CRITERION 3. STUDENT OUTCOMES

A. Student Outcomes

List the student outcomes for the program and indicate where the student outcomes are documented. If the student outcomes are stated differently than those listed in Criterion 3, provide a mapping of the program's student outcomes to the student outcomes (a) through (k) listed in Criterion 3.

EP *Program Outcomes*

The *Engineering Physics (EP) Program* utilizes the resources of five different programs: *Physics*, *Aerospace Engineering, Chemical Engineering*, *Electrical Engineering* and *Mechanical Engineering*, which are hosted in four different departments. Above engineering programs, including EP, are currently ABET accredited and all of them are preparing for re-accreditation in 2018. Each of the engineering programs has a common set of *Program Outcomes (a)-(k),* as required by ABET.

While other engineering programs at NMSU typically have additional program-specific outcomes as well, this is not the case for the *EP Program*. Each of the other engineering programs at the *College of Engineering* have their own established *Program Outcomes & Assessment Procedures* to assess *Program Outcomes (a)-(k)* through their courses. The *EP Program* has little influence on assessment procedures formulated by other engineering programs, which were established such that they were adequate for their own majors. However, this is not the case for physics courses that are under full control of the *Department of Physics.* Therefore, the *EP Program* formulated a separate own *Program Outcomes & Assessment Procedure* using physics courses and other measures under the control of the department.

It should be noted, however, that curricular changes (e.g. changes in the course sequence, delivery and content) by participating engineering departments may affect the *EP Program* as well. This is one reason why representatives of participating engineering departments are members the *EP Program Committee*. If needed, these engineering representatives will disseminate and discuss the internal findings, assessment results and proposed course actions. In addition, these representatives help develop and change the *EP Program Outcomes & Assessment Procedure*, as appropriate. The separate assessment responsibilities of courses taught in physics or engineering courses provide the benefit of multiple independent and complementary measurements for each *Program Outcome*.

After consultation with the *Deans of the College of Engineering*, faculty members from the *Department of Physics*, the *EP External Advisory Board* (EPEAB), industry representatives, and current students and graduates, it was concluded that the current *Program Outcomes (a)-(k)* suffice to ensure the quality of our *EP Program*. An additional advantage is that these outcomes are common to all engineering programs, making the cross-departmental and cross-college *EP Assessment* more straightforward. Subsequently, we continue to adopt the *ABET Program Outcomes (a)-(k)*, with some minor addition in the *Program Outcomes (e)*, *(h)* and *(k)*, where we specifically add the word *physics* into the phrasing. The *EP Program Outcomes* are listed in Table 3.1., and each of the *Program Outcomes* was named with an identifying acronym for future reference. These *Program Outcomes* are posted in near the main office of the *Department of Physics* and displayed on the *EP Program*'s website.

Table 3.1. *Engineering Physics (EP) Program Outcomes (a)-(k).*

(a)	**Scientific Expertise:** an ability to apply knowledge of mathematics, science, and engineering.
(b)	**Experimental Training:** an ability to design and conduct experiments, as well as to analyze and interpret data.
(c)	**Design Abilities:** an ability to design a system, component, or process to meet desired needs with realistic constraints such as economic, environmental, social, political, ethical, health & safety, manufacturability, and sustainability.
(d)	**Teamwork:** an ability to function on multi-disciplinary teams.
(e)	**Problem Solving:** an ability to identify, formulate, and solve engineering and physics problems.
(f)	**Professional Responsibility:** an understanding of professional and ethical responsibility.
(g)	**Communication Skills:** an ability to communicate effectively.
(h)	**Societal Impact:** the broad education necessary to understand the impact of engineering and physics solutions in a global, economic, environmental, and societal context.
(i)	**Life-long Learning:** a recognition of the need for and an ability to engage in life-long learning.
(j)	**Contemporary Issues:** a knowledge of contemporary issues.
(k)	**Technical Know-How:** an ability to use the techniques, skills, and modern engineering tools necessary for engineering physics practice.

Like for most other engineering programs, *EP Program Outcomes Assessment* is predominantly done *via* measurements in individual courses. The *EP Program Committee* assigned one or more outcomes measures to each physics course that is part of the EP curriculum. Prior to the course, each instructor is informed about which of the *Program Outcomes* he/she is supposed to measure. While the *EP Program Committee* provides guidance to assigned instructors on how certain *Program Outcomes* may be measured, it is left up to the instructor to develop adequate quantitative assessment tools themselves. In most cases, instructors will utilize previously established assessment tools. The *Course Assessment Matrix for Physics Courses* has undergone changes in recent years by selecting additional courses for assessing *Program Outcomes (f)*, *(h)*, *(i)* and *(j)*, which are commonly considered as the more 'difficult' outcomes to assess. This change was needed because all *EP Concentrations* had to reduce the number of elective courses needed for graduation because of curricular pressure elsewhere, such as the addition of an ENGR 100 course for all engineering courses. Prior to that change, *Program Outcomes (f)*, *(h)*, *(i)* and *(j)* were assessed only in physics electives and the required PHYS 315 course. The reduction of electives left gaps in the measurements for those *Program Outcomes*, and the gap was filled by selecting additional core physics courses for assessment of such outcome.

Course *Program Outcomes* Assessment

The *Department of Physics* has a long history of monitoring student progress and learning (well before the introduction of the *EP Program*) since *Physics Education* had been one of its research strength in the department going back to the early 1990s. While the then-developed assessment tools could be easily extended to measure some of the *ABET Program Outcomes*, particularly

Program Outcomes (a), (b) and *(e)*, the instructors developed their own assessment tools for many of the other *Program Outcomes*, typically under the guidance of the *EP Program Committee*. In general, the *EP Program Outcomes & Assessment Procedure* is driven by the desire that each of the *Program Outcomes* should be measured by multiple courses and other methods. Doing so, we made sure that the process is less dependent on individual courses, types of measurements, assessment methods or individual instructors. Below, we summarize some of the assessment approaches for the different *Program Outcomes*.

Nationally-normed tests

The *Department of Physics* commonly uses standardized national tests for measurements of achievement, particularly for *Program Outcome (a) - Scientific Expertise* and *Program Outcome (e) - Problem Solving*.

For more than 20 years, the *Department of Physics* made use of *Graduate Record Exam* (GRE) questions to monitor student competitiveness at a national level. GRE questions are embedded in homework and/or exam problems, and the results can be taken as a direct measure of *Program Outcome (e) – Problem Solving*.

The *Department of Physics* uses a senior-level test from the *Educational Testing Service® (ETS) - the Physics Major Field Test* (MFT). The MFT is given annually at the end of an upper-level physics course, such as PHYS 455 *(Quantum Mechanics II*) or PHYS 462 *(Intermediate Electricity and Magnetism II)*, but it is open to all seniors in physics or EP. Students are encouraged to take the test in their senior year, and participation is fully paid for by the *Department of Physics.* The MFT is not mandatory, but every EP student has an opportunity to take the test at least once. The MFT is a commercially-produced test that is widely used by physics and engineering programs across the country. It provides a comparison with the national norm for general physics topics in mechanics, electricity & magnetism, thermodynamics, and modern physics. The MFT consists of two parts: the first one is on *Introductory Physics* and the second part is on *Advanced Physics* topics. Results on the first part are used for measurement of achievement of *Program Outcome (a) - Scientific Expertise* and results of the second part are used for *Program Outcome (e) - Problem solving*. Furthermore, we use the percentage participation of students in the MFT as an indicator of achievement of *Program Outcome (i) – Life-Long Learning*, since the test is voluntary.

Similarly, we use the *Force Concept Inventory* (FCI) test, which can be taken as a direct measure of *Program Outcome (a) - Scientific Expertise*. The FCI test was first introduced by Hestenes, Wells and Swackhamer, *The Physics Teacher* 30, 1992, 141-158. The FCI measures the understanding of the basic concepts of Newtonian physics. For some courses, this test is given both at the beginning and end of the course to gauge the net student gain. Typically, the FCI test is used in freshman courses (PHYS 213 or PHYS 215G), but we have also given it as part of the upper-division physics course on mechanics (PHYS 451). Freshman students are typically below the *entry level* but should be past that level at the end of their first year; graduating students should be at the *mastery level*.

In some cases, instructors used the national average of skill-builder questions in on-line homework programs, such as *Mastering Physics®* used in introductory courses, as additional measurement for *Program Outcome (a) - Scientific Expertise*.

Tests and probes previously developed by NMSU *Physics Education Research (PER)* group

The *Department of Physics* was very fortunate to have had Dr. Steve Kanim as one of its faculty members. While Dr. Kanim is now retired, he continues his research in *Physics Education*

Research (PER). He helped develop many different (nationally recognized) exams and other probes to test student's conceptual understanding of physics.

As part of his research, he had also developed much of the material for the introductory physics laboratories, particularly for PHYS 213L and PHYS 215GL, the introductory mechanics labs in physics. These labs make it possible to evaluate student performance at several levels, one of which provides a measurement for *Program Outcome (b) – Experimental Training*. Dr. Kanim also co-authored the *E&M TIPERs; Electricity & Magnetism Tasks* (ISBN-10: 0131854992), which is widely used nationally for the instruction of introductory electricity and magnetism, including our PHYS 214L and PHYS 216GL labs.

Dr. Kanim also designed several standardized pre-requisite tests, which are given to students prior to the course. The purpose of the pre-requisite tests is to test whether students have been adequately prepared and remember the pre-requisite materials needed for taking a course. While most pre-requisite tests are not *a priori* designed to measure ABET *Program Outcomes*, they test the level of student learning, therefore providing input on how to improve content delivery. One of his more commonly administered tests is the so-called *Mechanics & Electricity Assessment Test* (MEAT), which does provide an indicator if *Program Outcomes* are met.

Assessment tools developed by *Engineering Physics (EP) Program Committee*

The *EP Program Committee* designed a *Teamwork Evaluation Form* and an *Oral Report Evaluation Form* that can be used by individual instructors to assess *Program Outcome (d) – Teamwork* and *Program Outcome (g) Communication Skills*, respectively. Instructors are free to choose whether to make use of the provided forms for the evaluation of these two outcomes, and most of them do. These forms are provided in *Supplementary Information*.

Assessment tools developed by individual instructors

Program Outcomes (c) - Design Abilities, *(f) – Professional Responsibility*, *(h) – Societal Impact*, *(i) – Life-long Learning*, *(j) – Contemporary Issues* and *(k) – Technical Know-how*, are typically assessed using assessment tools designed by individual instructors.

Program Outcome (c) and *(k)* are mostly technical in nature, and they are typically extracted from scores or partial scores of individual assignments or projects, such as a capstone design task.

Program Outcomes (f), *(h)*, *(i)* and *(j)* have been found to be the most difficult to determine. Instructors have used a variety of approaches to come up with quantitative measures for the *Program Outcome(s)*, such as sub-scores in essays, class attendance, specialized assignments, class participation, or similar.

Other *Program Outcomes* Assessment

EP students in their graduating semester are asked complete a *Senior Student Exit Interview (SSEI)*, which include questions about students' perceptions for achievement of each of the *Program Outcomes (a)-(k).*

More details of the *Program Assessment Tools* for each individual *Program Outcome* are presented in *Criterion 4 – Continuous Improvement*.

The current *EP Outcomes Assessment Matrix* is provided in Table 3.2.a. The table includes the assessment assignments for required physics courses, approved technical physics electives, some other electives and non-course measures. Some rows contain two alternative courses, e.g. PHYS 213 or PHYS 215G, where both measure the same *Program Outcome(s)*. The curriculum of our *EP Program* and the individual course contents have been designed such that there are multiple measures for each of the *Program Outcomes*. The last row after each category indicates how often each *Program Outcome* is measured for an EP student throughout program completion.

Table 3.2.a. *Current EP Outcomes Assessment Matrix for Program Outcomes (a)-(k).*

Required Physics or Capstone Course for all EP majors	***Program Outcome***										
	(a)	***(b)***	***(c)***	***(d)***	***(e)***	***(f)***	***(g)***	***(h)***	***(i)***	***(j)***	***(k)***
PHYS 213 or 215G Mechanics	X										
PHYS 213L or 215GL Mechanics Lab		X									
PHYS 214 or 216G Electricity & Magnetism	X										
PHYS 214L or 216GL Electricity and Magnetism Lab		X									
PHYS 217 Heat, Light, & Sound	X										
PHYS 217L Heat, Light, & Sound Lab		X	X	X			X				
PHYS 315 Modern Physics	X					X		X	X	X	
PHYS 315L Modern Physics Lab		X	X	X		X	X				X
PHYS 395 Intermediate Mathematical Methods for Physics											X
PHYS 454 Intermediate Modern Physics I					X						
PHYS 455 Intermediate Modern Physics II					X						
PHYS 461 Int. Electricity & Magnetism I					X	X		X	X	X	
Number of times an outcome is measured in required physics and capstone courses	*4*	*4*	*2*	*2*	*3*	*3*	*2*	*2*	*2*	*2*	*2*
Required Physics Course for some EP Concentrations (indicated in brackets)	***Program Outcome***										
	(a)	***(b)***	***(c)***	***(d)***	***(e)***	***(f)***	***(g)***	***(h)***	***(i)***	***(j)***	***(k)***
PHYS 451 (CHE, EE) Intermediate Mechanics					X	X		X	X	X	
PHYS 462 (AE, CHE, ME) Int. Electricity & Magnetism II					X	a		a	a	a	
PHYS 480 (EE) Thermodynamics					X	a		a	a	a	
Total number of times an outcome is measured for any EP student in required courses	***4***	***4***	***2***	***2***	***4-5***	***2-4***	***2***	***2-4***	***2-4***	***2-4***	***3***

a: whether this Program Outcome is measured depends on the individual instructor and/or the topic of the course.

Table 3.2.a. *- continued*

Technical Physics Electives	***Program Outcome***										
	(a)	***(b)***	***(c)***	***(d)***	***(e)***	***(f)***	***(g)***	***(h)***	***(i)***	***(j)***	***(k)***
PHYS 468 Intermediate X-Ray Diffraction		X		X		X	X				X
PHYS 471 Modern Experimental Optics		X	X	X		X	X		X		X
PHYS 475 Advanced Physics Laboratory		X	X	X		X	X				X
PHYS 476 Computational Physics			X								X
Physics 488 Intro to Condensed Matter Physics					X	X		X	X	X	
Physics 489 Introduction to Modern Materials					X	X		X	X	X	
PHYS 493 Experimental Nuclear Physics		X	a	X		a	X				X
PHYS 495 Mathematical Methods of Physics											X
Number of times an outcome is measured in a technical elective		***0-1***	***0-1***	***0-1***	***0-1***	***0-1***	***0-1***	***0-1***	***0-1***	***0-1***	***0-1***

Non-Technical Physics Electives	***Program Outcome***										
	(a)	***(b)***	***(c)***	***(d)***	***(e)***	***(f)***	***(g)***	***(h)***	***(i)***	***(j)***	***(k)***
PHYS 303V Energy and Society	a	a		a		a	a	a	a	a	
PHYS 305V Water in the Solar System	a	a		a		a	a	a	a	a	

Non-Course Outcomes Measures	***Program Outcome***										
	(a)	***(b)***	***(c)***	***(d)***	***(e)***	***(f)***	***(g)***	***(h)***	***(i)***	***(j)***	***(k)***
Senior-Student Exit Interviews	X	X	X	X	X	X	X	X	X	X	X
MFT Test	X				X	X					
Number of times an outcome is measured outside of a course	***2***	***1***	***1***	***1***	***2***	***2***	***1***	***1***	***1***	***1***	***1***

a: whether this Program Outcome is measured depends on the individual instructor and/or the topic of the course

A few faculty members in the *Department of Physics* pointed an obvious flaw of the current assessment matrix, namely that some courses are required to measure multiple *Program Outcomes*, while other course are required to measure just one. Subsequently, instructors of those courses have carried a higher burden in the assessment effort. Although the *EP Program Committee* did entertain some discussion on how course assessment could be distributed more uniformly, it was decided to postpone a re-distribution for now, given that ABET is expected to change its *Program Outcomes* definitions, i.e. changing from *(a)-(k)* to *(1)-(6)*, in the coming year.

Like the *EP Outcomes Matrix* used by the *Department of Physics* for assessing the *EP Program*, the *Course Outcomes Matrices* of participating engineering departments have undergone some changes since their last accreditation cycle due to changes is their respective curricula. Courses taught in participating engineering programs have been assigned to measure one or more of the *Program Outcomes (a)-(k)*, and many of those courses are required for the EP curriculum, depending on the *Concentration*, i.e. *Aerospace (AE), Chemical (CHE), Electrical (EE) or Mechanical (ME) Engineering.*

The *Course Program Assessment Matrix* for required ME and AE courses for EP-AE students are given in Tables 3.2.b; the one for required CHME courses for EP-CHE students is given in Table 3.2.c, the one for required EE courses for EP-EE students is given in Table 3.2.d, and the one for EP-ME students is given in Table 3.2.e. Moreover, all EP students are required to take the ENGR 100 course and EP majors with the AE or ME concentration are required to take CE 301 with outcomes assessment assignments as shown in Table 3.2.f. The separate outcomes assessment in engineering ensures the program quality and delivery for the engineering portions of our *EP Program*. The engineering departments typically have also additional program-specific outcomes, but those are not part of our *EP Program.* Since EP students do not have the same course requirements in their concentration compared to the majors in that engineering degree, the engineering assessment will not necessarily cover every single one of those *Program Outcomes* independently (although it typically covers most of them) for every single EP student.

The *EP Program* requires supporting courses in MATH, CHEM and ENGL/COMM and there are also additional *General Education* and *Viewing-the-Wider World* requirements for their majors (see *Criterion 5- Curriculum*), and none of those courses is currently required to provide some assessment to the *ABET Program Outcomes (a)-(k)*, although they may have defined their own outcomes. In all cases, these courses meet the university's general accreditation criteria, which are aligned with the requirements of the *Higher Learning Commission* (HLC) of the *North Central Association of Colleges and Schools* (NCA); see *Appendix D – Institutional Summary*.

Table 3.2.b. *Current Aerospace-Engineering Course Assessment Matrix for Program Outcomes (a)-(k). Only required courses for EP majors with the Aerospace Concentration are included. For EP-AE students, Program Outcomes (f), (h), (i) and (j) are not separately measured in ME or AE courses required for their major.*

Required Mechanical or Aerospace Engineering Course for EP-AE majors	***Program Outcome***										
	(a)	***(b)***	***(c)***	***(d)***	***(e)***	***(f)***	***(g)***	***(h)***	***(i)***	***(j)***	***(k)***
ME 236 Engineering Mechanics I	X				X						X
ME 237 Engineering Mechanics II					X						
ME 240 Thermodynamics					X						
ME 261 Mechanical Engineering Problem Solving	X				X						X
ME 345 Experimental Methods I		X					X				X
AE 339 Aerodynamics I	X	X	X		X						
AE 362 Orbital Mechanics	X				X						X
AE 363 Aerospace Structures	X				X						X
AE 364 Flight Dynamics Control	X				X						X
AE 419 Propulsion	X				X						X
AE 424 Aero Systems Engineering			X	X			X				
AE 439 Aerodynamics II	X				X						X
AE 447 Aero Fluids Laboratory	X	X			X		X				
Number of times an outcome is measured in required ME and AE courses for EP-AE majors.	***9***	***3***	***2***	***1***	***11***		***3***				***8***

The methods used to assess the assigned *Program Outcomes* in courses and the ways on how measurements are enforced are under the control of the *Department of Mechanical & Aerospace Engineering*.

For a discussion of changes in the *EP Curriculum* with the *Aerospace Concentration* compared to the 2012 catalog, see *Criterion 5 – Curriculum*.

Table 3.2.c. *Current Chemical-Engineering Course Assessment Matrix for Program Outcomes (a)-(k). Only required courses for EP majors with the Chemical Concentration are included.*

Required Chemical Engineering Course for EP-CHE majors	***Program Outcome***										
	(a)	***(b)***	***(c)***	***(d)***	***(e)***	***(f)***	***(g)***	***(h)***	***(i)***	***(j)***	***(k)***
CHME 101 Introduction to Chemical Engineering Calculations	X			X	X	X	X		X	X	X
CHME 102 Material Balances	X			X	X	X	X				X
CHME 201 Energy Balances and Basic Thermodynamics	X	X			X						X
CHME 303 Chemical Engineering Thermodynamics	X	X		X	X			X			X
CHME 305 Transport Operations I: Fluid Flow	X		X		X		X				X
CHME 306 Transport Operations II: Heat and Mass Transfer	X		X	X	X		X				X
CHME 307 Transport Operations III: Staged Operations	X		X		X		X				X
CHME 352L Simulation of Unit Operations	X				X						X
CHME 361 Engineering Materials	X			X	X			X		X	
CHME 441 Chemical Kinetics and Reactor Engineering	X	X	X	X	X	X	X			X	X
Number of times an outcome is measured in required AE courses for EP-CHE majors.	***10***	***3***	***4***	***6***	***10***	***3***	***6***	***2***	***1***	***3***	***9***

The methods used to assess the assigned *Program Outcomes* in courses and the ways on how measurements are enforced are under the control of the *Department of Chemical & Materials Engineering*.

For a discussion of changes in the *EP Curriculum* with the *Chemical Concentration* compared to the 2012 catalog, see *Criterion 5 – Curriculum*.

Table 3.2.d. *Current Electrical-Engineering Course Assessment Matrix for Program Outcomes (a)-(k). Only required courses for EP majors with the Electrical Concentration are included. For EP-EE students, Program Outcome (i) is not separately measured in EE courses required for their major.*

Required Mechanical or Aerospace Engineering Course for EP-AE majors	***Program Outcome***										
	(a)	***(b)***	***(c)***	***(d)***	***(e)***	***(f)***	***(g)***	***(h)***	***(i)***	***(j)***	***(k)***
EE 100 Introduction to Electrical and Computer Engineering	X		X	X							
EE 112 Embedded Systems	X		X	X	X						
EE 200 Linear Algebra and Probability	X	X			X						X
EE 212 Computer Organization and Design						X		X		X	
EE 230 AC Circuits and Introduction to Power	X	X			X		X				X
EE 317 Semiconductor Devices and Electronics I	X		X				X				X
EE 320 Signals and Systems I	X	X									
EE 340[a)] Fields and Waves	X	X		X	X						
Number of times an outcome is measured in required EE courses for EP-AE majors.	***7***	***4***	***3***	***3***	***4***	***1***	***2***	***1***		***1***	***3***

[a)]EP-EE student can satisfy the EE 340 requirement by taking PHYS 462 instead.

The methods used to assess the assigned *Program Outcomes* in courses and the ways on how measurements are enforced are under the control of the *Department of Electrical & Computer Engineering*.

For a discussion of changes in the *EP Curriculum* with the *Electrical Concentration* compared to the 2012 catalog, see *Criterion 5 – Curriculum*.

Table 3.2.e. *Current Mechanical-Engineering Course Assessment Matrix for Program Outcomes (a)-(k). Only required courses for EP majors with the Mechanical Concentration are included. For EP-ME students, Program Outcomes (h) and (i) are not separately measured in ME courses required for their major.*

Required Mechanical Engineering Course for EP-ME majors	***Program Outcome***										
	(a)	***(b)***	***(c)***	***(d)***	***(e)***	***(f)***	***(g)***	***(h)***	***(i)***	***(j)***	***(k)***
ME 159 Graphical Communication and Design			X								X
ME 236 Engineering Mechanics I	X				X						
ME 237 Engineering Mechanics II					X						
ME 240 Thermodynamics					X						
ME 261 Mechanical Engineering Problem Solving	X				X						X
ME 326 Mechanical Design			X	X		X				X	
ME 338 Fluid Mechanics	X	X	X		X						
ME 341 Heat Transfer	X				X						
ME 345 Experimental Methods I		X					X				X
ME 425 Aerodynamics I	X	X	X		X						
Number of times an outcome is measured in required ME courses for EP-ME majors.	***5***	***3***	***4***	***1***	***7***	***1***	***1***			***1***	***3***

The methods used to assess the assigned *Program Outcomes* in courses and the ways on how measurements are enforced are under the control of the *Department of Mechanical & Aerospace Engineering*.

For a discussion of changes in the *EP Curriculum* with the *Mechanical Concentration* compared to the 2012 catalog, see *Criterion 5 – Curriculum*.

Table 3.2.f. *Current Engineering Course Assessment Matrix for Program Outcomes (a)-(k) for ENGR 100 (required by all EP majors), CE 301 (required by EP-AE and EP-ME majors) and Engineering Design Capstone (required by all EP majors).*

Other Engineering Courses for EP majors	***Program Outcome***										
	(a)	***(b)***	***(c)***	***(d)***	***(e)***	***(f)***	***(g)***	***(h)***	***(i)***	***(j)***	***(k)***
ENGR 100 Introduction to Engineering				X		X	X	X	X	X	X
CE 301 Mechanics of Materials	X		X		X						
Engineering Design Capstone (2 courses)			X				X				X
Number of times an outcome is measured in other engineering course.	***0-1***		***1-2***	***1***	***0-1***	***1***	***2***	***1***	***1***	***1***	***2***

Each instructor teaching a physics course is responsible for measuring the assigned *Program Outcomes*, complete the *Post-Course Instructor Comment Form* and save it and other relevant materials to the designated *OneDrive* folder. All physics faculty members have access to this folder, and the *Department of Physics* performs annual reviews of achievement for each *Program Outcomes* and uses the data to determine whether program or course changes are needed. *Program Outcomes Assessment Reviews* are also stored in another folder on *OneDrive*.

Documentation for Assessment of *Program Outcomes*

After completion of a physics course that may be taken by EP students as part of their curriculum, the course instructors of these courses are required to fill out a *Post-Course Instructor Comment Form* (see *Appendix E – Supplementary Documents*), which summarizes class details, results of *Program Outcome* measurements, and some general comments. The *Post-Course Instructor Comment Form* and other course-related materials are collected in so-called *'Maroon' Instructor Notebooks*, which are called 'maroon' because print-outs of the materials had been collected in maroon-colored binders for many years. As a practical matter, we began keeping the notebooks online in 2008, and print only the most relevant material for the ABET site visit. The completed *Post-Course Instructor Comment Form* and other course-related materials are then uploaded by the instructor to a *OneDrive* folder designated to the *EP Program* every time a course was taught. This provides important feedback to instructors of future course and ensures continuity. Virtual notebooks are available to all faculty and are more useful in that form. The EP-designated *OneDrive* folder also contains data on non-course *Program Outcomes* measures.

Supplementary *'White' Course Notebooks* are prepared once every 6 years, just prior to an ABET accreditation visit. The *'White' Course Notebooks* contain examples of student work for all assignments the last time a course was taught prior to the ABET site visit.

Finally, there are separate *'Blue' Program Outcomes Notebooks*, which contains data, summaries and reports for each of the *Program Outcomes (a)-(k).*

A list of contents for the *'Maroon'*, *'White'* and *'Blue' Notebooks* is provided in *Appendix E – Supplementary Documents*.

B. Relationship of Student Outcomes to Program Educational Objectives

Describe how the student outcomes prepare graduates to attain the program educational objectives.

The goal of our *EP Program* is to design a curriculum and implement processes that prepare students for achievement of the *EP Educational Objectives 1-3*, which were introduced and discussed in more detail in *Criterion 2 – Educational Objectives*. The *Educational Objectives* for the *EP Program* are *Objective 1 – Competitiveness*, *Objective 2 – Adaptability*, and *Objective 3 – Teamwork and Leadership*.

Table 3.3 provides an attempt to identify primary and secondary relationships between the *Program Outcomes (a)-(k)* and the *Educational Objectives (1)-(3)* of the *EP Program*. Each *Program Objective* maps to multiple *Program Outcomes*, and *vice versa*. We only measure the mapping of each *Program Outcome* to its primary *Education Objective* (marked with an '**X**' in the table). *Program Outcomes* may also map to secondary *Educational Objective(s),* but we do not formally evaluate them for that purpose (marked with a '**s**' in the table).

Table 3.3. *Relationship between EP Educational Objectives and Program Outcomes. Relationships of primary importance with a formal feedback loop are marked 'X', significant relationships with no formal feedback are marked 's'.*

EP Educational Objective	***Program Outcome***										
	(a) Scientific Expertise	***(b)*** Experimental Training	***(c)*** Design Abilities	***(d)*** Teamwork	***(e)*** Problem Solving	***(f)*** Professional Responsibility	***(g)*** Communication Skills	***(h)*** Societal Impact	***(i)*** Life-long Learning	***(j)*** Contemporary Issues	***(k)*** Technical Know-How
Objective 1	**X**	**s**	**X**		**X**						**X**
Objective 2	**s**		**s**	**s**	**s**	**s**	**s**	**X**	**X**	**X**	**s**
Objective 3		**X**		**X**		**X**	**X**	**s**			

As discussed in *Criterion 2 – Educational Objectives*, the feedback from our *Engineering Physics External Advisory Board* (EPEAB) provides evidence that the *EP Program* achieves its stated *Educational Objectives*, as evidenced by the success of our alumni, their career choices, and employment history, for example. This should be taken as evidence that our efforts toward *Program Outcomes* and *Continuous Improvement* (see *Criterion 4*) are generally supportive in achieving the program's *Educational Objectives*.