# BACKGROUND INFORMATION

The mission of *Engineering Physics (EP) Program* at *New Mexico State University (NMSU)* is to offer an accredited degree that combines high-quality engineering and physics programs to best prepare our graduates for careers in state-of-the-art industry or to move on to advanced study in in physics or an engineering discipline.

## A. Contact Information

*List name, mailing address, telephone number, fax number, and e-mail address for the primary pre-visit contact person for the program.*

The main contact for the *Engineering Physics Program* is:


Dr. Heinz Nakotte
Chair of the Engineering Physics Program Committee
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Dr. Nakotte is the current Chair of the *Engineering Physics (EP) Program Committee*, which administers all aspects of the program. The *EP Program Committee* has members from the *Department of Physics* (*College of Arts & Sciences*) and the *Departments of Mechanical & Aerospace Engineering*, *Chemical & Materials Engineering* and *Electrical & Computer Engineering* (*College of Engineering*).

The primary contact for EP program in the *College of Engineering* is:


Dr. Sonya Cooper, Ph.D., P.E.
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## B. Program History

*Include the year implemented and the date of the last general review. Summarize major program changes with an emphasis on changes occurring since the last general review.*

For more than 50 years, the *Department of Physics* has offered the traditional physics degrees, i.e. *Bachelors of Science (BS)*, *Masters of Science (MS)*, and *Doctorate of Philosophy (PhD)*. By the 90s, most of the emphasis of the physics programs had been on the graduate degrees, and the BS was designed mostly to prepare students for advanced graduate studies in Physics.

At the same time, however, the *Department of Physics r*ecognized a steadily increasing demand for students with a more applied undergraduate degree, especially for industry and national laboratories. In response, the *Department of Physics* implemented two new degrees: first, a *Bachelor's of Arts (BA)*, which requires a minor in a second field (popular minors are Astronomy, Chemistry or Mathematics, and later, a *Bachelor's of Science in Engineering Physics (BS-EP)* degree. In addition, the Department of Physics also offers a Minor in Physics.

The EP degree was proposed in 2001 with two concentrations, one in *Mechanical Engineering* and one in *Electrical Engineering*, and separate curricula for these EP concentrations were developed jointly with the corresponding engineering departments. This Self Study Report focusses on the BS-EP degree. The EP program was internally approved and placed in *NMSU's Undergraduate Catalog* for the first time in 2002. In 2004, EP celebrated its first graduate, who had switched his major from physics to EP.

About 5 years after introduction of the EP program, the *Department of Physics* filed for its first accreditation of the EP program with ABET, and it was successfully accredited in 2007. Following ABET accreditation, the EP program added two additional concentrations, one in *Aerospace Engineering* and another in *Chemical Engineering*, in response to needs and demands from program constituents. Like the original concentrations, the respective curricula were developed in close consultation with the corresponding engineering departments. The EP program and all four of its current concentrations were successfully re-accredited by ABET in 2013.

EP is not one of traditional engineering disciplines; there were fewer than 20 ABET-accredited programs nation-wide when the program was first introduced at NMSU. On the other hand, the demand for graduates with a background in EP continues to grow and therefore several other institutions have introduced EP programs seeking accreditation since then. EP is generally considered as one of the most challenging degree programs in academia; however, the potential rewards are very high, as indicated by the quote from *The Princeton Review®*:

> *It might seem like engineering physics is someone's idea of a cruel joke —combining two of the toughest majors into one. But no pain, no gain, my friend! And gains in this field come in the form of a wide blanket of job opportunities and—if you play your cards right—a nice-looking starting salary.*

After accreditation by ABET in 2007, the EP program at NMSU started growing at an average of ~5 students per year. As shown in Diagram 0.1, this trend continued until 2015, after which the enrollment seems to have settled around 40 students. In Fall of 2017, the enrollment in EP at NMSU totaled 39 students, which is comparable to the number of physics BS and BA majors combined.

While the EP program has among the lowest enrollments among all engineering programs at NMSU, it produces high-quality graduates who typically have little trouble securing rewarding career opportunities or getting admitted to advanced graduate programs after graduation (see *Criterion 2 – Program Educational Objectives*).

Another indicator for the quality of the EP program are the strong retention and graduation rates. Table 0.1 lists the retention and graduation rates for incoming EP freshman since Fall of 2008.

This may be largely attributed to more individual attention and guidance provided to students in low-enrollment programs. It should also be noted that EP students who left EP typically switched majors to a pure physics or an engineering major, which is to be expected when freshman/sophomore EP students develop a stronger affinity to either pure sciences or more applied engineering subjects. In other words, while those students appear in the minus column for EP retention, they are not lost in the overall retention statistics of the colleges, i.e. *Arts & Sciences* for physics majors and *Engineering* for engineering majors. Similarly, students who switched majors from other engineering degrees to EP are not included in either program-specific retention statistics.

***Diagram 0.1.*** *Enrollment of Physics and Engineering Physics majors since 2000.*

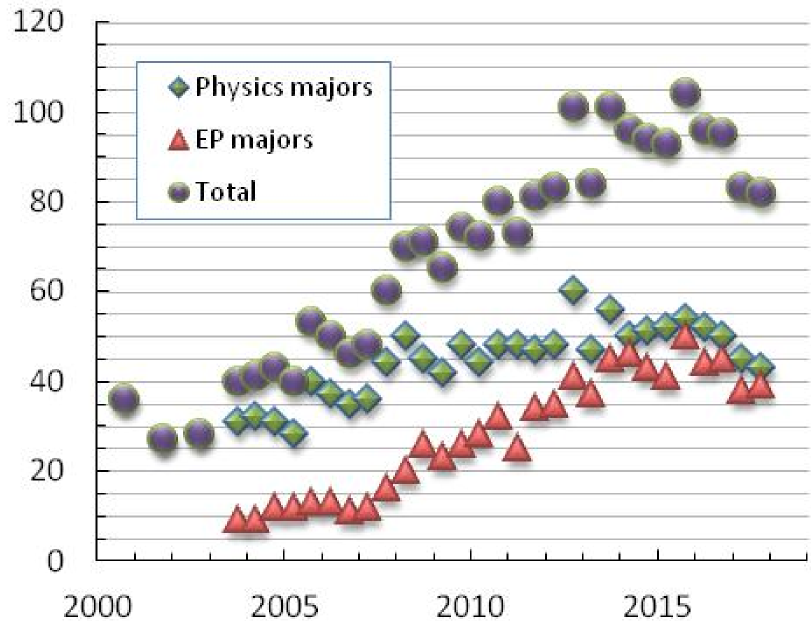



***Table 0.1.*** *Retention and Graduation Statistics for incoming EP freshman since 2008.*

| Semester | Number of Incoming Freshman EPs | Number of Freshman EPs graduating after 4 years | Number of Freshman EPs graduating after 5 years | Number of Freshman EPs graduating after 6 years | Total Freshman EPs Retained |
|---|---|---|---|---|---|
| *Fall 2008* | 4 | 2 | 1 | | 3 (75%) |
| *Fall 2009* | 7 | 1 | 2 | | 3 (42.6%) |
| *Fall 2010* | 2 | | | | 0 (0%) |
| *Fall 2011* | 6 | 1 | | 1 | 2 (33.3%) |
| *Fall 2012* | 8 | 3 | 1 | | 5 (62.5%)[a] |
| *Fall 2013* | 3 | | | | 3 (100%) |
| *Fall 2014* | 5 | | | | 4 (80%) |
| *Fall 2015* | 14 | | | | 11 (78.6%) |
| *Fall 2016* | 9 | | | | 7 (77.8%) |

[a]: One EP student is still in the program and on track to graduate in 2018

## EP Program Organization

The EP program at NMSU is a program supported and co-administered by the colleges of *Engineering* and *Arts & Sciences*. It is supported by four mature departments – *Physics* (*College of Arts & Sciences*), *Electrical & Computer Engineering* (*College of Engineering*), *Mechanical & Aerospace Engineering* (*College of Engineering*) and *Chemical & Materials Engineering* (*College of Engineering*).

EP is a program in the *Department of Physics*, which belongs to NMSU's *College of Arts & Sciences*. The *Department of Physics* receives its annual budget allocations from the *College of Arts & Sciences*, and the department utilizes the budget to support all of its academic programs: the *MS* and *PhD in Physics*, the *BS* or *BA in Physics* and the *BS in Engineering Physics*. The *Department of Physics* receives some additional support from the *College of Engineering* through its allocations of the *Engineering Fee*.

EP is an engineering degree and therefore administered by NMSU's *College of Engineering*. The *College of Engineering* oversees all academic issues of the EP program, including accreditation, curricular issues, and program quality.

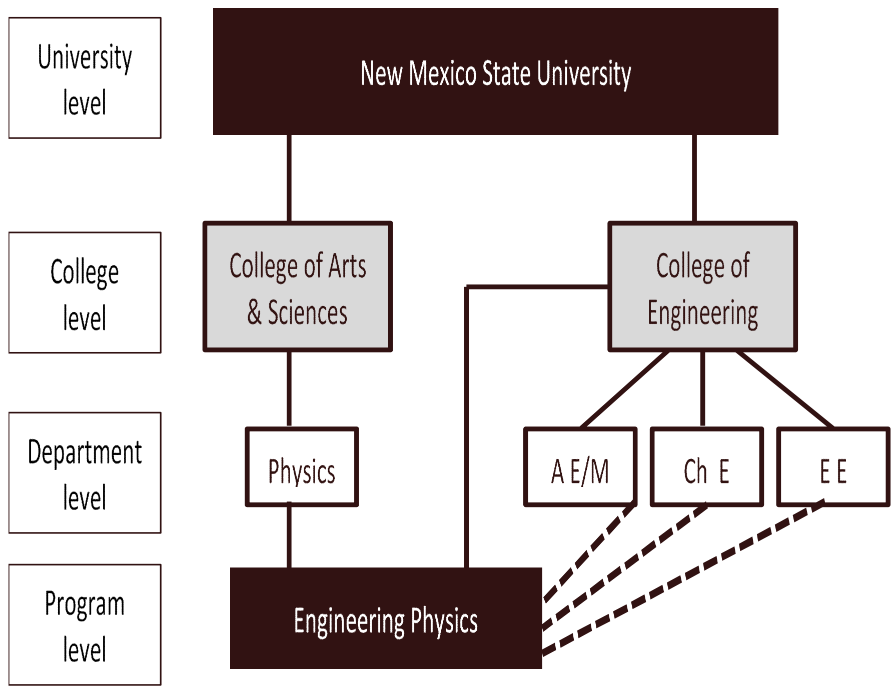
Both colleges benefit from the across-college EP degree. The *College of Engineering* benefits in that the program is fully supported financially through the *Department of Physics* in the *College of Arts & Sciences*. The *College of Arts & Sciences* benefits as the EP program secures sufficient enrollment for a healthy overall physics program.

The EP program itself is run by an *EP Program Committee*, which consists of members from the *Departments of Physics* (*College of Arts & Sciences*) and the Departments of *Mechanical & Aerospace Engineering*, *Chemical & Materials Engineering* and *Electrical & Computer Engineering* (*College of Engineering*). The EP Committee oversees all program issues, including curricula, program evaluation & growth etc. Current members of the *EP Program Committee* are given in Table 0.2. The organizational chart of the EP program is given in Diagram 0.3.

***Table 0.2.*** *Members of the Engineering Physics (EP) Program Committee – 2017/2018*

| |
|---|
| Dr. Heinz Nakotte (Chair), Professor, Department of Physics |
| Dr. Thomas Hearn, Associate Professor, Physics |
| Dr. Steve Pate, Professor, Physics |
| Dr. Igor Vasiliev, Professor, Physics |
| Dr. Mike DeAntonio, College Professor, Physics |
| Dr. Young-Ho Park, Associate Professor, Mechanical & Aerospace Engineering |
| Dr. Steve Stochaj, Professor, Electrical & Computer Engineering |
| Dr. Hongmei Luo, Associate Professor, Chemical & Materials Engineering |
| Dr. Stefan Zollner, Department Head, Department of Physics (*ex officio*) |
| Dr. Sonya Cooper, Associate Dean for Academics, College of Engineering (*ex officio*) |

***Diagram 0.2.*** *Organizational Chart of the Engineering Physics (EP) program at NMSU.*




Of the 39 EP majors enrolled in Fall 2017, 7 classify as freshmen, 7 as sophomores, 9 as juniors and 16 as seniors within the university system. It should be noted that university-level classification strictly depends on credit hours taken and/or transferred. In other words, high-school students admitted from dual-credit programs or with *Advanced Placement (AP)* credits or transfers from junior colleges are often classified at a higher level than would be inferred by the semester that the students join the EP program. Since the EP program tends to attract the stronger high-school graduates, a more meaningful classification based on the starting semester yields the following distribution: 11 freshmen, 12 sophomores, 7 juniors and 9 seniors. NMSU in an accredited minority-serving institution, and this is reflected also in EP enrollment: A total of 62% of the EP students enrolled in Fall 2017 are self-declared minorities: i.e. of the 39 EP students, 21are self-declared Hispanic, 2 are self-declared American-Indian and 1 is a self-declared African-American.

## C. Options

*List and describe any options, tracks, concentrations, etc. included in the program.*

The title of the degree awarded is *Bachelor of Science in Engineering Physics* and there are currently four different concentrations: the *Aerospace*, *Chemical*, *Electrical* and *Mechanical Concentrations*.

In 2016, NMSU decided to reduce the requirement of minimum credit hours for a degree from 128 to 120 with the goal of increasing graduation rates. After careful consideration, the *EP Program Committee* (see Table 0.2.) decided that the EP could not really decrease its minimum credit hours without adversely affecting the program quality and still fulfilling the various other requirements, including those for ABET accreditation, the state-mandated general-education and the university-level *Viewing-the-Wider-World (VWW)* requirements.

The current requirements for all EP concentrations are listed in the *2017-2018 Undergraduate Catalog*, and they are briefly summarized in the following sections.

The *Aerospace Engineering (AE) Concentration* of the EP program requires a total of 130 credit hours, which consist of 15 credits in the State of New Mexico Common Core areas IV and V, 6 credits in VWW courses, 14 credits in Mathematics, 10 credits in English and Communications, 4 credits in Chemistry, 33 credits in Physics (12 of which have significant engineering content), 3 credits in General Engineering, 3 credits in Civil Engineering, 12 credits in Mechanical Engineering, 27 credits in Aerospace Engineering, and 3 credits of an Engineering Design Capstone.

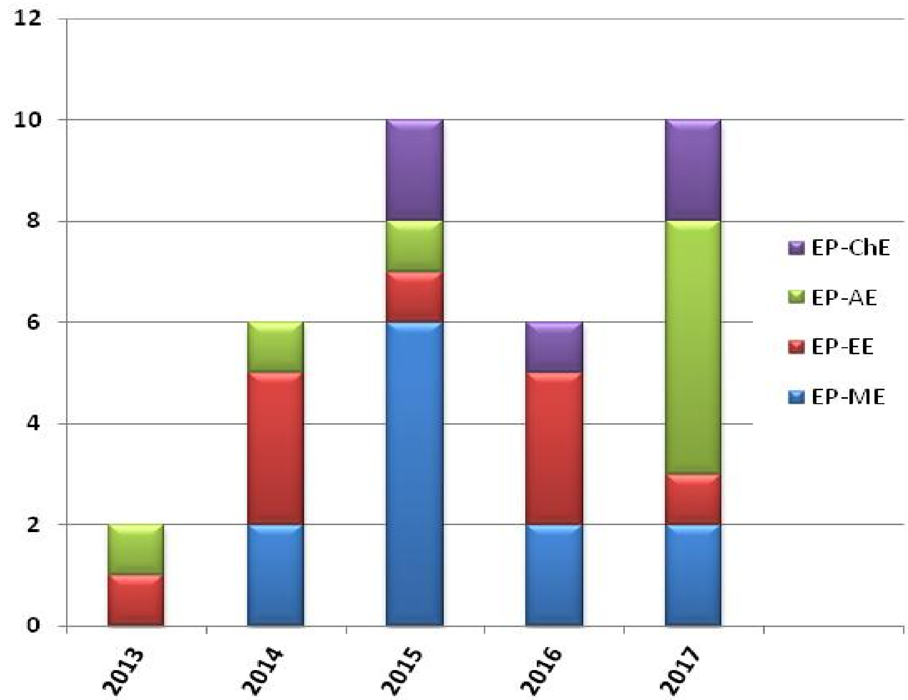
The *Chemical Engineering (CE) Concentration* of the EP program requires a total of 132 or 133 credit hours, which consist of 15 credits in the State of New Mexico Common Core areas IV and V, 6 credits in VWW courses, 14 credits in Mathematics, 10 credits in English and Communications, 11 credits in Chemistry, 39 credits in Physics (15 of which have significant engineering content), 3 credits in General Engineering, 28 credits in Chemical Engineering, 3 credits of a Technical Elective (with engineering content), and 3-4 credits of an Engineering Design Capstone. EP students with the Chemical Concentration can either take the 4-credit capstone in the Chemical Engineering Department of a 3-crcdit capstone in any other engineering department.

The *Electrical Engineering (EE) Concentration* of the EP program requires a total of 130 or 131 credit hours, which consist of 15 credits in the State of New Mexico Common Core areas IV and V, 6 credits in VWW courses, 14 credits in Mathematics, 10 credits in English and Communications, 4 credits in Chemistry, 42(39) credits in Physics (12 of which have significant engineering content), 3 credits of General Engineering, 27(31) credits in Electrical Engineering, 3 credits of a Technical Electives (with engineering content), and 6 credits of an Engineering Design Capstone. EP students with the Electrical Concentration can opt to take *EE 351 to* satisfy the *PHYS 462* requirements.

The *Mechanical Engineering (ME) Concentration* of the Engineering Physics program requires a total of 129 credit hours, which consist of 15 credits in the State of New Mexico Common Core areas IV and V, 6 credits in VWW courses, 14 credits in Mathematics, 10 credits in English and Communications, 4 credits in Chemistry, 36(33) credits in Physics (12 of which have significant engineering content), 3 credits of General Engineering, 3 credits of Civil Engineering, 29(32) credits in Mechanical Engineering, 3 credits of a Technical Elective (with engineering content), and 6 credits of an Engineering Design Capstone. EP students with the Mechanical Concentration can opt to opt to take *ME 333* (significant engineering content) to satisfy the *PHYS 451* (no significant engineering content).

Of the 39 EP students enrolled in Fall of 2017, the most popular concentration was the *Mechanical Concentration* with 16 students, followed by the *Aerospace Concentration with* 12, then the *Electrical Concentration* with 8, and the *Chemical Concentration* with 3. A similar trend in preferences for EP concentrations is seen also in the graduation over the past five years, see Diagram 0.3.

*__Diagram 0.3.__ Annual graduation rates of EP students and their concentrations.*




## D. Program Delivery Modes

*Describe the delivery modes used by this program, e.g., days, evenings, weekends, cooperative education, traditional lecture/laboratory, off-campus, distance education, we-based, etc.*

The EP program is a face-to-face program with some co-op options. All the courses are offered during daytime hours, Monday through Friday, and are intended primarily for full-time or nearly full-time students. Students also have the option of summer sessions for some of their beginning level courses.

Except for the capstone design projects, course and laboratories are typically taught using traditional teaching approaches. Capstone design courses require students to be involved some major design project. In general, the students will work in (sometimes interdisciplinary) teams of 3-5 students. In general, EP students will participate in capstone projects offered through different engineering departments. Participating departments will provide the necessary budget and the space needed to complete a capstone project. In many cases, capstones are done in collaboration with industrial partners, and those might provide some of the needed funding. Occasionally, students may propose their own capstone project, which are sponsored and supervised by individual faculty members. In all cases, students are expected to give presentations on the progress of a project, to participate in formal design review sessions and to write a final design document. It is common that physics faculty members are involved in the evaluation process of final-design presentations of projects that involve EP students.

## E. Program Locations

*Include all locations where the program or a portion of the program is regularly offered (this would also include dual degrees, international partnerships, etc.).*

Lecture courses and teaching laboratories utilize lecture halls, classrooms and laboratory facilities that are available at the participating departments, i.e. *Gardiner Hall* in the case of *Department of Physics*, *Jett Hall* in the case of the *Department of Chemical & Materials Engineering* as well as the *Department of Aerospace & Mechanical Engineering*, *Thomas Brown Hall* and *Goddard Annex* in the case of the *Department of Electrical & Computer Engineering*. Program-specific requirements in *Mathematics* and *Chemistry* are typically held in *Science Hall* and the *Chemistry Building*, respectively. General-education, *VWW* and other courses are held all over campus in buildings that house the support department which offer the course or in big lecture halls, such as *Hardmann Hall*.

## F. Public Disclosure

*Provide information concerning all the places where the Program Education Objectives (PEOs), Student Outcomes (SOs), annual student enrollment and graduation data is posted or made accessible to the public. If this information is posted to the Web, please provide the URLs.*

Program Educational Objective, Program Outcomes, student enrollment and graudation data are made available to the public through links at http://engineeringphysics.nmsu.edu/.

## G. Deficiencies, Weaknesses or Concerns from Previous Evaluation(s) and the Actions Taken to Address Them

*Summarize the Deficiencies, Weakness, or Concerns remaining from the most recent ABET Final Statement. Describe the actions taken to address them, including effective dates of actions, if applicable. If this is an initial accreditation, it should also be indicated.*

The last ABET site visit for the EP program took place at NMSU between October 14-16, 2012. The initial assessment of the *EP Program Reviewer* indicated one weakness in *Criterion 5 – Curriculum* and one concern in *Procedures and Policies*.

The initial assessment of a weakness related to whether all concentrations of the EP program provide an equivalent of one and one-half years of engineering topics. The problem arose mostly because the EP program failed to clearly indicate and justify which of the physics courses can be counted toward the engineering contingent and which cannot. Following the initial assessment, the *Department of Physics* submitted a clarification to ABET and Table 5.1. In the *Final Statement of Accreditation* from ABET, dated August 12, 2013, this initial weakness was downgraded to an observation. It read: *'At the time of the visit, there was some confusion as to which courses the program intended to include in the one and one-half years of engineering topics. It is entirely appropriate for technical electives to be included in the engineering topics component, but it is very important that the choices available for students to include in this component have content that is clearly engineering topics, not basic science. The program could* *improve the clarity of its documentation by clearly identifying the engineering topics component.'*

Physics courses are obviously a major component of any EP program. Naturally, every physics course is expected to consist of fundamental-science components, the underlying concepts and the theoretical models, and this may raise concerns whether such any of those courses can be counted toward the engineering contingent. Some (but not all) physics courses do include engineering applications at some level. On the other hand, it is usually up to the instructor of a course to what extend current or potential applications are covered. In consultation with course instructors, the EP Program Committee identified the physics courses, for which expectations of significant engineering components are most reasonable; see *Criterion 5 – Curriculum*. Instructors of the identified courses are informed about such additional expectations.

The initial assessment of a concern in *Procedures and Policies* was deemed a weakness in the *Final Statement of Accreditation*. The concern/weakness raised was: *'The Accreditation Policy and Procedure Manual section II.A.6. requires that each accredited engineering program must be specifically identified as accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. The engineering physics website does not identify the program in this manner. In addition, Section II.G.6.b.(1) requires that the instructional and learning environments be adequate and safe for the intended purposes. At the time of the visit the program facilities did not have Materials Safety Data Sheets on display. Also, the Physics Education Research Laboratory is used to store certain senior design projects that are developing laboratory demonstrations. However, this space is also used in conducting outreach to pre-college students, which could expose the pre-college students to safety hazards. The program lacks strength of compliance with the Accreditation Policy and Procedure Manual.'*

Corrections to the EP program's webpages were already made at the time of the 2012 ABET site visit and they were found to be complying by ABET staff. In addition, a policy was implemented requiring that all hazardous materials and safety hazards are removed from laboratories before a visit from pre-college students. Accessibility to MSDS data sheets for all chemicals is provided as required by OSHA guidelines. All students and employees who work in the program laboratory are informed of the location during the site-specific HAZCOM training. The weakness was found to be resolved.