Criterion 3: Student Outcomes

Engineering Physics

Bachelor of Science in Engineering Physics

Self-Study Report

New Mexico State University

June 2012

CRITERION 3. STUDENT OUTCOMES

A. Student Outcomes

Describe the process used for establishing and revising student outcomes.

The Engineering Physics program uses the resources of five different programs: Engineering Physics, Aerospace Engineering, Chemical Engineering, Chemical Engineering and Mechanical Engineering (hosted in four different departments), Except for Aerospace Engineering (which applies for accreditation for the first time in 2012), all other programs are currently ABET accredited programs and are preparing for re-accreditation. All of the above programs have a common set of *Program Outcomes (a)-(k)* that are required by ABET. While the other engineering programs have program-specific outcomes as well, this is not the case for Engineering Physics.

The different programs have established outcomes and assessment procedures for each of their courses in order to assess the *Program Outcomes (a)-(k)*. For assessment of these outcomes in engineering course, the Engineering Physics program relies on the other engineering programs' current procedures. For assessment of these outcomes in physics courses, the Department of Physics has implemented their own assessment processes and procedures, as will be outlined below. Assessment done in the engineering departments will not be discussed here since each engineering programs provide their self-study reports. It should be noted, however, that curricular changes (e.g. course delivery and content) in participating engineering departments may affect the Engineering Physics program as well. For that reason, representatives of these departments sit on the Engineering Physics Program Committee. If needed, these engineering representatives will disseminate and discuss the internal findings, assessment results and proposed courses of action. In addition, these representatives help develop and change assessment procedures, as appropriate. The separate assessment responsibilities for physics and engineering courses are actually beneficial since each program outcome is assessed independently and therefore complementary or supplementary data exist. This makes for a particularly strong program.

After consultation with faculty members from the College of Engineering and Department of Physics, the Engineering Physics External Advisory Board, industry representatives, and current students and graduates, it was concluded that the ABET 2012 *Program Outcomes (a)* thru *(k)* would continue suffice to ensure the quality of our Engineering Physics program. In addition, these outcomes are common to the all the engineering programs, making the cross-departmental Engineering Physics assessment easier. Subsequently, we adopted ABET 2000 Program Outcomes, with some minor addition in the *Program Outcomes (e)*, *(h)* and *(k)*, where we included 'physics' specifically.

Our EP Program Outcomes, each named for future reference, are given in Table 3.1.

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.

Below, we provide a more detailed description and the common measurements for each of the above program outcomes.

(a) **Scientific Expertise:** EP graduates understand the basic concepts, notation and techniques in fundamental disciplines of physics and engineering, such as mechanics, electromagnetism, thermodynamics and modern physics. The Force Concept Inventory given at the freshman and junior levels are used for many courses. Freshman courses often use the Mastering Physics online homework system. This system includes the ability to measure outcomes from subsets of homework. For example, the skill builder problems can be used to measure Scientific Expertise. Other courses used standardized questions of a specific type embedded in tests and quizzes.

(b) **Experimental Training:** EP graduates will be able to perform fundamental experimental studies in physics and engineering, and they will be able to analyze the data. This outcome is measured in laboratory courses. Outcomes are based on questions embedded in final exams or the instructor assessment of students and groups.

(c) **Design Abilities:** EP graduates can design and implement an experimental or theoretical study to tackle physics problems in an applied context, such as economic, environmental, or societal. This outcome is measured in upper division lab courses or computer courses.

Instructors have used the ability to design a particular piece of software code or the ability to set up and run a particular experiment.

(d) **Teamwork:** EP graduates learn to work as effective members of a team, and they will be able to take responsibility for some or all aspects of a common goal. This outcome is measured in upper-division lab courses based on peer-evaluation of group performance.

(e) **Problem Solving:** EP graduates use the existing scientific understanding and models to solve physics and engineering problems. The common measure of this outcome is based on Graduate Research Exam (GRE) questions embedded in quizzes and exams.

(f) **Professional Responsibility:** EP graduates will demonstrate high standards of ethics and integrity in their professional activities. This outcome is measured through written reports in selected classes. One instructor used the student completion rate of homework and in-class worksheets to indicate if the students were being responsible for completing homework and attending class. Students are also expected to pass a radiation safety course.

(g) **Communication Skills:** EP graduates will be able to present information (both, orally and written) in an effective, well-organized, logical and scientifically-sound manner. This outcome is measured through the use of both written and oral reports in upper-division classes.

(h) **Societal Impact:** EP graduates will appreciate the human dimension and the impact of their profession in a diverse social, cultural and economic environment. Laboratory reports and oral reports were used to assess societal impact.

(i) **Life-long Learning:** EP graduates will understand the need for life-long learning in order to accommodate rapid changes in science and technology. Written and oral reports were used to assess this outcome. Some instructors have also used embedded test questions that required understanding of issues of current topical interest.

(j) **Contemporary Issues:** In order to be effective members of the society throughout their careers, EP graduates have to understand the need to be current on important issues within their discipline and profession. Both written and oral reports were graded for the selection of content by the students.

(k) **Technical Know-How:** EP graduates will be able to use or understand how to use widely-spread state-of-the-art tools used in modern engineering practice. Instructors used in-lab observation and questions from the Fundamentals of Engineering exam (FE exam) to rate this outcome.

The curriculum of our Engineering Physics program and the content of the courses have been designed such that there are multiple independent measures for achievement of our *Program Outcomes (a)* thru *(k)*. In table 3.2.a, the correspondences of program outcomes with the Physics courses required in the Engineering Physics program is shown. The last row in the table indicates how often a particular program outcome is expected to be measured throughout the complete Engineering Physics program. Note, that some of the rows contain two courses, both of which will measure the same program outcomes. In some cases, the two courses may be alternative options (e.g. *PHYS 213* or *PHYS 215*). In other cases, however, the two courses may be both required and will be taken in sequence (e.g. *PHYS 454* and *455*, or *PHYS 461* and *462*), thus providing two independent measures of particular program outcomes. Each faculty member is responsible for measuring the appropriate outcomes. These are documented in the instructors *Post Instruction Comment Form* and put into a binder for that course. Each year the Department of Physics prepares a review for each outcome that uses these data and discusses any changes that need to be made in the program. The outcome reviews are kept in a separate folder.

Two classes have been dropped from the curriculum *Physics 470 – Physical Optics* and *Physics 471 - Modern Experimental Optics*, and we introduced *Physics 473 - Introduction to Optics* and *Physics 395 - Intermediate Mathematical Methods of Physics*.

Similar to Physics, the participating engineering program developed own assessment matrices for their engineering courses, as shown in Table 3.2.b-e. For the engineering courses, assessment of the *Program Outcomes (a)-(k)* is done in the engineering department, which hosts that particular program for their majors, i.e. the Department of Electrical Engineering will assess EE courses, the Department of Mechanical & Aerospace Engineering will assess AE and ME courses, and the Department of Chemical Engineering will assess ChE courses. Since Engineering Physics students do not have the same course requirements in their concentration compared to the majors in that particular engineering degree, the engineering assessment will not necessarily cover every single of those program outcomes independently (although it typically covers most of them) for every single Engineering Physics student. Moreover, the AE and ME programs do not assess *Program Outcome (h) – Societal Impact* in any of their own program courses. These two program outcomes utilize the university's General Education requirements for assessment of this particular outcome.

It should also be noted that NMSU's Aerospace Engineering is a fairly new (but rapidly growing) program, which was introduced in 2006. While the AE program has been successful in building the infrastructure (personnel, facilities) to run the program, offerings of AE-specific courses are still fairly limited (i.e. there are no present AE electives). Our Engineering Physics students with the *Aerospace concentration* are required to take all of the AE courses presently offered, as is the case also for the AE majors. Currently, AE electives are not yet offered on a regular basis, and AE students are required to take specialized upper-level courses in Mechanical, Electrical and Chemical Engineering, which our Engineering Physics students with the *Aerospace concentration* do not need to take.

Table 3.2.a. Assessment Matrix showing the Correspondence of *Program Outcomes (a)* thru *(k)* to Physics courses of the Engineering Physics degree.

Physics Courses	Program Outcome										
	(a) Scientific Expertise	*(b)* Exp. Training	*(c)* Design Abilities	*(d)* Teamwork	*(e)* Problem Solving	*(f)* Prof. Responsib.	*(g)* Comm. Skills	*(h)* Societal Impact	*(i)* Life-long Learning	*(j)* Contemp. Issues	*(k)* Technical Know-How
Core Courses[1)]											
Physics 213 or 215 Mechanics	X										
Physics 213L or 215L Mechanics Lab		X									
Physics 214 or 216 Electr. & Magn.	X										
Physics 214L or 216L Electr, & Magn. Lab		X									
Physics 217 Heat, Light & Sound	X										
Physics 217L Heat, Light &Sound Lab		X	N	N							
Physics 315 Modern Physics	X					X		X	X	X	
Physics 315L Modern Physics Lab		X	a	X			X				X
Physics 395 Math Methods *(new)*						N					
Physics 451 Interm. Mechanics					X						
Physics 454 and 455 Int. Mod. Phys. I & II					X						

Table 3.2.a. - continued

Physics Courses	**Program Outcome**										
	(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h)*	*(i)*	*(j)*	*(k)*
Physics 461 and 462 Int. El. & Magn. I & **II**					**X**						
Physics 475 Adv. Exp. Phys. Lab		**X**	**a**	**X**			**X**				**X**
Physics 480 Thermodynamics					**X**						
Electives											
Physics 305V Water in Solar System						**X**		**X**	**X**	**X**	
Physics 450 Capstone design			**X**	**X**			**X**				**X**
Physics 471 Exp. Optics Lab		**X**	**a**	**X**			**X**				**X**
Physics/EE 473 Intro. Optics *(new)*						**N**					
Physics 495 Math. Methods II											**X**
Physics 488 Solid State Physics						**X**		**X**	**X**	**X**	
Physics 489 Modern Materials						**X**		**X**	**X**	**X**	
Other Physics Elective			**a**	**a**		**a**		**a**	**a**	**a**	**a**
Number of times an outcome is measured	***4***	***5***	***up to 3***	***2-3***	***6***	***1-2***	***2***	***1-2***	***1-2***	***1-2***	***3-4***

[1)]Some of the core courses may not be required by Engineering Physics students, depending on the actual engineering concentration.
a: whether this Program Outcome will be measured depends on the individual instructor and/or the topic of the course
N: indicates a new course, i.e. a new assessment

Table 3.2.b. Assessment Matrix showing the Correspondence of *Program Outcomes (a)* thru *(k)* with Electrical Engineering courses of the Engineering Physics degree with the *Electrical concentration*.

Electrical Engineering Courses	Program Outcome										
	(a) Scientific Expertise	*(b)* Exp. Training	*(c)* Design Abilities	*(d)* Teamwork	*(e)* Problem Solving	*(f)* Prof. Responsib.	*(g)* Comm. Skills	*(h)* Societal Impact	*(i)* Life-long Learning	*(j)* Contemp. Issues	*(k)* Technical Know-How
Core Courses											
EE 161 Comp Aid. Probl. Solv.				X	X		X				X
EE 162 Dig. Circuit Des.	X		X	X							X
EE 210 Eng. Anal. I	X	X			X						X
EE 260 Embedded Systems	X		X		X						X
EE 280 AC & DC circuits	X	X	X	X	X	X	X				X
EE 310 Eng. Anal. II	X				X						X
EE 312 Signals & Syst. I	X				X						X
EE 351 Appl. Electromagn.	X			X	X						X
EE 380 Electronics I	X		X				X				X
EE 418 Capstone I			X	X	X		X	X			X
EE 419 Capstone II			X	X			X				

Table 3.2.b. - continued

EE Courses	Program Outcome										
	(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h)*	*(i)*	*(j)*	*(k)*
Electives											
EE 314 Signals & Syst. II	**X**				**X**						**X**
EE 363 Comp. Syst. Arch.	**X**					**X**		**X**		**X**	
EE 391 El. Power Eng.	**X**	**X**	**X**	**X**		**X**	**X**			**X**	**X**
EE 425 Semicond. Dev.	**X**										**X**
EE 431 Power Syst. II	**X**										**X**
EE 473 Intro Optics	**X**		**X**		**X**		**X**				**X**
EE 478 Opt. Sources & Detect.	**X**	**X**	**X**	**X**	**X**		**X**		**X**		**X**
EE 486 Dig. VLSI Des.	**X**		**X**			**X**		**X**		**X**	**X**
Other EE Elective	**a**	**a**	**a**	**a**	**a**	**a**	**a**	**a**	**a**	**a**	**a**

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

Table 3.2.c. Assessment Matrix showing the Correspondence of *Program Outcomes (a)* thru *(k)* with Mechanical Engineering courses of the Engineering Physics degree with the *Mechanical concentration*.

Electrical Engineering Courses	Program Outcome										
	(a) Scientific Expertise	*(b)* Exp. Training	*(c)* Design Abilities	*(d)* Teamwork	*(e)* Problem Solving	*(f)* Prof. Responsib.	*(g)* Comm. Skills	*(h)* Societal Impact	*(i)* Life-long Learning	*(j)* Contemp. Issues	*(k)* Technical Know-How
Core Courses											
ME 102 ME Orientation			X			X					
ME 159 Graph. Comm. & Des.			X								X
ME 236 Eng. Mechanics I	X				X						X
ME 237 Eng. Mechanics II	X				X						
ME 240 Thermodynamics					X						
ME 261 ME Probl. Solv.	X				X						X
ME 326 Mech. Design			X	X		X				X	
ME 328 Eng. Anal. I	X										
ME 333 Int. Dynamics					X						
ME 338 Appl. Electromagn.	X	X	X		X						
ME 341 Heat Transfer	X				X						

Table 3.2.c. - continued

ME Courses	**Program Outcome**										
	(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h)*	*(i)*	*(j)*	*(k)*
ME 425 Des. Machine Elements	**X**		**X**		**X**						**X**
ME 426/427 Design Proj. Lab. I & II			**X**	**X**			**X**				
ME 449 Senior Seminar						**X**	**X**		**X**	**X**	
Electives											
ME 329 Eng. Anal. II	**X**										**X**
ME 331 Int. Strength Mat.						**X**					
ME 338 Fluid Mech.	**X**	**X**	**X**		**X**						
ME 445 Exp. Methods II		**X**			**X**		**X**				**X**
Other EE Elective	**a**	**a**	**a**	**a**	**a**	**a**	**a**		**a**	**a**	**a**

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

Table 3.2.d. Assessment Matrix showing the Correspondence of *Program Outcomes (a)* thru *(k)* with Aerospace Engineering courses of the Engineering Physics degree with the *Aerospace concentration*.

Electrical Engineering Courses	Program Outcome										
	(a) **Scientific Expertise**	***(b)*** **Exp. Training**	***(c)*** **Design Abilities**	***(d)*** **Teamwork**	***(e)*** **Problem Solving**	***(f)*** **Prof. Responsib.**	***(g)*** **Comm. Skills**	***(h)*** **Societal Impact**	***(i)*** **Life-long Learning**	***(j)*** **Contemp. Issues**	***(k)*** **Technical Know-How**
Core Courses											
AE 339 Aerodynamics I	**X**	**X**	**X**		**X**						
AE 362 Orbital Mechanics.	**X**				**X**						**X**
AE 363 Aerosp. Struct.	**X**				**X**						**X**
AE 364 Flight Dyn. & Contr.	**X**				**X**						**X**
AE 419 Propulsion	**X**				**X**						**X**
AE 424 Aerosp. Syst. Eng.			**X**	**X**			**X**				
AE 428 Aerosp. Capst. Des.			**X**	**X**			**X**				
AE 439 Aerodynamics II	**X**				**X**						
AE 447 Aerofluidics Lab	**X**	**X**			**X**		**X**				

Table 3.2.e. Assessment Matrix showing the Correspondence of *Program Outcomes (a)* thru *(k)* with Chemical Engineering courses of the Engineering Physics degree with the *Chemical concentration*.

Chemical Engineering Courses	Program Outcome										
	(a) Scientific Expertise	*(b)* Exp. Training	*(c)* Design Abilities	*(d)* Teamwork	*(e)* Problem Solving	*(f)* Prof. Responsib.	*(g)* Comm. Skills	*(h)* Societal Impact	*(i)* Life-long Learning	*(j)* Contemp. Issues	*(k)* Technical Know-How
Core Courses											
ChE 111 Comp. Calc. in ChE	X										X
ChE 201 Mat. & Energy Bal.	X		X	X	X		X				X
ChE 301 ChE Thermodyn. I	X			X	X		X				X
ChE 302 and 302l ChE Thermodyn. II	X				X						x
ChE 305 Transport I: Fluids	X				X						
ChE 306 Transp. II: Heat & Mass	X		X		X						X
ChE 307 Transp. III: Staged Op.s	X		X		X						
ChE 361 Engineering Mat.	X										
ChE 361 Int. Dynamics	X							X			
ChE 441 Kinetics & React. Eng..	X				X						

Table 3.2.e. - continued

ChE Courses	Program Outcome										
	(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h)*	*(i)*	*(j)*	*(k)*
ChE 412 Proc. Dyn. & Contr.	**X**				**X**						
ChE 452L Chem. Proc. Sim.	**X**	**X**	**X**	**X**	**X**	**X**	**X**			**X**	**X**
ChE 455 Chem. Plant Des.	**X**		**X**		**X**	**X**	**X**			**X**	
ChE 490 Senior Seminar				**X**		**X**	**X**	**X**	**X**	**X**	
Other ChE Elective	**a**	**a**	**a**	**a**	**a**	**a**	**a**	**a**	**a**	**a**	**a**

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

Each of the participating departments publishes and distributes the respective assessment matrices among all of their faculty members and other instructors. Therefore, each course instructor knows which of the program outcomes are assigned to be measured in his/her course. It is up to the instructor of each course to come up with a way to quantitatively measure each of the assigned program outcomes. In most cases, instructors will utilize previously established assessment tools.

The Department of Physics has an established history of monitoring student progress and learning. In some cases, the tools used could easily be extended to measure particular program outcomes. However, there are no similar established assessment tools for many of the other program outcomes. In such cases, instructors had to develop their own outcomes-specific assignments, often under the guidance of the Engineering Physics Program Committee.

Emphasis was put on the desire that each of the program outcomes is measured by multiple courses and methods. Doing so, we made sure that the process is less dependent on individual courses, types of measurements, assessment methods or instructors. Below, we summarize some of the assessment approaches for the different program outcomes.

Nationally-normed tests

In general, we use standardized nationally-administered tests for measurements of achievement particularly for *Program Outcome (a) - Scientific Expertise* and *Program Outcome (e) - Problem Solving*.

For almost 15 years, the Department of Physics made use of *Graduate Record Exam (GRE)* questions in order 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*.

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 introduced by Hestenes, Wells and Swackhamer (see: *The Physics Teacher* 30, 1992 141-158), and it 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, but we have also given it as part of the upper-division physics mechanics course. Freshman students are typically below the *entry leve*l but should be past that at the end of their first year; graduating students should be at the *mastery level*.

Most recently, the Department of Physics has begun using a senior-level test from the *Educational Testing Service (ETS) - the Physics Major Field Test*. This test was given at the end of the second semester of PHYS 455 (Quantum Mechanics II). The ETS test is a commercially-produced test that is widely used physics and engineering programs across the country. It provides nationally-normed measures for mechanics, electricity & magnetism, thermodynamics, and modern physics. The ETS test allows the course instructor to use individual scores for the second part of the exam as part of the course grade while using group scores for individual subjects to evaluate both *Program Outcome (a) - Scientific Expertise* and *Program Outcome (e) - Problem solving*.

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 developed by the Physics Education group

The Department of Physics is very fortunate to have Dr. Steve Kanim as one of its faculty members. Kanim's research is in Physics Education research and he developed many different (nationally recognized) exams and other probes to test student's conceptual understanding of physics,

As part of his research, he also developed much of the material for the introductory physics laboratories. Kanim's labs allow that student performance can be evaluated at several levels, one of which provides a measurement for *Program Outcome (b) – Experimental Training.*

As one of the results, Dr. Kanim co-authored the *E&M TIPERs; Electricity & Magnetism Tasks* (ISBN-10: 0131854992), which is used at several institutions in physics lab instruction.

Dr. Kanim also designed many of the standardized pre-requisite tests, which are given to students prior to each course. The purposed of the pre-requisite tests is to test whether students have been adequately prepared and remember the necessary material needed for taking a course. Although most pre-requisite test are not intended to measure any particular program outcomes, they are a very important ingredient to test the level of achievement and improve content delivery overall.

Assessment tools developed by Engineering Physics Program Committee

The Engineering Physics Program Committee designed a *Teamwork Evaluation Form* and an *Oral Report Evaluation Form* that can be used by individual instructors in order 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 can be accessed at http://engineeringphysics.nmsu.edu/forms.html, and copies are also provided in *Supplementary Information*.

Assessment tools developed by individual instructors

All other program outcomes, i.e. *Program Outcome (c) - Design Abilities*, *Program Outcome (f) – Professional Responsibility*, *Program Outcome (h) – Societal Impact*, *Program Outcome (i) – Life-long Learning*, *Program Outcome (j) – Contemporary Issues* and *Program Outcome (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 these particular outcomes, such as sub-scores in essays, class attendance, specialized assignments, class participation, completion percentage of assignments etc.

More details of the assessment tools for each individual program outcome are presented in *Criterion 4 – Continuous Improvement*.

Documentation for Assessment of Program Outcomes

Every time after teaching a relevant course, the instructor is expected to file course and evaluation materials in the *'Maroon' Instructor Notebook* (it is called 'maroon' because of the color of the binder). The most important document in the *Instructor Notebook* is the completed *Post-Course Instructor Comment Form*, which summarizes class details, results of program-outcome measurements and some general comments. A copy of the *Post-Course Instructor Comment Form* can be accessed at http://engineeringphysics.nmsu.edu/forms.html, and it is also provided in *Supplementary Documentation*. Other materials that instructors will file in the *Instructor Notebook* are listed below. In general, the *Instructor Notebook* will contain information and a summary the course each semester it was taught. This provides important feedback to instructors of future course and ensures continuity. Its contents are listed below.

A complementary '*White' Course Notebook* is prepared once every 6 years, just prior to ABET accreditation visit. The *Course Notebook* contains a detailed summary and examples of student work for each assignment. Its contents are listed below.

Finally, there is a separate *'Blue' Program Outcomes Notebook*, which contains yearly reports for each of the program outcomes, among other documents (see detailed list below). Since 2010, each faculty member of the Department of Physics will be charged in summarizing the measurements of a particular program outcome. This ensures faculty involvement in the ABET assessment process. The *Program Outcomes Notebook* also contains the results of our yearly student progress reports, where progress of each student is reviewed individually. Its contents are listed below.

As a practical matter, we began keeping the contents of each notebook online in 2008, and print them out for ABET assessment. Virtual notebooks are available to all faculty members and are deemed to be more accessible in that form.

In summary, the notebooks contain the following:

- **'Maroon' Instructor's Notebook** (prepared at the end of each course)
    - completed *Post-Course Instructor Comment Form*
    - supporting material for Assessment of *Program Outcomes (a)-(k)* (questions, tests, etc.)
    - syllabus and actual schedule followed
    - copies of exams, quizzes and homework, or references thereto.
    - copies of other class materials
- **'White' Course Notebook** (prepared for ABET review each cycle)
    - course outline and syllabus
    - copies of all assignments, i.e. pre-req. test, exams/labs/quizzes/homeworks/projects
    - exemplary copies of student work for each assignment (typically: high/medium/low)
    - hand-outs and other material used
    - summary of student evaluations

- **'Blue' Outcomes Notebook** (summarized yearly)
    - Yearly summaries of outcomes assessment (this process was implemented in 2008)
    - Yearly student progress reports

In the previous ABET cycle (2006-2012), we also required pre-requisite tests, grade summaries for tests and homeworks, and information about instructor evaluations in the Instructor's Notebooks. While this material was often useful for the instructors, some of the required material was not directly connected with the assessment results for the ABET *Program Outcomes (a) –(k).*

Furthermore, in the past the *Post-Course Instructor Comment Form* required a summary of the student evaluations, given at the end of the semester. Student evaluations are not immediately available to the instructor, and they often caused a delay in instructor submissions to *Instructor Notebook*. For the upcoming ABET cycle (2012-2018), we modified the submission requirements, so that the Instructor's Notebooks can be prepared at the same time class grades due.

B. Relationship of Student Outcomes to Program Educational Objectives

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

The ultimate goal of our Engineering Physics program is to design a curriculum and implement processes that prepare students for achievement of the EP *Educational Objectives* 1-3, which were introduced in *Criterion 2- Educational Objectives*. The *Educational Objectives* for the Engineering Physics program are as follows:

- **EP Objective 1: Competitiveness.** Graduates are competitive in internationally-recognized academic, government and industrial environments;
- **EP Objective 2: Adaptability.** Graduates exhibit success in solving complex technical problems in a broad range of disciplines subject to quality engineering processes;
- **EP Objective 3: Teamwork and Leadership.** Graduates have a proven ability to function as part of and/or lead interdisciplinary teams.

While the *Educational Objectives* are independently measured from measures based on the success of our alumni through surveys, interviews with alumni, and feedback of the External Advisory Board, there is a clear correlation between *Program Outcomes (a)-(k)* and *Educational Objectives EP 1-3*. Table 3.2 clarifies how the *Program Outcomes (a)* thru (*k)* support each of the above *Educational Objectives*. Each of the three *Educational Objectives* maps to multiple *Program Outcomes*. Strong correlations are marked with '**X**' in Table 3.2, secondary correlations marked with an '**s**'.

Table 3.3. Relationship between EP *Educational Objectives* and *Program Outcomes*. The relationships of primary importance are marked 'X', significant (but secondary) relationships are marked 's'; an empty box represents a negligible relationship.

EP Educational Objectives	Program Outcomes										
	(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
EP Objective 1: Competitiveness	**X**	**s**	**X**		**X**						**X**
EP Objective 2: Adaptability	**s**		**s**	**s**	**s**	**s**	**s**	**X**	**X**	**X**	**s**
EP Objective 3: Teamwork and Leadership		**X**		**X**		**X**	**X**	**s**			