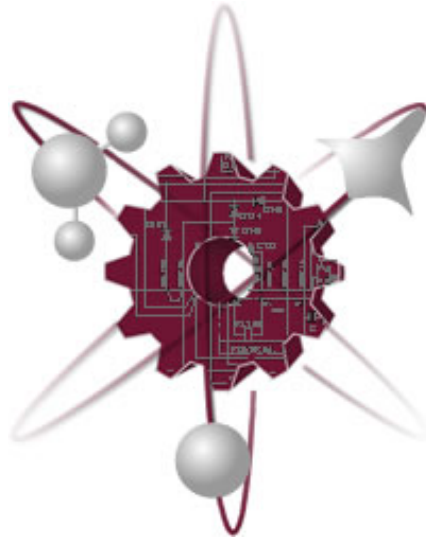


# Background Information

## Engineering Physics

Bachelor of Science in Engineering Physics



## Self-Study Report

New Mexico State University



June 2012

## BACKGROUND INFORMATION

The mission of Engineering Physics program at New Mexico State University is to offer an ABET-accredited degree that combines high-quality engineering and physics programs to best prepare our graduating students for careers in state-of-the-art industry or to move on to advanced study in engineering or physics

### 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

Department of Physics

New Mexico State University

PO Box 30001, MSC 3D

Las Cruces, New Mexico 88003

Phone: (575) 646-2459

Fax: (575) 646-1934

E-mail: [hnakotte@nmsu.edu](mailto:hnakotte@nmsu.edu)

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

The primary contact for the College of Engineering is:

Dr. Sonya Cooper, Ph.D., P.E.

Associate Dean of Academics

College of Engineering, MSC 3449

New Mexico State University

P.O. Box 30001

Las Cruces, NM 88003-8001

Phone: (575) 646-2912

Email: [socooper@nmsu.edu](mailto:socooper@nmsu.edu)

Fax: 575-646-3549

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

faculty members recognized a steadily increasing demand for students with a more applied undergraduate degree, especially for industry and the public school systems. In addition, our BS degree did not adequately prepare students who wished to pursue other disciplines in graduate school. Therefore, in 1998, the Department added a Bachelor's of Arts (BA), designed to retain most of the core physics courses, but requires a minor in another department. Popular minors are Mathematics and Astronomy.

Even with the introduction of a BA degree, it became quickly apparent that this degree did not fully satisfy the needs of new-technology industries. At the same time, most traditional engineering curricula do not provide an in-depth coverage of important concepts in modern physics (quantum mechanics, condensed matter physics, laser optics, atomic physics, and nuclear physics), which play an instrumental role in modern technology. Moreover, many prospective students had expressed concern about the job opportunities with 'just' a BS in Physics. There had been (and still is) a widespread belief that a graduate degree is required for a rewarding career of a physicist.

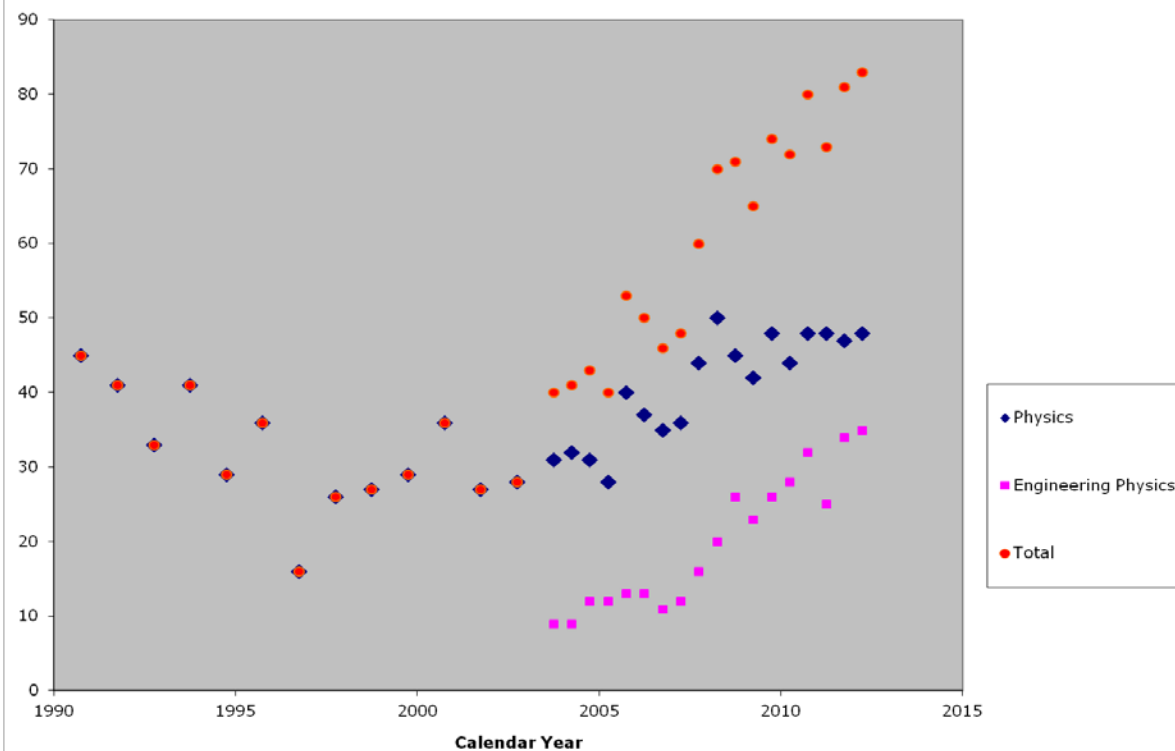
In response, the Department of Physics therefore proposed a Bachelor's of Science in Engineering Physics (EP) degree. The degree was proposed in 2001 and curricula for two emphasis areas (one in *Mechanical Engineering* and one in *Electrical Engineering*) were developed jointly with the respective engineering departments. The Engineering Physics degree was internally approved and placed in NMSU's Undergraduate Catalog for the first time in 2002. In 2004, Engineering Physics celebrated its first graduate. In 2006, the Department of Physics filed for the first accreditation of the Engineering Physics program with ABET, and the program was accredited in 2007.

Following ABET accreditation, Engineering Physics added two additional emphasis areas (one in *Aerospace Engineering* and another in *Chemical Engineering*), in response to needs and demands from program constituents. Since then, the program experienced continuous average growth at a rate of  $\sim 4$  students per year, as can be seen in Diagram 0.1. In Spring of 2012, the enrollment in Engineering Physics at New Mexico State University totaled 35 students, 17 of which were in the *Mechanical*, 11 in the *Electrical*, 4 in the *Chemical* and 3 in the *Aerospace concentrations*.

Similar to other science and engineering programs, Engineering Physics exhibits 'saw-like' enrollment with higher numbers in the fall semesters (when high-school graduates typically come in) and decreased numbers in the spring semesters. This can be attributed to the fact that incoming high-school graduates often do not have the necessary math and science background needed for a demanding program such as Engineering Physics and switch to less demanding degree programs within the university or drop out completely.

By now, the Engineering Physics enrollment has almost reached the number of physics majors, where the enrollment has become fairly stagnant in recent years. In fact, it can be estimated that in 1-3 years, there will be more Engineering Physics than physics undergrads in the department. Moreover, the Engineering Physics program is almost solely responsible for the growth of the total undergraduate enrollment (combined Physics BS or BA and Engineering Physics BS) in the department.

**Diagram 0.1. Enrollment of Physics and Engineering Physics majors since 1990.**



In the past 2 years (i.e. since Fall of 2010), 24 ‘new’ students had entered the Engineering Physics program, 17 of which remain in the program. Of those incoming students, slightly more than 50% are high-school graduates registering for the first time in college; others are transfers from junior colleges, other institutions or other majors. The majority of enrolled students leave the program just after or during their freshman year due to inadequate high-school preparation in the STEM disciplines. However, another significant fraction of Engineering Physics students switch majors in their junior year, mostly because they run into troubles with 400-level upper-division physics courses. The Engineering Physics Program Committee has tried to address these retention issues for example by the introduction of a new *PHYS395* course on *Intermediate Mathematical Methods in Physics*. New Mexico State University is located in a fast growing sun-belt city of Las Cruces, near the large multi-cultural metropolitan areas of El Paso, Texas and Ciudad Juarez, Mexico. Tuition remains relatively low and therefore we expect a continuous increase in EP enrollment over the next decade.

Of the presently enrolled Engineering Physics students, 5 were classified as freshman, 8 as sophomores, 9 as juniors and 13 as seniors within the university system. It should be noted, however, that university-level classification strictly depends on credit hours taken 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 actually join the EP program. Since Engineering Physics tends to attract the stronger high-school graduates, a more

meaningful classification based on the starting semester yields the following distribution: 8 freshman, 6 sophomores, 10 juniors and 11 seniors. New Mexico State University is an accredited minority-serving institution, and this is reflected also in EP enrollment: Of the 35 EP students (Spring 2012), 14 EP students and 1 EP student are self-declared Hispanic or American Indian, respectively.

### 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." At NMSU, a minimum of 128 credit hours are currently required for graduation in any field. Engineering Physics consists of a core set of courses in physics, a core set of courses in a particular engineering field, required credits in mathematics and other sciences, state-mandated general-education requirements, *Viewing-the-Wider-World (VWW)* courses as well as some electives.

When originally introduced, Engineering Physics was offered with two 'options': one in *Electrical Engineering* and another in *Mechanical Engineering*. In 2010, the term 'option' was changed to 'concentration' in order to ensure consistency in terminology for specified areas of study across campus. The number of actual credits in each category depends upon the program concentration chosen by the student, which is discussed in detail below. Currently, Engineering Physics students may choose the *Aerospace, Chemical, Electrical or Mechanical concentrations*. Starting with the 2012-2013 Undergraduate Catalog, the requirements for the different concentrations are briefly summarize in the following sections.

The *Aerospace Engineering concentration* of the Engineering Physics 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, 42 credits in Mechanical & Aerospace Engineering, 3 credits in Civil Engineering, and 3 credits of Electives (upper-level Physics or Engineering course).

The *Chemical Engineering concentration* of the Engineering Physics 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, 16 credits in Chemistry, 39 credits in Physics and 30 credits in Chemical Engineering.

The *Electrical Engineering concentration* of the Engineering Physics 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, 42(36) credits in Physics, 33(39) credits in Electrical Engineering and 3 credits of Electives (upper-level Physics or Electrical Engineering course). Students can opt to take *EE 310* and *EE 351* to satisfy the *PHYS 461* and *462* requirements.

The *Mechanical Engineering 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, 39(36) credits in Physics and 38(41) credits in Mechanical Engineering and 3 credits in Civil Engineering. Students can opt to opt to take *ME 333* to satisfy the *PHYS 451* requirement.

#### **D. Organizational Structure**

*Using text and/or organizational charts, describe the administrative structure of the program (from the program to the department, college, and upper administration of your institution, as appropriate).*

The Engineering Physics (EP) program at New Mexico State University (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 and Computer Engineering (College of Engineering), Mechanical & Aerospace Engineering (College of Engineering) and Chemical Engineering (College of Engineering).

Engineering Physics is a program in the Department of Physics, which belongs to NMSU's College of Arts & Sciences. The Department of Physics receives its 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.

However, the Engineering Physics degree is an engineering degree and therefore administered by NMSU's College of Engineering. The College of Engineering is in charge of all academic issues of the Engineering Physics program, including accreditation, curricular issues, program quality.

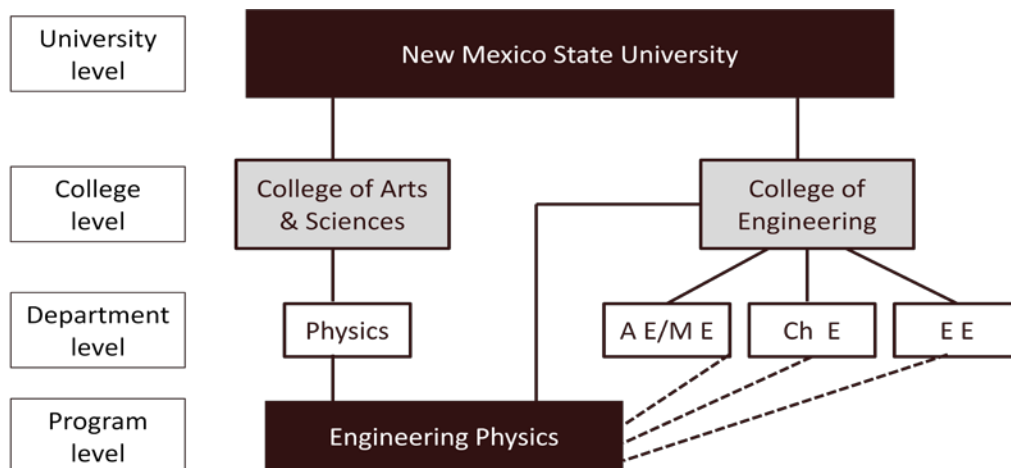
Both colleges benefit from the across-college Engineering Physics degree. The College of Engineering benefits in that the program is fully supported financially through the Department of Physics in the College of Arts & Sciences. The College of Arts & Sciences benefits as the Engineering Physics program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

The Engineering Physics program itself is run by an Engineering Physics Program Committee, which consists of members from the Departments of Physics (College of Arts & Sciences), Mechanical & Aerospace Engineering, Chemical Engineering and Electrical Engineering. The EP Committee is in charge of all program issues, including curricula, program evaluation & growth etc. Current members of the Engineering Physics Program Committee are given in Table 0.1. The organizational chart of the Engineering Physics program is given in Diagram 0.2.

**Table 0.1. Members of the Engineering Physics Program Committee – 2012**

<p>Dr. Heinz Nakotte (Chair), Faculty, Department of Physics          Dr. Thomas Hearn, Faculty, Department of Physics          Dr. Steve Pate, Faculty, Department of Physics          Dr. Igor Vasiliev, Faculty, Department of Physics          Dr. Mike DeAntonio, Faculty, Department of Physics          Ms. Elena Fernandez, Staff, Department of Physics          Dr. Young Park, Faculty, Mechanical &amp; Aerospace Engineering Department          Dr. Muhammed Dawood, Faculty, Electrical Engineering Department          Dr. Paul Andersen, Faculty, Chemical Engineering Department          Dr. Stefan Zollner, Department Head, Department of Physics (<i>ex officio</i>)          Dr. Sonya Cooper, Associate Dean for Academics, College of Engineering (<i>ex officio</i>)</p>
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**Diagram 0 2. Organizational Chart of the Engineering Physics program at NMSU.**



### E. 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 Engineering Physics program is a face-to-face program with some co-op options. All of 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 face-to-face teaching approaches. Capstone design courses often require students to be involved some major design project. In general, the students will work in (often interdisciplinary) teams of 3-5 students, more or less independent of an actual instructor. If approved, 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 design 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.

## **F. 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.).*

In general, 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 Engineering as well as the Department of Aerospace & Mechanical Engineering, *Thomas Brown Hall* and *Goddard Annex* in the case of the Department of Electrical Engineering. Program-specific requirements in Mathematics and Chemistry are typically held in *Science Hall* and the *Chemistry Building*, respectively. General-education and other courses are either held all over campus in buildings housing the respective department offering a particular course or in big lecture halls, such as *Hardmann Hall*.

## **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.*

During the first ABET site visit in Fall 2006, the program reviewer for Engineering Physics had identified two program shortcomings:

1) *The program is well organized and has defined educational objectives. However there is no data on the attainments of graduates who are 3 to 5 years beyond graduation because the first graduate of the program finished in 2004. The program has plans in this area but it remains to be seen if the results of evaluations will be used to develop and improve program outcomes. The program has a “weakness” because the program has not yet demonstrated compliance with criteria 2.*

2) *The capstone design experience involves multi-disciplinary teams from engineering physics, electrical engineering, and mechanical engineering. The engineering physics program is currently making efforts to satisfy this criterion, but this is a relatively new program and there is potential for engineering physics students to not be appropriately included. The program has a “concern” in terms of compliance with criteria 4.*

The former of these short-coming was mostly due to fact that in 2006 our Engineering Physics program was a new program and did not have any graduates 3-5 years beyond graduation at that time. The latter of these stated short-comings triggered more involvement of physics faculty in capstone design projects that are held in the Engineering Departments as well as the offering of some capstone projects in the Department of Physics.



The Engineering Physics Program Committee submitted two interim reports dated 6/1/2008 and 4/30/2009 to ABET in order to address these shortcomings. A final statement from ABET received in June of 2009 indicated that both short-comings have been resolved. Therefore, no previous shortcomings are addressed in this document. Instead, processes for self-evaluation and corrective actions have been implemented; see specifically *Criterion 4 – Continuous Improvement*.

## **H. Joint Accreditation**

*Indicate whether the program is jointly accredited or is seeking joint accreditation by more than one commission.*

NMSU's Engineering Physics program is neither jointly accredited nor is it seeking joint accreditation with another commission.