for high technology materials. With approximately five full professors at various administrative positions, the department finds itself requiring an influx of talent to keep growing its student body and research portfolio.

[1] http://www.hed.state.nm.us/students/new-mexico-postsecondary-institutions.aspx

Appendix A: 2016-2017 ABET review

415 North Charles Street Baltimore, MD 21201
+1.410.347.7700 www.abet.org

August 30, 2017

Chaouki Abdallah
MSC05 3300
1 University of New Mexico
Albuquerque, NM 87131-0001

Dear Prof. Abdallah :

I am pleased to transmit to you the findings of the Engineering Accreditation Commission (EAC) of ABET with respect to the evaluation conducted for University of New Mexico during 2016-2017. Each of ABET's Commissions is fully authorized to take the actions described in the accompanying letter under the policies of the ABET Board of Directors.

We are pleased that your institution has elected to participate in this accreditation process. This process, which is conducted by approximately 2,000 ABET volunteers from the professional community, is designed to advance and assure the quality of professional education. We look forward to our continuing shared efforts toward this common goal.

Sincerely,

Wayne R. Bergstrom

Wayne R. Bergstrom
President

Enclosure: Commission letter and attachments

415 North Charles Street Baltimore, MD 21201
+1.410.347.7700 www.abet.org

August 30, 2017

Christos Christodoulou
School of Engineering
MSC01 1140
1 University of New Mexico
Albuquerque, NM 87110

Dear Dr. Christodoulou :

The Engineering Accreditation Commission (EAC) of ABET recently held its 2017 Summer Meeting to act on the program evaluations conducted during 2016-2017. Each evaluation was summarized in a report to the Commission and was considered by the full Commission before a vote was taken on the accreditation action. The results of the evaluation for University of New Mexico are included in the enclosed Summary of Accreditation Actions. The Final Statement to your institution that discusses the findings on which each action was based is also enclosed.

The policy of ABET is to grant accreditation for a limited number of years, not to exceed six, in all cases. The period of accreditation is not an indication of program quality. Any restriction of the period of accreditation is based upon conditions indicating that compliance with the applicable accreditation criteria must be strengthened. Continuation of accreditation beyond the time specified requires a reevaluation of the program at the request of the institution as noted in the accreditation action. ABET policy prohibits public disclosure of the period for which a program is accredited. For further guidance concerning the public release of accreditation information, please refer to Section II.A. of the 2016-2017 Accreditation Policy and Procedure Manual (available at www.abet.org).

A list of accredited programs is published annually by ABET. Information about ABET accredited programs at your institution will be listed in the forthcoming ABET Accreditation Yearbook and on the ABET web site (www.abet.org).

It is the obligation of the officer responsible for ABET accredited programs at your institution to notify ABET of any significant changes in program title, personnel, curriculum, or other factors which could affect the accreditation status of a program during the period of accreditation stated in Section II.H. of the 2016-2017 Accreditation Policy and Procedure Manual (available at www.abet.org).

ABET requires that each accredited program publicly state the program's educational objectives and student outcomes as well as publicly post annual student enrollment and graduation data as stated in Section II.A.6. of the Accreditation Policy and Procedure Manual (available at www.abet.org).

ABET will examine all newly accredited programs' websites within the next two weeks to ensure compliance.

Please note that appeals are allowed only in the case of Not to Accredit actions. Also, such appeals may be based only on the conditions stated in Section II.L. of the 2016-2017 Accreditation Policy and Procedure Manual (available at www.abet.org).

Sincerely,

John A. Orr, Chair

Engineering Accreditation Commission

Enclosure: Summary of Accreditation Action
Final Statement

cc: Robert Frank, President
Charles B. Fleddermann, 1 University of New Mexico
Lizette Chevalier, Visit Team Chair

Engineering Accreditation Commission

Final Statement of Accreditation
to

University of New Mexico

Albuquerque, NM

2016-2017 Accreditation Cycle

Computer Engineering
BS Program

Program Criteria for Electrical, Computer, Communications, Telecommunication(s) and Similarly Named Engineering Programs

Introduction

The computer engineering BS program, which is housed in the Department of Electrical and Computer Engineering, offers two concentrations, one in software and another in hardware. The department has a total of 32 full-time faculty members, of whom 12 are associated with the program. Additionally, the department utilizes the support of about six to nine adjunct faculty per semester. The program currently enrolls 195 students and produced 28 graduates in the 2015-16 academic year.

Program Strength

1. Many senior design projects are externally sponsored by companies and research laboratories and, thus, provide students with a unique perspective of engineering as well as related business aspects. In some cases, the projects have even led to the commercialization of the final product.

Program Weakness

1. Criterion 4. Continuous Improvement This criterion requires the program to regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained. While the program collects data related to student outcomes, the documentation of the process is incomplete and inconsistent and the implementation of the process is inconsistent. The assessment tools presented in the self-study report are not applied as specified, and some of the data presented in the course material did not align with the outcome being assessed. As a consequence, there is lack of evidence that all student outcomes are appropriately assessed and evaluated. Therefore, strength of compliance with this criterion is lacking.

    - 30-day due-process response: The EAC acknowledges receipt of documentation describing improved mapping of courses against outcomes, standardization of rubrics for

improved consistency, and the development of a program assessment handbook. In addition, the rubrics were used in the fall and spring terms. Suggested improvement actions were proposed based on the assessment results.

- The weakness is resolved.

Program Concern

1. Criterion 1. Students This criterion requires that students be advised regarding curriculum and career matters. The university recently reorganized the advising process and placed all first year students from the University College into the departments. In addition, three college advisors separated from the School of Engineering. As a result, a single advisor for electrical and computer engineering is advising over 400 students. This high student to advisor ratio might negatively affect the quality of student advising. Therefore, the potential exists for non-compliance with this criterion in the future.

   - 30-day due-process response: The EAC acknowledges receipt of documentation providing evidence that a second professional advisor has been hired as of December 2016. In addition, a third advisor will be hired in May or June 2017 that will advise students in the Department of Electrical and Computer Engineering and Department of Mechanical Engineering.

   - The concern is resolved.

Electrical Engineering
BS Program

Program Criteria for Electrical, Computer, Communications, Telecommunication(s), and Similarly Named Engineering Programs

Introduction

The electrical engineering BS program is administered by the Department of Electrical and Computer Engineering. The department has a total of 32 tenured or tenured track faculty members, with 23 in electrical engineering, three full-time lecturers and six to nine adjunct professors. The program currently enrolls 253 students and produced 45 graduates in the 2015-16 academic year.

Program Strength

1. Many senior design projects are externally sponsored by companies and research laboratories and, thus, provide students with a unique perspective of engineering as well as related business aspects. In some cases, the projects have even led to the commercialization of the final product.

Program Weakness

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- The weakness is resolved.

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   - The concern is resolved.

Appendix B: PhD/MS exam rubrics