The information supplied in this Self-Study Report is for the confidential use of ABET and its authorized agents, and will not be disclosed without authorization of the institution concerned, except for summary data not identifiable to a specific institution.
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BACKGROUND INFORMATION

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.

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   Assistant Professor and Department Assessment Chair
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   United States Naval Academy
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   Maury Hall, Mail Stop 14B
   Annapolis, MD 21402
   Phone: (410) 293-6158
   Fax: (410) 293-3493
   Email: owalker@usna.edu

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.

The United States Naval Academy was established in 1845 with a general education program to develop future naval officers. In 1930, the Naval Academy was accredited by the Association of American Universities. Although the Naval Academy offered separate courses of instruction for engineering and deck officers in the late 19th century, the first departure from a fixed curriculum occurred in 1959, when elective courses as well as validation and overloads for superior students were introduced. This was followed, in 1963, by the appointment of a civilian Academic Dean. Far-reaching changes to the curriculum were introduced in 1964 which reduced the number of required courses and, for the first time, insured that every midshipman would be able to pursue an individual academic area of interest in depth through an elected six-course minor. Many, through validation and overloads, were able to achieve majors. Additional changes introduced with the Academic Year 1969-1970 (AY1969-70), make it possible for every
midshipman to earn a major. Today, the Electrical Engineering program is one of eight engineering degrees available to the midshipman at the Naval Academy.\(^1\)

The Electrical Engineering program at the Naval Academy has been accredited by ABET since October 1970. The last general ABET review of the Electrical Engineering program occurred during the AY2005-06. The major program change since the last ABET visit is that the Naval Academy has expanded the engineering program to include a Computer Engineering program, which is administered through the expanded Electrical and Computer Engineering Department. The first graduation from the Computer Engineering program occurred in the spring of 2011. Our Computer Engineering program is concurrently seeking its initial ABET accreditation.

C. Options

_List and describe any options, tracks, concentrations, etc. included in the program._

The Electrical Engineering program does not offer tracks or concentration specific degrees.

D. Organizational Structure

_Use 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 Division of Engineering and Weapons is one of five divisions within the Naval Academy. The Division Director (equivalent to a Dean of Engineering at peer institutions) reports to the Superintendent via the Academic Dean and Provost. There are five academic departments in the division: Aerospace Engineering, Electrical and Computer Engineering, Mechanical Engineering, Naval Architecture and Ocean Engineering, and Weapons and Systems Engineering. These five departments currently offer six EAC/ABET accredited programs: Aerospace Engineering, Electrical Engineering, Mechanical Engineering, Naval Architecture, Ocean Engineering, and Systems Engineering. In addition, there are two currently non-accredited programs, General Engineering and Computer Engineering, which are both seeking their initial ABET accreditation during this cycle. Computer Engineering is a new program which had its first graduates in the class of 2011 (and is seeking accreditation for those graduates as well). General Engineering is provided for students who are interested in engineering but who are unable to complete one of the other engineering degree programs within the allotted four years of study.

The academic department chairs report to the Division Director. In addition, the Director of the Technical Support Department (TSD), the Faculty Directors of the all of the independent laboratory groups and the Senior Professor report to the Division Director. The TSD Director manages the staff in all of the lab groups with the exception of the Hydro Lab and the Satellite Ground Station. The Senior Professor is a post-chair member of one of the departments in the division who advises the Division Director on all matters relating to the execution of the programs within the division including but not limited to staffing, budgeting and space utilization issues. The Division Director is a senior rotational military officer assigned to the Academy for

\(^1\) USNA Faculty Handbook
typically three years. While the Division Director has had significant leadership and command experience in the military, their academic experience may be a little more limited. The Senior Professor provides the long term understanding of the academic programs that bridges the tenures of the Division Directors.

Within the Division of Engineering and Weapons, the division leaders are:

- CAPT Lloyd Brown, USN
  Division Director (until approximately Aug 15, 2012)

- CAPT Jay Bitting, USN
  Division Director (effective approximately Aug 15, 2012)

- Dr. Pat Moran, Professor
  Senior Professor

- CAPT Ken Ham, USN
  Chair, Aerospace Engineering Department

- Dr. Robert Ives, Associate Professor
  Chair, Electrical and Computer Engineering Department

- Dr. Oscar Barton, Professor
  Chair, Mechanical Engineering Department

- Dr. David Kriebel, Professor
  Chair, Naval Architecture and Ocean Engineering Department

- Dr. Kiriakos Kiriakidis, Professor
  Chair, Weapons and Systems Engineering Department

Organizational charts at the Academy, Academic Dean and Provost and the Division level are included in Figure B-1 through Figure B-3. Figure B-4 shows the reporting structure for the laboratory groups in the division.

The organizational structure of the Electrical and Computer Engineering Department is shown in Figure B-5. Administratively, the department is led by the Department Chair with the assistance of the Associate Department Chair and the Executive Assistant. The Associate Chair handles all affairs associated with the military faculty in the department which includes managing officer reporting and detaching requirements, drafting of officer fitness reports, drafting and submission of military awards, and assignment and monitoring performance of military collateral duties. The Executive Assistant manages the department’s budget and schedules all instructors, classrooms, and exams.
Figure B-1. U. S. Naval Academy Organization

Figure B-2. Academic Dean Organization
Figure B-3. Engineering and Weapons Division Organization

Figure B-4. Engineering and Weapons Lab Organization
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, web-based, etc.

The Academy operates on a semester schedule, graduating midshipmen primarily in May with delayed graduations held in August and December. Class and laboratory sessions for the programs in the Division of Engineering and Weapons are offered between the hours of 7:55 am and 3:20 pm, Monday through Friday. Examinations common to large enrollment classes, called X-period exams, can extend the regular class hours from 6:55 am to 3:20 pm. These exams are scheduled twice a semester at the six and twelve week points. Instruction follows a traditional lecture/laboratory format. The Naval Academy does not engage in cooperative, off-campus, distance, or web-based education other than exchange programs with other service academies and semester-abroad programs.

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.).

Generally, all material is delivered on site. There are opportunities for midshipmen to participate in exchange programs at the other service academies and overseas. These exchange opportunities are handled on an individual basis, with the midshipmen working closely with their academic advisor to ensure progress towards graduation is maintained.
G. Deficiencies, Weaknesses or Concerns from Previous Evaluation(s) and the Actions Taken to Address Them

Summarize the Deficiencies, Weaknesses, 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 be so indicated.

Institution-wide Deficiencies, Weaknesses or Concerns

At the end of the 2006 visit, an institutional concern remained unresolved. The concern centered on Criterion 2 - the evaluation of the Program Educational Objectives and assessment of achievement of the objectives. Extracted from the final statement, the concern read:

Two offices at the USNA are responsible for assessment. The Office of Academic Assessment assists with the measurement of student attitudes and performance, which helps determine attainment of program outcomes. The Office of Institutional Research measures how well graduates meet the needs of the Navy. The Office of Academic Assessment, which helps assess achievement of outcomes, is not in a position to measure the career and professional accomplishments of the programs’ graduates. The Office of Institutional Research, which tracks career and professional accomplishments of USNA graduates, does not necessarily measure attributes relevant to the attainment of objectives for each engineering program.

As a result of the 2005/2006 cycle EAC/ABET accreditation visit and the Middle States Commission on Higher education accreditation visit during 2005, a more focused approach to assessment has was implemented. The Academy Effectiveness Board (AEB) was established. It’s goal is to develop a consistent and comparable data gathering process so that over time there will be a stable set of data for determining the success of USNA graduates in the fleet and to provide information about graduates’ perceptions of their programs of study while at the Academy. The Academy Effectiveness Board (AEB) is now a standing committee of the USNA Senior Leadership Team (SLT), which is chaired by the Superintendent. The SLT is responsible for Academy-wide policy formation and resource allocation. The AEB is co-chaired by the Vice Academic Dean, Deputy Commandant, and Deputy Athletic Director and has representatives from all areas of the Academy. A variety of assessment initiatives are underway. The Engineering Division’s periodic survey of it graduates (done for ABET assessment purposes) has been included as one of the AEB activities. The Engineering programs will benefit from information obtained by some of the other AEB initiatives.

As for the survey of engineering graduates, this was completed for the first time in the spring of 2006 and the initial results were used as part of the due process response to ABET and are noted in the final statement of the 2005/2006 cycle visit. The survey has been conducted again in the fall semester of this past academic year. The results are a part of the assessment efforts addressed in this Self-Study.

With reference to the periodic determination and evaluation of PEOs, engineering majors at USNA utilize various methods to assess and revise their Program Educational Objectives. These include having department visiting committees review and comment on the PEOs, asking past graduates of the program for their opinions on the PEOs (many past graduates return to serve as...
rotational military faculty members in the departments in which they majored), and asking military officers from the various U.S. Navy and Marine Corps communities for their opinions on the PEOs (many are asked when they are serving at USNA in roles as rotational military faculty or as Permanent Military Faculty). These Navy and Marine Corps communities employ the vast majority of USNA graduates and are thereby the principal constituencies of the engineering majors. Specific information describing how this engineering program periodically determines and evaluates its PEOs is presented in Criterion 2, Part E of this self-study.

Program Deficiencies, Weaknesses or Concerns

During the 2006 visit, ABET identified one Program Concern that the program has subsequently been addressed. Specifically, ABET noted that:

Criterion 3 requires that the engineering programs demonstrate that their students attain an ability to design a system, component, or process to meet desired needs within realistic constraints. Students must be required to consider some of the constraints listed in Criterion 3(c), which does not appear to be the case for the electrical engineering program.

In its due-process response, the program acknowledged that improved documentation may be required to demonstrate inclusion of realistic constraints. The concern remained in the 2006 Final Statement.2

In response to this concern, the department’s Curriculum Committee worked in conjunction with the lead faculty member for student outcome (c) to improve the teaching of design throughout the curriculum including a renewed emphasis on the role of resource constraints. The inclusion of a robotic project in EE221 and a prototyping project in EE241 are examples of this effort. In these projects as well as in the capstone design courses, the students are given numerous design alternatives and asked to consider design tradeoffs and the impact of realistic resource constraints. Subsequent assessments have indicated that our students have performed well on these assignments and, in general, have developed an understanding of designing in the context of realistic resource constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability. The documentation has also been improved with substantial changes in the assessment methods used which now include an extensive survey of capstone senior design faculty mentors. Further details can be found in the student outcome (c) summary in Criterion 4, Section B.

H. Joint Accreditation

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

The Electrical Engineering program is not seeking joint accreditation.

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GENERAL CRITERIA

CRITERION 1. STUDENTS

For the sections below, attach any written policies that apply.

A. Student Admissions

*Summarize the requirements and process for accepting new students into the program.*

The admissions criteria for entrance to the Naval Academy apply to all candidates. Candidates must qualify medically and scholastically and pass a physical aptitude test. A high school rank in the upper 40% is normally required, as well as a specified level in the “whole person” evaluation, called the candidate multiple, which is a predictor of academic and military performance, retention and majors interest.

The incoming Naval Academy Class of 2015 (shown in Figure 1-1) class size was 1,229 midshipmen which reflected 1,426 offers of appointment from an applicant pool of 19,145. Academic highlights of the 2015 incoming class included:

- 52% were in the Top 10% of their high school class and 79% were in the top 25%.
- The middle 50th percentile for the verbal portion of the SAT was 590-720 and for the math portion was 610-730.
- 32% of the class came from college or post-high school preparatory programs.

Figure 1-1. United States Naval Academy Class of 2015.

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3 *Class of 2015 Portrait* on the USNA Admissions website at http://www.usna.edu/Admissions/.
Before the beginning of the freshmen year, the incoming class is integrated into the Brigade of Midshipmen (student body). The Brigade is organized into 30 companies of roughly 140 midshipmen each. Companies are led by a Company Officer (usually a Navy Lieutenant or Marine Captain), and is composed of midshipmen from all four year groups (freshmen through seniors).

Selection of an academic major comes during the second semester of the freshman (plebe) year. The Electrical and Computer Engineering department provides each midshipman, who expresses interest in its programs, the opportunity to join the department. Beginning in the fall of each year, the department conducts a series of “open houses” for the entire plebe class. These open houses are hosted by both department faculty and current majors and are highlighted by extensive one-on-one interaction with the plebes. They also feature student project displays and tours of the various departmental laboratories. Additional open houses are held at the start of the spring semester and the week prior to major selection in the spring (normally in early to mid-March).

B. Evaluating Student Performance

Summarize the process by which student performance is evaluated and student progress is monitored. Include information on how the program ensures and documents that students are meeting prerequisites and how it handles the situation when a prerequisite has not been met.

All students follow a clearly defined program of study, referred to as a matrix, the content of which depends on the student’s major. The matrix for students in the Electrical Engineering program is presented in Criterion 5, Curriculum. All students are required to take a minimum of 15 credit hours per semester. Approval by the Associate Dean for Academic Affairs is required to take more than 23 credit hours per semester. Progress through the matrix is monitored by the student’s academic advisor and the Naval Academy Registrar. The academic advising process is presented in Section D of this Criterion. It is the academic advisors’ responsibility to ensure that a student remains on track, help them choose appropriate courses each semester based on prerequisites and co-requisites, and ensure that they register for at least 15 credit hours. As students approach graduation, a final check is made by both the registrar’s office and the Electrical Engineering program’s senior academic advisor to ensure they have met all requirements (the role of the senior academic advisor is discussed in more detail in Section D). In the event of an error, the senior academic advisor and the student’s academic advisor are notified in time to correct the problem.

The Naval Academy uses the letter-based A, B, C, D, F grading system: A denotes excellent; B, good; C, satisfactory; D, marginal but unsatisfactory; and F, failing. Quality Point Equivalents (QPE) are 4.0, 3.0, 2.0, 1.0, and 0.0, respectively. The faculty member teaching a course has the sole authority for assigning grades in that course. Grades are averaged, using a weighted semester-hour system called a Quality Point Rating (QPR) calculated for the semester as

\[
\text{Semester QPR} = \frac{\sum (\text{Course Credit} \times \text{Numeric Grade})}{\sum \text{Course Credit}}
\]
and for the cumulative academic record to date as

\[
\text{Cumulative QPR} = \frac{\sum (\text{Course Credit} \times \text{Numeric Grade})}{\sum \text{Credit Hours}} = \frac{\sum \text{Quality Points}}{\sum \text{Credit Hours}}
\]

Treated solely as an index of academic performance, the QPR does not include grades received in professional drills, conduct, military performance, or physical education. A semester QPR of 2.0 is the minimum satisfactory academic performance level. Academic requirements for graduation and commissioning include completion or validation of a minimum of 138 credit hours with a cumulative QPR of at least 2.0. A cumulative QPR of 2.0 in majors courses is necessary for the graduating midshipman to receive a degree bearing the name of the major (in this case, a B.S. in Electrical Engineering). Failure to achieve this QPR results in the midshipmen graduating with the degree of Bachelor of Science with no other designation.

Grades received in military performance and professional courses are also used to compute a midshipman’s rank in the class which is called the Order of Merit (OOM). The OOM is used primarily to determine the service assignment of each midshipman and it is also an input to the immediate graduate school application screening process. Service communities from which midshipmen can choose include Aviation, Marine, Submarine, and Surface Warfare. The OOM is a weighted representation of grades received in academics, military performance, conduct, physical education, athletics, and professional competence. Academic performance accounts for 65% of the OOM.

Faculty members are responsible for providing on-line same-day reports of absent or tardy midshipmen for each meeting of the courses they teach. Faculty members are also responsible for progress grades, after the sixth and twelfth week of the semester. End-of-semester grades include a 16th week progress grade, a final examination grade, and a final grade for the semester.\(^4\)

To fulfill the Naval Academy mission, each midshipman must be counseled and given direction toward attaining standards of performance required for graduation and becoming an officer in the naval service. The grades that midshipmen earn in the courses they take are essential but not sufficient information for this purpose. A Midshipmen Academic Progress Report (MAPR) provides additional information needed to obtain a more complete assessment of a midshipman's academic performance. These are submitted electronically by faculty members using the Midshipman Information Data System (MIDS) maintained by the Information Technologies Services Division. MAPR's must be entered at the end of the interim marking periods for the fall and spring semesters and at the end of each week and for the end of any summer course for midshipmen with D or F grades. MAPR's must also be entered at the end of an academic term, whatever the grade, when required by the Academic Board. The comments section of a MAPR is its most important part. Here, faculty members are asked to provide, as best they can, assessments of the midshipman's academic ability, attitude, alertness, discipline, bearing and appearance, effort, initiative, interest, and officer potential. For interim grading periods, recommendations for improvement are appropriate when the MAPR is being submitted because

\(^4\) USNA Faculty Handbook
of poor performance. MAPR's submitted for the Academic Board should also include recommendations for retention or separation to facilitate the Board’s decision on whether an academically deficient midshipman should be retained. Faculty members may write MAPR's for any of their students at any marking period or at the end of the semester for any reason. Indeed, faculty members are encouraged to write MAPR's that praise good performance.5

C. Transfer Students and Transfer Courses

 Summarize the requirements and process for accepting transfer students and transfer credit. Include any state-mandated articulation requirements that impact the program.

The Naval Academy does not allow transfer students. All students must start out as fourth class (freshmen) and must go through the Plebe summer training program prior to their freshman year. Majors are selected at the end of the freshman year and the Electrical Engineering program begins with the fall semester of the second year. While not prohibited, student transfers into the Electrical Engineering program after the beginning of the third class (sophomore) year would be difficult because the Naval Academy does not normally support delayed graduation beyond four years except in extraordinary circumstances. Student transfers from Computer Engineering to Electrical Engineering is more viable because they take many of the same courses in their first year in the major.

D. Advising and Career Guidance

 Summarize the process for advising and providing career guidance to students. Include information on how often students are advised, who provides the advising (program faculty, departmental, college or university advisor).

The structure for all academic programs at the United States Naval Academy consists of a freshman, or plebe, year component and an upper class, or majors, component. The midshipmen in the student body are identified by their rank as follows:

- First class (1/C) midshipmen (seniors)
- Second class (2/C) midshipmen (juniors)
- Third class (3/C) midshipmen (sophomores)
- Fourth class (4/C) midshipmen, or Plebes (freshmen)

The Naval Academy has established its overarching guidance for undergraduate advising in USNA Instruction 1531.39 Academic-Advising System. It notes that an academic advising system designed for use in undergraduate education must recognize: (a) that students must develop themselves intellectually, and (b) that Academic Advisers should provide guidance to students in the form of information and advice. In accordance with this philosophy, the Academic Adviser's role is to offer helpful and timely guidance to the student as he/she pursues educational choices at the United States Naval Academy. Such choices are extensive and range from classroom performance to academic major selection to graduate school qualification. Students have the right to make these educational choices but must seek intellectual development

5 USNA Instruction 1531.33F
and do the academic work necessary to support their goals. Students who fail, having made such a choice, may well forfeit their right to continued academic enrollment. 

In the following, we first look closely at the institution-wide Plebe Academic Advising program and then turn our attention to the Electrical Engineering Academic Advising program for first, second, and third class majors in the Electrical Engineering program. We close this section with a discussion of the military counseling system that is largely unique to the service academies but in some ways similar to career guidance in other undergraduate institutions.

**Plebe (Freshmen) Academic Advising**

The plebe year curriculum is common to all midshipmen. Academic advising is coordinated by the director of Plebe Programs who is part of the Center for Academic Excellence (CAE). Currently, the director of the CAE is Dr. Eric Bowman. CDR Donald J. Carlson USN (Ret) is the director of the plebe advising program, and has been in this leadership position for over 15 years. Assessment and evaluation of the plebe program occurs annually under the supervision of the director of the program.

Faculty and staff volunteer as plebe advisors, many of whom have served in their capacities for five or more years. A plebe advising team can have as many as three advisors, and each team is assigned to a company in the brigade. For each team, a person who has served for multiple years as a plebe advisor is designated the team’s senior academic advisor. Senior academic advisors coordinate the activities of his/her team and mentor their junior counterparts. 85 faculty and staff members formed the advising network for the 1200 midshipmen of the Class of 2015. All plebe advisors, including senior academic advisors, must attend a yearly training session held each summer prior to the start of plebe summer. During the session, all aspects of the plebe curriculum are discussed. The current plebe advisor’s handbook can be viewed at http://intranet.usna.edu/AcCenter/docs.php (internal website) and is included in the supporting material of Appendix G.

Once advisor training is completed, two important meetings occur between plebes and their advisors during plebe summer. The first, referred to as the Academic Counseling and Registration (ACR) session, is an orientation meeting. At the ACR, midshipmen are introduced to the academic program in general, to various courses they will be taking, and to their matrix of courses for the fall semester. In addition, results of validation exams are provided. The second meeting is the Academic Advising and Study Skills (AA/SS) meeting. At this meeting, more details about the academic program are discussed, but the focus is primarily on academic readiness and performance. Tips for success, time management and study skills highlight this 2½ hour session. Consequences of poor academic performance are discussed and support programs to remedy poor performance are detailed. For their reference, the plebes are also provided an academic handbook that can be viewed at http://intranet.usna.edu/AcCenter/docs.php (internal website) and is included in the supporting material of Appendix G.

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6 USNA Instruction 1531.39 Academic-Advising System
Plebe advisors schedule additional meetings after the semester has started to track academic performance through the three grading periods, to prepare for pre-registration of spring courses, and to educate the midshipmen on the selection of majors available.

In the second semester of the plebe year, plebes select their academic major. As discussed in Section A of this criterion, departments hold a series of open houses for the plebes throughout the fall and winter to introduce the plebes to the different programs. These open houses provide the plebes an excellent opportunity to interact with both faculty members and current upper class students. In addition, a set of plebe major briefings are held in January. Organized around a conference format, these briefings showcase each program in turn and offer another opportunity to learn more about the range of majors available and are the last promotions prior to major selection. In early spring, just prior to Spring Break, midshipmen select their academic majors through the online Midshipmen Information System (MIDS). Midshipmen are then assigned advisors from among the faculty in their chosen academic department and the role of the plebe academic advisor officially ends.

Major Academic Advising

After selecting their major, midshipmen are assigned an academic advisor from among faculty in their chosen major. Communication between the midshipmen and their newly assigned department academic advisors varies according to needs and to desires of individuals involved. The obligations of an academic advisor in the Electrical Engineering program are laid out in the ECE Advising Guide (included in Appendix E) and include the following:

1. Meet with advisee before each preregistration period.
2. Check that students are properly registered and progressing towards graduation.
3. Promptly respond to requests for schedule and course changes.
4. Counsel students for the best academic experience:
   a. Get to know your advisees. Ask about their goals for their education. Know if they are in a varsity sport or time-intensive Extra-curricular Activity (ECA), or if they aim to get highly involved in positions of military responsibility in the brigade.
   b. Ensure that advanced students are aware of programs like language minors, exchanges, independent study, double majors, research opportunities, internships, and graduate education programs.
   c. Guide struggling students to appropriate resources: the CAE for help with study and test-taking skills and writing, summer school for reducing course loading, etc.7

The registration process for each semester occurs in two phases, a pre-registration phase and a registration phase. Pre-registration occurs during the semester prior to registration and is used to determine which courses and how many sections will be needed the following semester. It also provides information on student interest in major electives. Midshipmen are required to meet with their academic advisors to review academic progress and course selection prior to pre-

7 ECE Advising Guide.
registration. Course descriptions are available to the student in an on-line course listing (http://www.usna.edu/AcDean/courses/courses.html) or from the on-line catalog (http://www.usna.edu/Catalog/). These course descriptions, as applicable to the Electrical Engineering program, can be found in the Course Syllabi listings in Appendix A. Midshipmen then select courses for pre-registration using the MIDS program. Advisors are directed to review the status of their advisees using MIDS after pre-registration to ensure that prerequisites have been met and course sequencing is correct. Once courses and number of sections have been determined, students are directed to complete registration on MIDS to finalize their schedules. At this point, sections are assigned, schedules are determined, and any problems are identified.

There are four separate checks in place to ensure graduation requirements are met: (1) the registrar, (2) the department chairman, (3) the senior academic advisor, and (4) the academic advisor. As graduation approaches, the department chair and the senior academic advisor are prompted by an e-mail from the Associate Dean for Academic Affairs to review all of the majors’ matrices to ensure they will satisfy requirements for graduation. The academic advisor completes the initial review and verification of the midshipmen program. The advisor is aided in this task by MIDS, which enables the advisor to check the status of midshipmen course completion for general distribution requirements and for completion of required courses. The Naval Academy registrar also performs an automated screening using MIDS and forwards the results to the senior academic advisor for follow-up. Both the senior academic advisor and the department chairman then perform their own check on all graduating students to check for odd cases and verify that they are all on track to graduate. The Electrical Engineering program’s senior academic advisor is Associate Professor Samara Firebaugh. Assigned Electrical Engineering academic advisors are:

1. Associate Professor Samara Firebaugh (EE Senior Advisor)
2. Assistant Professor Chris Anderson
3. Associate Professor Rob Ives
4. Associate Professor Brian Jenkins
5. Associate Professor Deborah Mechtel
6. Associate Professor Tom Salem
7. LCDR Robert Schultz, USN
8. Associate Professor Louisa Sellami
9. Assistant Professor Justin Blanco
10. CDR Charles Hewgley, USN
11. CDR Hartley Postlethwaite, USN

The average student-to-advisor ratio in the Electrical Engineering program is 8.18. In a recent change to the Electrical Engineering academic advising process, academic advisors are now assigned only to a set of students in a single class year for the duration of their enrollment in the program, beginning in their fourth class year immediately following major selection and continuing through graduation. The reason for the change in advisor assignment was that in recent years there have been a number of matrix changes both within our own department with the start of the new ECE major, and also with other departments. As a result there were small but significant variations in matrices from year to year. The senior academic advisor observed that this generated confusion among both the students and advisors. The new system allows advisors to specialize in the matrix for a particular class. Also, there was concern that the
advisors did not receive enough preparation for advising even though the department addressed advising as part of a regular monthly meeting every year. The senior academic advisor felt that this form of training was not effective because it was too general and did not come at a time when advisors were focused on that particular task. The most time-compressed and important advising period is when students first enter the major. With the new advising system there are only 3-5 advisors who are working with the rising 4/C, so it is much easier to schedule a focused advising training session for these advisors at this time when they need it.

The senior academic advisor plans to assess this change by asking long-time advisors how the new system compares in advisor workload to the old system after 2-3 years have passed. In addition, the Naval Academy has initiated an institution-wide assessment of the majors advising program beginning with the class of 2012. As this data becomes available, it will provide additional insight into the adequacy of the revised advising program and insight into further changes that might improve its effectiveness.

Military Counseling and Career Guidance

Military counseling policy and expectations at the Naval Academy are also established in USNA Instruction 1531.39 Academic-Advising System. Military indoctrination counseling provided at the Naval Academy arises directly from the Academy's mission to prepare midshipmen for service as Naval/Marine officers. The Academy provides midshipmen the indoctrination in naval customs, courtesies, discipline, and esprit de corps required by the officer training mission. Such military indoctrination requires the frequent use of direct counseling. Through counseling, the military counselor, usually the midshipmen’s Company Officer, actively strives to modify the midshipman's attitude and behavior to conform to the desires of the institution. Company Officers issue explicit instructions, correct inappropriate behavior, and direct the pursuit of remedial courses of action. All of these forms of counseling seek to prepare midshipmen fully to assume their military leadership responsibilities as officers in the naval service.

At the Naval Academy, this indoctrination counseling extends in scope beyond traditional military performance into academic performance. Academic work is a major part of a midshipman's assigned duties. Through academic work, a midshipman reveals attitudes and patterns of behavior with respect to such desired officer characteristics as attention to duty, perseverance, and self-discipline. Company Officers therefore should evaluate a midshipman's academic performance for these character qualities and provide the appropriate counseling to the midshipman. Such appropriate counseling includes directive counseling aimed at modifying attitudes and behavior that are not acceptable for officers of the naval service. Thus, the academic advising system designed for the Naval Academy must include direct counseling of midshipmen by Company Officers specifically tasked to train future Naval/Marine officers.

Professional counseling (the equivalent of career guidance) is provided by the military officer faculty component, which consists of officers from a variety of Navy warfare specialties (most typically surface line, submarines, aviation, engineering duty and civil engineering corps) and from other military services when these officers are assigned to the Electrical Engineering faculty. All officers bring the benefit of their operational experience with them into the classroom. The permanent military professors (PMPs) are more senior Navy officers with PhDs.
The rotational officers tend to have more recent fleet experience, but at lower ranks. The inter-
service exchange officers provide an appreciation of their service’s career paths. Regardless, the
operational perspectives and career paths of the military faculty frequently augment the
classroom academic discussions. This extends beyond the classroom as numerous midshipmen
will have a military faculty member who serves as an “officer representative” to a sports team or
extracurricular activity. The dialogue that occurs between midshipmen and officers benefits the
midshipmen in understanding the career progression / sequence of assignments and assists the
midshipmen in evaluating their own request for service assignment.

E. Work in Lieu of Courses

Summarize the requirements and process for awarding credit for work in lieu of courses.
This could include such things as life experience, Advanced Placement, dual enrollment, test
out, military experience, etc.

A validation process exists at the Naval Academy to allow credit to be awarded for previous
work equivalent to that covered in courses in the Naval Academy curriculum. For the core
courses in math, science and the humanities, students have the option to validate courses through
examination during Plebe Summer, which is the summer preceding the fourth class (freshman)
year. The validation exams are administered and graded by their respective departments.
Excellent performance on these placement exams may result in a midshipman validating a
course, and thus accelerating portions of his/her academic program.

In addition, any academic course in the Electrical Engineering program can be validated in
accordance with Academic Dean Instruction 1531.39B (included in Appendix G) and Electrical
and Computer Engineering Department Notice 1531 (included in Appendix F). Validation
exams may take place at any time mutually convenient to the department and the midshipman.
Arrangements for validation are to be made by the midshipman with the ECE Department Chair.
Where validation warrants the administration of a validation exam, only one opportunity for
validation is allowed. Validations must be approved by the Department Chair and by the
Associate Dean for Academic Affairs.

Validation of a course may be revoked either at the request of the midshipman or the ECE
Department if the midshipman's progress in a sequential course indicates the need to revert to a
lower-level course. This action requires approval of the midshipman's academic adviser and the
ECE Department Chair.

Validation is generally only granted for equivalent college level experience elsewhere. Special
consideration may be given in cases where midshipmen have documented prior experience in the
Electrical and/or Computer Engineering fields and have successfully passed validation exams for
both course and laboratory work. Self study, tutorial assistance, or completion of
correspondence courses is not grounds for validation unless approved in advance by both the
Department Chair and the Associate Dean for Academic Affairs.

There are no other provisions for awarding credit for such things as life experience, Advanced
Placement, dual enrollment, military experience, etc.
F. Graduation Requirements  
*Summarize the graduation requirements for the program and the process for ensuring and documenting that each graduate completes all graduation requirements for the program. State the name of the degree awarded (Master of Science in Safety Sciences, Bachelor of Technology, Bachelor of Science in Computer Science, Bachelor of Science in Electrical Engineering, etc.)*

Graduates of the Electrical Engineering program at the Naval Academy receive a Bachelor of Science in Electrical Engineering degree. All students seeking an EAC/ABET-accredited degree at the Naval Academy must satisfactorily complete a degree-specific matrix of courses that includes required core, divisional, and majors courses specified for the assigned major. The degree-specific matrix of courses for the Electrical Engineering program can be found in Criterion 5, Curriculum. Matrices are prepared and revised by cognizant academic departments and approved by the Executive Steering Committee. Major matrices are managed electronically through the Midshipman Information System (MIDS) and academic adviser roles utilize MIDS to check their advisees’ records. Midshipman records are also checked by Senior Academic Advisers in each department and by the Registrar’s Office to ensure compliance with graduation requirements.

A cumulative grade point average of 2.0 (C) on a 4.0 scale is required for graduation. Starting with the Class of 2005, a midshipman must also have a cumulative average of 2.0 (C) in those courses designated as part of the major in order to receive a degree designation on the transcript and diploma. If this criterion in the major courses is not met, then the degree is awarded as a Bachelor of Science with no other designation. This criterion grew out of the Final Statement from the 1999 ABET visit, which recommended that a minimum grade point average be adopted for the engineering program. At the recommendation of the Faculty Senate, the criterion was endorsed for all academic majors at the Academy and was approved by the Superintendent.

G. Transcripts of Recent Graduates  
*The program will provide transcripts from some of the most recent graduates to the visiting team along with any needed explanation of how the transcripts are to be interpreted. These transcripts will be requested separately by the team chair. State how the program and any program options are designated on the transcript. (See 2011-2012 APPM, Section II.G.4.a.)*

The Electrical Engineering program has no program options, tracks, or concentrations that require explanation for evaluating a graduate’s transcript. On a graduate’s transcript, the program is indicated by a major of “Electrical Engineering” and a major code of “EEE.” Recent graduate transcripts will be provided to the ABET visiting team chair upon request.

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8 USNA Instruction 1531.49B
CRITERION 2. PROGRAM EDUCATIONAL OBJECTIVES

A. Mission Statement

Provide the institutional mission statement.

Since its founding in 1845, the U.S. Naval Academy has graduated officers who served with distinction in our armed services, and since that time a highly qualified civilian and military faculty has made significant contributions to the Academy’s mission:

“To develop Midshipmen morally, mentally and physically and to imbue them with the highest ideals of duty, honor and loyalty in order to graduate leaders who are dedicated to a career of naval service and have potential for future development in mind and character to assume the highest responsibilities of command, citizenship and government.”

In its Strategic Plan 2020, the Naval Academy has elucidated the following vision statement to support our mission statement:

“To be the nation’s premier institution for developing future naval leaders from diverse backgrounds to serve in an increasingly interdependent and dynamic world.”

To support our vision statement, the U.S. Naval Academy has developed a core set of attributes that we desire to imbue into our students during their time here at the Academy. These seven attributes are included in our Strategic Plan 2020:

“We graduate midshipmen who are warriors ready to meet the demands of a country at war or at peace. Our graduates are:

• Selfless
  Selfless leaders who value diversity and create an ethical command climate through their example of personal integrity and moral courage.

• Inspirational
  Mentally resilient and physically fit officers who inspire their team to accomplish the most challenging missions and are prepared to lead in combat.

• Proficient
  Technically and academically proficient professionals with a commitment to continual learning.

• Innovative
  Critical thinkers and creative decision makers with a bias for action.

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9 USNA Faculty Handbook
10 http://www.usna.edu/StrategicPlan/docs/overview.pdf
• Articulate
  Effective communicators.

• Adaptable
  Adaptable individuals who understand and appreciate global and cross-cultural dynamics.

• Professional
  Role models dedicated to the profession of arms, the traditions and values of the Naval Service and the constitutional foundation of the United States.¹¹

The Electrical and Computer Engineering Department is housed within the Division of Engineering and Weapons, which is somewhat analogous to a traditional College of Engineering within a civilian University setting. Our Division has its own mission statement, which is available on its public website:

The Division of Engineering and Weapons provides midshipmen an education in fundamental engineering principles that equips them to address the technical needs of the Navy and Marine Corps.

The Division of Engineering and Weapons at the U.S. Naval Academy is composed of five departments, encompassing eight academic majors. Midshipmen are immersed in a hands-on, project-based environment geared toward teaching real world engineering problem solving skills by combining practical knowledge and a thorough understanding of mathematical and scientific fundamentals.

The complexity of today's Naval weapon and engineering systems mandates a multidisciplinary approach in which revolutionary advancements in applied engineering and technology are brought to the classroom to prepare our graduates for service in the technically advanced Navy and Marine Corps of the 21st Century.¹²

As available on the department’s public website, the mission statement of the Electrical and Computer Engineering Department builds upon the mission statements of the Division as well as the Academy and supports the vision statement of the Academy and our core set of attributes and is:

¹¹ http://www.usna.edu/StrategicPlan/docs/overview.pdf
¹² http://www.usna.edu/EngineeringandWeapons/
The mission of the Electrical and Computer Engineering Department is to prepare midshipmen to be leaders in today’s technologically advanced Navy and Marine Corps by providing them with a firm understanding of the fundamentals of electrical and computer engineering.

Our graduates:

- Understand the principles that underlie electrical, electronic, and computational technology.
- Can apply their knowledge quantitatively and qualitatively to solve technical problems.
- Can communicate their ideas clearly, both orally and in writing.
- Work effectively either independently or in teams.
- Are aware of the larger moral and societal context for their actions, and are committed to the highest standards of ethical behavior.
- Engage in lifelong learning so that they can continue to serve the nation and contribute positively to their community throughout their career, whether or not they are in uniform. \(^\text{13}\)

B. Program Educational Objectives

List the program educational objectives and state where these can be found by the general public.

The following Electrical Engineering Program Educational Objectives are available on the department’s publicly accessible website.

Three to five years after graduation the Department of Electrical and Computer Engineering expects its graduates to be Navy or Marine Corps officers who:

1. Possess a fundamental knowledge in engineering, basic sciences, humanities, and social sciences; coupled with an expertise in Electrical or Computer Engineering that enables them to solve both well- and ill-defined shipboard, squadron or tactical Navy and Marine Corps engineering problems.
2. Are able to work independently and with others, effectively using oral and written communication skills.
3. Recognize the need to continually update their knowledge and skills and are engaged in life-long learning.
4. Know and practice their ethical and professional responsibilities as embodied in the United States Navy core values. \(^\text{14}\)

\(^{13}\) http://www.usna.edu/EE/
\(^{14}\) http://www.usna.edu/ee
C. Consistency of the Program Educational Objectives with the Mission of the Institution

Describe how the program educational objectives are consistent with the mission of the institution.

The Electrical Engineering program fulfills the United States Naval Academy mission statement by enforcing a curriculum that develops our students morally, mentally, and physically. The Program Educational Objectives specifically align with the Mission statement of the Academy as follows:

**Program Educational Objective #1:** Possess a fundamental knowledge in engineering, basic sciences, humanities, and social sciences; coupled with an expertise in Electrical or Computer Engineering that enables them to solve both well- and ill-defined shipboard, squadron or tactical Navy and Marine Corps engineering problems.

- This objective supports and aligns with the following portions of the institutional mission statement “To develop midshipmen ... mentally ... in order to graduate leaders who ... assume the highest responsibilities of command, citizenship and government”\(^\text{15}\) by equipping our students with the necessary intellectual competency to fulfill their responsibilities.
- This objective supports the following portions of the institutional vision statement and core set of attributes “We graduate midshipmen ...ready to meet the demands of a country ... Mentally resilient ... Technically and academically proficient professionals ... Critical thinkers”\(^\text{16}\) by equipping our students with the necessary intellectual competency to fulfill their responsibilities.
- This objective supports the following portions of the divisional mission statement “…provides midshipmen an education in fundamental engineering principles that equips them to address the technical needs of the Navy and Marine Corps”\(^\text{17}\) by equipping our students with the necessary intellectual competency to fulfill their responsibilities.
- This objective supports the following portions of the department mission statement “Understand the principles that underlie electrical, electronic, and computational technology. Can apply their knowledge quantitatively and qualitatively to solve technical problems.”\(^\text{18}\) by equipping our students with the necessary intellectual competency to fulfill their responsibilities.

**Program Educational Objective #2:** Are able to work independently and with others, effectively using oral and written communication skills.

- This objective supports and aligns with the institutional mission statement “To develop midshipmen ... mentally ... in order to graduate leaders who ... ”

\(^{15}\) USNA Faculty Handbook

\(^{16}\) http://www.usna.edu/StrategicPlan/docs/overview.pdf

\(^{17}\) http://www.usna.edu/EngineeringandWeapons/

\(^{18}\) http://www.usna.edu/EE/
assume the highest responsibilities of command, citizenship and government”\textsuperscript{19} by equipping our students with the necessary interpersonal skill competencies to function in their assigned command responsibilities.

- This objective supports and aligns with the institutional vision statement and core set of attributes “inspire their team to accomplish the most challenging missions”\textsuperscript{20} by equipping our students with the necessary interpersonal skill competencies to function in their assigned command responsibilities.

- This objective supports the following portions of the divisional mission statement “The complexity of today's Naval weapon and engineering systems mandates a multidisciplinary approach”\textsuperscript{21} by equipping our students with the necessary interpersonal skill competencies to function in their assigned command responsibilities.

- This objective supports the following portions of the department mission statement “Can communicate their ideas clearly, both orally and in writing … Work effectively … in teams”\textsuperscript{22} by equipping our students with the necessary interpersonal skill competencies to function in their assigned command responsibilities.

Program Educational Objective #3: Recognize the need to continually update their knowledge and skills and are engaged in life-long learning.

- This objective supports and aligns with the institutional mission statement “To develop midshipmen … mentally … in order to graduate leaders who … have potential for future development in mind …”\textsuperscript{23} by equipping our students with the motivation for continued life-long intellectual growth and development.

- This objective supports and aligns with the institutional vision statement and core set of attributes “academically proficient professionals with a commitment to continual learning”\textsuperscript{24} by equipping our students with the motivation for continued life-long intellectual growth and development.

- This objective supports the following portions of the divisional mission statement “The complexity of today's Naval weapon and engineering systems mandates a multidisciplinary approach in which revolutionary advancements in applied engineering and technology are brought to the classroom”\textsuperscript{25} by equipping our students with the motivation for continued life-long intellectual growth and development.

- This objective supports the following portions of the department mission statement “Engage in lifelong learning so that they can continue to serve the

\textsuperscript{19} USNA Faculty Handbook
\textsuperscript{20} http://www.usna.edu/StrategicPlan/docs/overview.pdf
\textsuperscript{21} http://www.usna.edu/EngineeringandWeapons/
\textsuperscript{22} http://www.usna.edu/EE/
\textsuperscript{23} USNA Faculty Handbook
\textsuperscript{24} http://www.usna.edu/StrategicPlan/docs/overview.pdf
\textsuperscript{25} http://www.usna.edu/EngineeringandWeapons/
nation and contribute positively to their community throughout their career, whether or not they are in uniform\textsuperscript{26} by equipping our students with the motivation for continued life-long intellectual growth and development.

**Program Educational Objective #4**: Know and practice their ethical and professional responsibilities as embodied in the United States Navy core values.

- This objective supports and aligns with the institutional mission statement “…to imbue them with the highest ideals of duty, honor and loyalty …”\textsuperscript{27} by equipping our students with a firm definition, understanding, and practical application of the ethical and lawful core values of United States Navy and the ethical and professional responsibilities of the engineering profession.
- This objective supports and aligns with the institutional vision statement and core set of attributes “leaders who value diversity and create an ethical command climate through their example of personal integrity and moral courage … adaptable individuals who understand and appreciate global and cross-cultural dynamics”\textsuperscript{28} by equipping our students with a firm definition, understanding, and practical application of the ethical and lawful core values of United States Navy.
- This objective supports the following portions of the divisional mission statement “prepare our graduates for service in the technically advanced Navy and Marine Corps of the 21st Century”\textsuperscript{29} by equipping our students with a firm definition, understanding, and practical application of the ethical and lawful core values of United States Navy.
- This objective supports the following portions of the department mission statement “Are aware of the larger moral and societal context for their actions, and are committed to the highest standards of ethical behavior”\textsuperscript{30} by equipping our students with a firm definition, understanding, and practical application of the ethical and lawful core values of United States Navy and the ethical and professional responsibilities of the engineering profession.

D. **Program Constituencies**

*List the program constituencies. Describe how the program educational objectives meet the needs of these constituencies.*

We define a constituent as anyone who has a vested interest in the quality of our graduates. Our program has two primary constituencies:

\textsuperscript{26} http://www.usna.edu/EE/
\textsuperscript{27} USNA Faculty Handbook
\textsuperscript{28} http://www.usna.edu/StrategicPlan/docs/overview.pdf
\textsuperscript{29} http://www.usna.edu/EngineeringandWeapons/
\textsuperscript{30} http://www.usna.edu/EE/
1. The leadership of both the Navy and Marine Corps
2. Graduate school faculty

In the following we discuss each of these constituencies in detail and highlight how our program educational objectives meet their needs.

Our program is unique in that our graduates are commissioned into either the Navy or Marine Corps. Accordingly, our primary program constituents are the leaders of the United States Navy and the United States Marine Corps. The Naval Academy’s mission statement has been formulated and agreed upon by the senior leadership of the armed forces. In aggregate, our four program educational objectives have been demonstrated to fully support the mission statement, vision statement, core set of attributes, division mission statement, and department mission statement in Criterion 2 Section C above. Thus, they meet the needs of our primary constituency group.

Upon graduation, our students become officers in one of the following warfighting communities:

**Standard Service Selection Options:**
- US Marine Corps Ground
- US Marine Corps Pilot
- US Marine Corps Naval Flight Officer
- US Navy Pilot
- US Navy Naval Flight Officer
- US Navy Submarine Warfare
- US Navy Surface Warfare
- US Navy Surface Nuclear
- US Navy Special Warfare (SEAL)
- US Navy Explosive Ordinance Disposal

**Special Case or Specially Qualified Service Selection Options:**
- US Navy Medical Corps
- US Navy Civil Engineering Corps
- US Navy Information Warfare Officer
- US Navy Intelligence Officer
- US Navy Supply Corps
- US Navy Human Resources Professional
- Commission in another US Military Service

Within these communities, our graduates may also have the opportunity to attend graduate school. Some of the communities permit graduate school attendance immediately upon graduation from the Naval Academy while others require an initial tour of duty. Accordingly, we also consider the faculty of these graduate school programs as constituents of our program. The following PEOs specifically address the needs of this constituency group:

**Program Educational Objective #1:** Possess a fundamental knowledge in engineering, basic sciences, humanities, and social sciences; coupled with an expertise in Electrical or Computer Engineering that enables them to solve both well- and ill-defined shipboard, squadron or tactical Navy and Marine Corps engineering problems.

**Program Educational Objective #3:** Recognize the need to continually update their knowledge and skills and are engaged in life-long learning.
E. Process for Revision of the Program Educational Objectives

Describe the process that periodically reviews and revises, as necessary, the program educational objectives including how the program’s various constituencies are involved in this process. Include the results of this process and provide a description of any changes that were made to the program educational objectives and the timeline associated with those changes since the last general review.

The process for review and improvement of our program educational objectives includes five main review components and a revision cycle as detailed below. Note that recommendations made from any one of the five review components triggers a revision cycle for the program educational objectives.

Review components of Program Educational Objectives and their associated inputs:

1. Naval Academy Board of Visitors: The Board of Visitors (BOV) is a high-level body that meets annually to review and provide guidance on the mission and operation of the United States Naval Academy. In this capacity, they represent the interests of our primary constituency group, the leadership of the Navy and Marine Corps. The BOV provides direct feedback to the Naval Academy leadership which is then shared with the various departments. Changes in vision, mission, and/or operational guidance potentially impact the department’s program educational objectives and are accordingly reviewed for action. The membership requirement for this board is:

The Naval Academy Board of Visitors (BOV) consists of four members of the U.S. Senate, five members of the U.S. House of Representatives, and six members at large designated by the President. Congress has chartered the BOV in Title 10, U.S. Code to inquire into the state of morale and discipline, the curriculum, instruction, physical equipment, fiscal affairs, academic methods, and other appropriate matters at the Naval Academy. The Board submits an annual report containing its views and recommendations to the President of the United States. The Superintendent’s Flag Secretary is secretary to the Board of Visitors.31

The 2011 Board of Visitors consisted of the following32:

**Appointed by the President:**
The Honorable Nancy Johnson, Vice Chair
LtGen. Frank Petersen, USMC (Ret.)
ADM. John Nathman, USN (Ret.)
Mr. Albert Hawkins III
RADM. Michelle Howard, USN
Mr. Roland Garcia

**Designees of the Chairmen, SASC/HASC:**
Senator John S. McCain, Arizona
Rep. Robert Wittman, Virginia, Chair

31 USNA Faculty Handbook
32 http://www.usna.edu/PAO/BOV.htm
Appointed by the Vice President:
Senator Barbara A. Mikulski, Maryland
Senator Benjamin L. Cardin, Maryland
Senator Mark S. Kirk, Illinois

Appointed by the Speaker of the House:
Rep. Dutch Ruppersberger, Maryland
Rep. Elijah Cummings, Maryland
Rep. John P. Kline, Minnesota
Rep. Rodney Frelinghuysen, New Jersey

2. **Department External Visiting Committee:** The External Visiting Committee is selected by the Chair of our Department with solicited input from the Assessment leadership team and is specifically targeted to represent the members of our military and graduate school constituencies. The External Visiting Committee specifically reviews our program educational objectives. This committee’s direct feedback provides the program a measure of the program educational objectives effectiveness in meeting the needs of our military and graduate school constituencies. The most recent on-site review of our program by our External Visiting Committee occurred in the spring of 2009. That committee consisted of the follow evaluators:

- Dr. Douglas J. Fouts
  Associate Dean of Research and Professor of Electrical and Computer Engineering
  U.S. Naval Postgraduate School
  Monterey, CA

- Dr. Joseph J. Suter
  Professor and Chair
  The Johns Hopkins University
  Whiting School of Engineering
  Technical Management Program
  and Managing Executive,
  Space Department

- Colonel Barry L. Shoop, Ph.D.
  Professor and Deputy Head
  Department of Electrical Engineering and Computer Science
  U.S. Military Academy
  West Point, NY

3. **Navy and Marine Corps officers at the Naval Academy.** These represent our primary constituent group, the leaders of the Navy and Marine Corps. These officers come from the various warfare communities described above and vary in rank from lieutenant (O-3) to captain (O-6). Each has at least three years of military experience in their community upon which to draw and formulate their opinions (significantly more in the case of the senior officers). These officers provide feedback on our program educational objectives through annual formal Naval Academy assessment reviews as well as periodic informal reviews within department meetings and in various positions of leadership throughout the Naval Academy.

4. **Naval Academy graduates.** Three to five years after graduation, we survey our graduates on not only their attainment of our program educational objectives (these results are discussed in Criterion 4, Section A), but also on the applicability of these objectives. Our graduates are Navy and Marine Corps officers with operational experience (often concurrently serving in their warfare assignments) and in that capacity they have become members of our primary constituent group, the leaders of the Navy and Marine Corps.
5. **ABET Accreditation Team:** Information gathered from the ABET Accreditation reviews is also used by our department to ensure that our program educational objectives are properly cast in the format, definition, and spirit of educational objectives.

**Revision cycle of Program Educational Objectives:**

Input from any one of the five review components discussed above triggers a potential revision of our program educational objectives as shown in Figure 2-1. These inputs are initially reviewed and analyzed by the department’s Assessment Leadership Team, consisting of the Department Assessment Coordinator, Electrical Engineering Program Assessment Lead, and Computer Engineering Program Assessment Lead. This Team determines a response to the input and prepares the necessary documentation for addressing the input. If the Assessment Team recommends restructuring the department’s program educational objectives, then a presentation of the proposed change(s) is brought before the department faculty during the regularly scheduled monthly department meeting for discussion and feedback. It should be emphasized that in this process, constructive feedback is also gathered specifically from the military officers identified above within the department. If the response is contentious in some way, the Assessment Chair may also elect to gather feedback on the proposed revised program educational objectives from our local military constituency outside of the department and the division. The Assessment Chair reports this feedback to the department and final decision on the proposed revised Program Educational Objectives may be made. If the feedback from the department faculty or local military constituency contains actionable comments, then the Assessment Chair may reconvene the Assessment Leadership Team to address the feedback and the process reiterates until there is concurrence among the department and our local military constituents.
History of the Electrical Engineering Program Educational Objectives since the last ABET accreditation:

Our program educational objectives have been revised twice since the last general review of our program by ABET in response to inputs from the ABET Accreditation Team in 2006 and the External Visiting Committee in 2009.

In the 2005 ABET Self-Study documentation submitted prior to our site visit; we had the following Program Educational Objectives:

The Electrical Engineering Program Objectives that guide the implementation of our Electrical Engineering Majors program include:

1. Graduates will have a broad education necessary for understanding the impact of electrical engineering solutions in global and societal contexts. This includes an understanding of professionalism, and ethics.

2. Graduates will be able to analyze and solve practical electrical engineering problems by applying fundamental principles of engineering, mathematics, and science. In addition, they will be able to use modern engineering techniques, skills, and tools.
(3) Graduates will be able to solve ill-defined electrical engineering problems. This includes problem definition, specification, design, implementation, test and operation of systems, components, and/or processes within performance and resource constraints.

(4) Graduates will be able to design and conduct scientific and engineering experiments and software simulations, as well as be able to analyze and interpret the resulting data.

(5) Graduates will be able to function in one-on-one situations and multidisciplinary teams, and communicate effectively, both verbally and in writing.

(6) Graduates will be able to engage in life-long learning and will recognize the need to continually update their knowledge and skills.  

These program educational objectives were revised based upon on-site comments offered by the last ABET evaluator team which noted that

“The educational objectives of the program are outcomes based and not career based. These should reflect the needs of the fleet and the career areas of the program graduates.”

Accordingly, the program educational objectives were revised to read as follows:

Three to five years after graduation the Department of Electrical Engineering expects its graduates to be Navy or Marine Corps officers who:

1. Will have a broad education with fundamental knowledge in engineering, basic sciences, humanities, and social sciences necessary to allow them to:
   - think and learn independently
   - develop insight in problem solving
   - practice sound judgment
   - develop intellectual perseverance and confidence in reasoning

2. Can communicate effectively, orally and in writing.

3. Can work effectively, independently, as well as with others.

4. Have sufficient depth and understanding of fundamental engineering principles to solve shipboard, squadron or tactical Navy and Marine Corps engineering problems, both well- and ill-defined.

5. Will engage in life-long learning and will recognize the need to continually update their knowledge and skills.

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33 2005 ABET Self-Study Report for USNA EE Department (will be available during the site visit)
6. Know and practice their ethical and professional responsibilities as embodied in the United States Navy core values.

These Program Educational Objectives satisfied the comments of the ABET evaluators and were adopted by the department. This documents the actions taken by the department from the input received from the program educational objective review component 5 (ABET Accreditation Team).

The next set of comments proffered to the department regarding these objectives occurred as input from our program educational objective review component 2 (Department External Constituency Visiting Committee) which occurred during their site visit in the spring of 2009. The committee noted that

“ABET objectives and outcomes are not as clear as they need to be. There appears to be some confusion between objectives and outcomes.”

Again, the revision cycle for the Program Educational Objective detailed above was triggered. This revision cycle was significantly influenced by discussion at the Engineering and Weapons Division level among the various engineering departments and Division Senior leadership as to whether or not the individual departments should all adopt a common set of Program Educational Objectives. In addition, during this revision cycle, members of the department assessment team sought insight into the formulation of Program Educational Objectives by attending several ABET sponsored conferences, symposia, and workshops. After considerable effort, discussion, and time, it was agreed upon at the Division level that the individual departments would not adopt a common set of Program Educational Objectives.

Accordingly, the revision cycle for the department (as described above) produced and adopted the following program educational objectives, which are presently in use by our department:

Three to five years after graduation the Department of Electrical and Computer Engineering expects its graduates to be Navy or Marine Corps officers who:

1. Possess a fundamental knowledge in engineering, basic sciences, humanities, and social sciences; coupled with an expertise in Electrical or Computer Engineering that enables them to solve both well- and ill-defined shipboard, squadron or tactical Navy and Marine Corps engineering problems.
2. Are able to work independently and with others, effectively using oral and written communication skills.
3. Recognize the need to continually update their knowledge and skills and are engaged in life-long learning.
4. Know and practice their ethical and professional responsibilities as embodied in the United States Navy core values.  

34 http://www.usna.edu/EE/assessment.php
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 to the (a) through (k) Student Outcomes.

In support of our program educational objectives, Electrical Engineering program students should achieve upon graduation:

(a) an ability to apply knowledge of mathematics, science, and engineering

(b) an ability to design and conduct experiments, as well as to analyze and interpret data

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

(d) an ability to function on multidisciplinary teams

(e) an ability to identify, formulate, and solve engineering problems

(f) an understanding of professional and ethical responsibility

(g) an ability to communicate effectively

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

(i) a recognition of the need for, and an ability to engage in life-long learning

(j) a knowledge of contemporary issues

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

These student outcomes were in use well before the 2006 ABET visit, but were recently relabeled (from (1) – (11) to (a) – (k)) and restated to clearly align with the ABET-identified student outcomes. They can also be found on our departmental assessment webpage (http://www.usna.edu/EE/assessment.php).
B. Relationship of Student Outcomes to Program Educational Objectives

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

Our student outcomes each support and are specifically aligned to prepare our graduates to attain one or more of our program educational objectives. This alignment is provided below and additional comments are included as needed. A summary mapping that we find useful in ensuring coverage across all program educational objectives is also included in Table 3-1.

Student Outcome (a): an ability to apply knowledge of mathematics, science, and engineering.
- Supports PEO #1: “Possess a fundamental knowledge in engineering, basic sciences, humanities, and social sciences... that enables them to solve both well- and ill-defined shipboard, squadron or tactical Navy and Marine Corps engineering problems.”

Student Outcome (b): an ability to design and conduct experiments, as well as to analyze and interpret data.
- Supports PEO #1: “Possess a fundamental knowledge in engineering, basic sciences, humanities, and social sciences; coupled with an expertise in Electrical or Computer Engineering that enables them to solve both well- and ill-defined shipboard, squadron or tactical Navy and Marine Corps engineering problems.”
- Supports PEO #2: “Are able to work independently and with others, effectively using oral and written communication skills.”
- Supports PEO #3: “Recognize the need to continually update their knowledge and skills and are engaged in lifelong learning.”
- Supports PEO #4: “Know and practice their ethical and professional responsibilities as embodied in the United States Navy core values.”

Student Outcome (c): an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- Supports PEO #1: “Possess a fundamental knowledge in engineering, basic sciences, humanities, and social sciences; coupled with an expertise in Electrical or Computer Engineering that enables them to solve both well- and ill-defined shipboard, squadron or tactical Navy and Marine Corps engineering problems.”
- Supports PEO #2: “Are able to work independently and with others, effectively using oral and written communication skills.”
- Supports PEO #3: “Recognize the need to continually update their knowledge and skills and are engaged in lifelong learning.”
- Supports PEO #4: “Know and practice their ethical and professional responsibilities as embodied in the United States Navy core values.”

The skills learned in the design process throughout the ECE curriculum are necessary for officers to “solve both well- and ill-defined … engineering problems” as required in PEO 1. These skills are taught in a variety of courses, providing a breadth of applicability that directly strengthens this objective. Additionally, some courses include design projects with precise requirements and expectations (i.e., well-defined), while other courses require students to demonstrate design skills in more open-ended (i.e., ill-defined) projects.

Furthermore, the skills learned in the design process support the requirement in PEO 2 that officers “work independently and with others, effectively using oral and written communication skills”, as well as the requirement in PEO 3 that officers “continually update their knowledge and skills and are engaged in lifelong learning.” Students typically consider practical problems that reinforce the need to stay current in their knowledge of engineering technology. Depending on the project, some students work independently, while others work...
in teams. All students must present their designs with both a written report and oral presentation.

- Finally, the application of realistic constraints, including societal and ethical constraints, supports PEO 4 by reinforcing the ability of the officers to “know and practice their ethical and professional responsibilities.”

**Student Outcome (d):** an ability to function on multidisciplinary teams.
- Supports PEO #2: “Are able to work independently and with others effectively using oral and written communication skills.”

**Student Outcome (e):** an ability to identify, formulate, and solve engineering problems.
- Supports PEO #1: “Possess a fundamental knowledge in engineering, basic sciences, humanities, and social sciences; coupled with an expertise in Electrical or Computer Engineering that enables them to solve both well- and ill-defined shipboard, squadron or tactical Navy and Marine Corps engineering problems.”

**Student Outcome (f):** an understanding of professional and ethical responsibility.
- Supports PEO #4: “Know and practice their ethical and professional responsibilities as embodied in the United States Navy core values.”

**Student Outcome (g):** an ability to communicate effectively.
- Supports PEO #2: “Are able to work independently and with others, effectively using oral and written communication skills.”

**Student Outcome (h):** the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
- Supports PEO #1: “Possess a fundamental knowledge in engineering, basic sciences, humanities, and social sciences; coupled with an expertise in Electrical or Computer Engineering that enables them to solve both well- and ill-defined shipboard, squadron or tactical Navy and Marine Corps engineering problems.”
- Supports PEO #4: “Know and practice their ethical and professional responsibilities as embodied in the United States Navy core values.”

**Student Outcome (i):** a recognition of the need for, and an ability to engage in life-long learning.
- Supports PEO #3: “Recognize the need to continually update their knowledge and skills and are engaged in life-long learning.”

**Student Outcome (j):** a knowledge of contemporary issues.
- Supports PEO #3: “Recognize the need to continually update their knowledge and skills and are engaged in life-long learning.”
- By recognizing the current technological trends and contemporary issues in the field of electrical and computer engineering, graduates understand that they need to continually update their knowledge and skills.
**Student Outcome (k):** an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

- **Supports PEO #1:** “Possess a fundamental knowledge in engineering, basic sciences, humanities, and social sciences; coupled with an expertise in Electrical Engineering that enables them to solve both well- and ill-defined shipboard, squadron or tactical Navy and Marine Corps engineering problems.”

- **Supports PEO #3:** “Recognize the need to continually update their knowledge and skills and are engaged in life-long learning.”

- The ability to use the techniques, skills, and modern engineering tools supports not only the officers’ ability to solve engineering problems but it also reinforces the need to continually update their knowledge and skills.

<table>
<thead>
<tr>
<th>Student Outcomes</th>
<th>Program Educational Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Possess a fundamental knowledge in engineering, basic sciences, humanities, and social sciences; coupled with an expertise in Electrical or Computer Engineering that enables them to solve both well- and ill-defined shipboard, squadron or tactical Navy and Marine Corps engineering problems.</td>
<td>(a) an ability to apply knowledge of mathematics, science, and engineering</td>
</tr>
<tr>
<td>(b) an ability to design and conduct experiments, as well as to analyze and interpret data</td>
<td>(b) an ability to design and conduct experiments, as well as to analyze and interpret data</td>
</tr>
<tr>
<td>(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability</td>
<td>(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability</td>
</tr>
<tr>
<td>(d) an ability to function on multidisciplinary teams</td>
<td>(d) an ability to function on multidisciplinary teams</td>
</tr>
<tr>
<td>(e) an ability to identify, formulate, and solve engineering problems</td>
<td>(e) an ability to identify, formulate, and solve engineering problems</td>
</tr>
<tr>
<td>(f) an understanding of professional and ethical responsibility</td>
<td>(f) an understanding of professional and ethical responsibility</td>
</tr>
<tr>
<td>(g) an ability to communicate effectively</td>
<td>(g) an ability to communicate effectively</td>
</tr>
<tr>
<td>(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context</td>
<td>(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context</td>
</tr>
<tr>
<td>(i) a recognition of the need for, and an ability to engage in life-long learning</td>
<td>(i) a recognition of the need for, and an ability to engage in life-long learning</td>
</tr>
<tr>
<td>(j) a knowledge of contemporary issues</td>
<td>(j) a knowledge of contemporary issues</td>
</tr>
<tr>
<td>(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.</td>
<td>(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.</td>
</tr>
</tbody>
</table>

Table 3-1. Mapping of Student Outcomes to Program Educational Objectives
CRITERION 4. CONTINUOUS IMPROVEMENT

This section of your self-study report should document your processes for regularly assessing and evaluating the extent to which the program educational objectives and student outcomes are being attained. This section should also document the extent to which the program educational objectives and student outcomes are being attained. It should also describe how the results of these processes are being utilized to effect continuous improvement of the program.

Assessment is defined as one or more processes that identify, collect, and prepare the data necessary for evaluation. Evaluation is defined as one or more processes for interpreting the data acquired through the assessment processes in order to determine how well the program educational objectives and student outcomes are being attained.

Although the program can report its processes as it chooses, the following is presented as a guide to help you organize your self-study report. It is also recommended that you report the information concerning your program educational objectives separately from the information concerning your student outcomes.

A. Program Educational Objectives

It is recommended that this section include (a table may be used to present this information):

1. A listing and description of the assessment processes used to gather the data upon which the evaluation of each the program educational objective is based. Examples of data collection processes may include, but are not limited to, employer surveys, graduate surveys, focus groups, industrial advisory committee meetings, or other processes that are relevant and appropriate to the program.

2. The frequency with which these assessment processes are carried out.

3. The expected level of attainment for each of the program educational objectives.

Assessment of our graduates’ attainment of our program educational objectives follows a standard program improvement process similar to that used for the student outcomes and is described in the following section. As indicated in Table 4-1, we chiefly use a periodic graduate survey that is assembled by the Engineering and Weapons Division and its associated departments. The survey is administered by the Naval Academy’s Office of Institutional Research, Planning, and Assessment to gather the survey data.

We provide the description of the assessment process, the frequency with which it is carried out and the expected level of attainment for the program educational objectives in Table 4-1. This is followed by the assessment results as well as the evaluation and action, as applicable, for the 2012 cycle. Difficulty in gaining approval from the military chain of command for the graduate survey resulted in the hiatus from 2006 (our last graduate survey) to 2012. The division appears to now have a solid process in place which is approved by the chain of command. We anticipate that we will be able to conduct the graduate survey every three years from this point forward.
Program Educational Objectives | Method(s) of Assessment | Length of assessment cycle (yrs) | Year(s)/semester of data collection | Target for Performance
--- | --- | --- | --- | ---
1. Possess a fundamental knowledge in engineering, basic sciences, humanities, and social sciences; coupled with an expertise in Electrical or Computer Engineering that enables them to solve both well- and ill-defined shipboard, squadron or tactical Navy and Marine Corps engineering problems. | Graduate Survey | 3 Years | 2015, 2018 | 70%

2. Are able to work independently and with others, effectively using oral and written communication skills. | Graduate Survey | 3 Years | 2015, 2018 | 70%

3. Recognize the need to continually update their knowledge and skills and are engaged in life-long learning. | Graduate Survey | 3 Years | 2015, 2018 | 70%

4. Know and practice their ethical and professional responsibilities as embodied in the United States Navy core values. | Graduate Survey | 3 Years | 2015, 2018 | 70%

Table 4-1. Assessment Plan for Program Educational Objectives

4. *Summaries of the results of the evaluation processes and an analysis illustrating the extent to which each of the program educational objectives is being attained.*

**Illustrative Example of Assessment Results, Evaluation, and Actions (from Electrical Engineering program):**

Here we show the results and analysis for the most recent 2012 Graduate Survey. This survey was sent to graduates that were 1 to 5 years beyond graduation (classes of 2006 thru 2010). The survey was sent out to 143 graduates from the Electrical Engineering program, of which 21 responded, a response rate of 15%. While low, this response rate is not atypical for these types of surveys. The survey was divided into two sections, the first of which addressed how well the Electrical Engineering program prepared them in specific areas, and the second addressed their current ability level in those same areas. The Likert scale provided in Table 4-2 was used to collect responses. The desired level of attainment corresponds to a 4 on the Likert scale.
In the following, we provide the assessment results and evaluation of the 2012 survey data for each of the program educational objectives. While these results have already been shared with our Student Outcome Champions, they will be formally briefed to the entire department during the fall semester “kickoff meeting” held in August 2012.

**PEO #1**: Possess a fundamental knowledge in engineering, basic sciences, humanities, and social sciences; coupled with an expertise in Electrical or Computer Engineering that enables them to solve both well- and ill-defined shipboard, squadron or tactical Navy and Marine Corps engineering problems.

**Assessment Results**: The following are the mean values of the responses for the survey questions related to PEO #1.

<table>
<thead>
<tr>
<th>Survey Question</th>
<th>Preparation</th>
<th>Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Apply knowledge of mathematics.</td>
<td>3.95 (79%)</td>
<td>3.85 (77%)</td>
</tr>
<tr>
<td>2. Apply knowledge of engineering.</td>
<td>3.90 (78%)</td>
<td>3.52 (70%)</td>
</tr>
<tr>
<td>3. Apply knowledge of your major.</td>
<td>3.81 (76%)</td>
<td>3.86 (77%)</td>
</tr>
<tr>
<td>4. Apply knowledge of science.</td>
<td>3.85 (77%)</td>
<td>3.81 (76%)</td>
</tr>
<tr>
<td>5. Apply knowledge of social sciences and humanities</td>
<td>3.52 (70%)</td>
<td>4.24 (85%)</td>
</tr>
<tr>
<td>6. Identify, formulate and solve engineering problems</td>
<td>3.86 (77%)</td>
<td>3.76 (75%)</td>
</tr>
<tr>
<td>7. Design systems, components, or processes to meet needs</td>
<td>3.81 (76%)</td>
<td>3.38 (68%)</td>
</tr>
<tr>
<td>8. Think critically in a complex technical environment</td>
<td>4.24 (85%)</td>
<td>3.95 (79%)</td>
</tr>
<tr>
<td>9. Use techniques, skills, and tools in engineering practice</td>
<td>3.76 (75%)</td>
<td>3.86 (77%)</td>
</tr>
<tr>
<td>20. Possess intellectual perseverance and confidence in reason</td>
<td>3.95 (79%)</td>
<td>3.90 (78%)</td>
</tr>
<tr>
<td>21. Have sufficient depth and understanding of fundamental engineering principles to solve well-defined shipboard, squadron or tactical Navy and Marine Corps engineering problems</td>
<td>3.90 (78%)</td>
<td>3.81 (76%)</td>
</tr>
<tr>
<td>22. Have sufficient depth and understanding of fundamental engineering principles to solve ill-defined shipboard, squadron or tactical Navy and Marine Corps engineering problems</td>
<td>3.81 (76%)</td>
<td>3.85 (77%)</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>77%</strong></td>
<td><strong>76%</strong></td>
</tr>
</tbody>
</table>

**Evaluation and Actions**: 2012 Graduate Survey responses indicate that our graduates currently attaining the 70% target for this program educational objective. The overall “preparation” average was 77% and respondents scored themselves above the target of 70% in preparation for all of the applicable survey questions. The overall “ability” average was 76% and respondents scored themselves above the target of 70% in current “ability” for all of the
applicable survey questions with the exception of “Design systems, components, or processes to meet needs” in which they scored themselves an average of 68%. The fact that the graduates rated themselves well above the target in terms of preparation provided by the program for this latter question indicates the challenges faced by our graduates once they join the Navy and Marine Corps. Most spend the first 3-5 years of their career in operational, warfighting roles that do not necessarily reinforce their engineering background. This, combined with often geographically remote assignments, often makes it difficult for them to sustain their level of engineering expertise. We continue, though, to respond to these indicators and attempt to meet our desired objectives in all areas.

As noted in Criterion 3, PEO #1 ties to student outcomes (a), (b), (c), (e), (h), and (k). The response in question is specifically related to both outcome (c) and outcome (e). Substantial changes to the capstone design sequence in recent years have resulted in improvements in this area but we are still working to produce the desired results in outcome (e) at graduation. Additional details can be found in the appropriate student outcome summaries in Section B and the full write-ups in Appendix E.

PEO #2: Are able to work independently and with others, effectively using oral and written communication skills.

Assessment Results: The following are the mean values of the responses for the survey questions related to PEO #2.

<table>
<thead>
<tr>
<th>Survey Question</th>
<th>Preparation</th>
<th>Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Prepare reports and documents</td>
<td>3.95 (79%)</td>
<td>4.29 (86%)</td>
</tr>
<tr>
<td>12. Prepare and deliver professional presentations</td>
<td>3.86 (77%)</td>
<td>3.90 (78%)</td>
</tr>
<tr>
<td>13. Function on multi-disciplinary teams</td>
<td>3.62 (72%)</td>
<td>3.30 (66%)</td>
</tr>
<tr>
<td>18. Think and learn independently</td>
<td>3.95 (79%)</td>
<td>3.95 (79%)</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>77%</strong></td>
<td><strong>77%</strong></td>
</tr>
</tbody>
</table>

Evaluation and Actions: 2012 Graduate Survey responses indicate that our graduates our currently attaining the 70% target for this program educational objective. The overall “preparation” average was 77% and respondents scored themselves above the target of 70% in “preparation” for all of the applicable survey questions. The overall “ability” average was also 77% and the respondents scored themselves above the target of 70% in current “ability” for all of the applicable survey questions with the exception of “Function on multi-disciplinary teams” in which they scored themselves an average of 66%. Given the make-up of today’s military, this latter finding is somewhat surprising but may speak to the fact that our graduates do not consider their military teams as multi-disciplinary.

As noted in Criterion 3, PEO #2 ties to student outcomes (c), (d), and (g). This particular question is directly related to outcome (d). The results align with the outcome (d) results (included in Section B of this criterion) which indicate that until a recently instituted change, the timetable of our senior design sequence put it out of alignment with that of other departments which limited the number of multi-disciplinary projects our students could be engaged in. Once this was corrected, our outcome champion saw a rise in the accompanying performance indicator and in the attainment of his outcome. We anticipate that this performance improvement will also
be seen in the next alumni survey. More details on this can be found in the outcome (d) summary in Section B and the full write-up in Appendix E.

**PEO #3**: Recognize the need to continually update their knowledge and skills and are engaged in life-long learning.

**Assessment Results**: The following are the mean values of the responses for the survey questions related to PEO #3.

<table>
<thead>
<tr>
<th>Survey Question</th>
<th>Preparation</th>
<th>Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Stay current in technologies related to my major</td>
<td>3.38 (68%)</td>
<td>3.62 (72%)</td>
</tr>
<tr>
<td>15. Recognize the need for life-long learning</td>
<td>3.90 (78%)</td>
<td>3.95 (79%)</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>73%</strong></td>
<td><strong>76%</strong></td>
</tr>
</tbody>
</table>

81% of the Electrical Engineering graduates indicated that they planned to pursue additional education at the graduate level. 29% of the graduates that responded to the survey indicated that they had completed some graduate level work. 19% indicated that they had acquired a Master of Science degree. None had progressed beyond the master’s level.

**Evaluation and Actions**: 2012 Graduate Survey “ability & preparation” responses indicate that our graduates our currently attaining the 70% target for this program educational objective. The overall “preparation” average was 70% and the respondents scored themselves above the target of 70% in “preparation” for the survey question “Recognize the need for life-long learning” but only 68% for the survey question “Stay current in technologies related to my major.” The overall “ability” average was 76% and the respondents scored themselves above the target of 70% in current “ability” for all of the applicable survey questions.

As noted in Criterion 3, PEO #3 ties to student outcomes (c), (i), (j) and (k). This particular question is directly related to outcomes (i) and (j). Seeking to improve student attainment of these outcomes, the outcome champions combined to introduce the concept of “ECE in the News” assignments in the introductory courses. Initial results of these initiatives have been positive and we anticipate that they will also be reflected in the next alumni survey. More details on this can be found in the outcome (i) and (j) summaries in Section B and the full write-ups in Appendix E.

**PEO #4**: Know and practice their ethical and professional responsibilities as embodied in the United States Navy core values.

**Assessment Results**: The following are the mean values of the responses for the survey questions related to PEO #4.

<table>
<thead>
<tr>
<th>Survey Question</th>
<th>Preparation</th>
<th>Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>14. Understand ethical and professional responsibility</td>
<td>4.29 (86%)</td>
<td>3.35 (67%)</td>
</tr>
<tr>
<td>19. Practice sound judgment</td>
<td>3.95 (79%)</td>
<td>3.95 (79%)</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>82%</strong></td>
<td><strong>73%</strong></td>
</tr>
</tbody>
</table>
**Evaluation and Actions:** 2012 Graduate Survey responses indicate that our graduates are currently attaining the 70% target for this program educational objective. The overall “preparation” average was 82% and the respondents scored themselves above the target of 70% in preparation for all of the applicable survey questions. The overall “ability” average was 73% and the respondents scored themselves above the target of 70% in current ability for the survey question “Practice sound judgment” but only 67% for the survey question “Understand ethical and professional responsibility.” This result is somewhat surprising given the nature of our institution, but likely reflects not “ethical and professional responsibility” as whole but rather as it pertains to engineering work. Interestingly, the “preparation” response for this question was exceptionally high (86%).

As noted in Criterion 3, PEO #4 ties to student outcomes (c), (f), and (h). This particular question is directly related to outcomes (f) and (h). Our student outcome champions recognized this trend several years ago based on student performance within the program and have already put into place a number of changes in the curriculum that should be reflected in the next alumni survey. These include the introduction of a number of engineering case studies throughout the program and the use of the Engineering and Science Issues Test (ESIT) to evaluate the students. Again, initial results of these initiatives have been positive and we anticipate that they will also be reflected in the next alumni survey. More details on this can be found in the outcome (f) and (h) summaries in Section B and the full write-ups in Appendix E.

5. *How the results are documented and maintained.*

The results from the assessment of our program educational objectives are maintained both electronically and in hardcopy form. This material includes the data from the survey as well as the evaluation and proposed actions. These results are briefed to the department during a regularly scheduled monthly department meeting and are included in the program’s annual assessment report to the Academic Dean. The actions, when they involve a curriculum change, are also recorded in the minutes of the department’s Curriculum Committee.

**B. Student Outcomes**

It is recommended that this section include (a table may be used to present this information):

1. A listing and description of the assessment processes used to gather the data upon which the evaluation of each student outcome is based. Examples of data collection processes may include, but are not limited to, specific exam questions, student portfolios, internally developed assessment exams, senior project presentations, nationally-normed exams, oral exams, focus groups, industrial advisory committee meetings, or other processes that are relevant and appropriate to the program.

2. The frequency with which these assessment processes are carried out

3. The expected level of attainment for each of the student outcomes

4. Summaries of the results of the evaluation process and an analysis illustrating the extent to which each of the student outcomes is being attained

5. How the results are documented and maintained

In this section, we begin by providing an overview of the process by which the department assesses, evaluates and takes action on our students’ progress towards attainment of our student outcomes. We then provide detailed reports for each of the student outcomes (a) through (k).
Overview of departmental student outcome assessment process

The Electrical and Computer Engineering (ECE) Department continuous program improvement process is student outcome-centered with an emphasis on closing the “assessment-evaluation-action” loop. Our process contains a program-level Assessment and Evaluation loop and a supporting course-level Assessment and Evaluation loop as shown in Figure 4-1. This continuous program improvement process is successful because program changes are driven by the assessment and evaluation of our students’ attainment of the individual outcomes provided in Criterion 3. It is facilitated by the close coordination between student outcome champions and course coordinators which links the program and course improvement loops of Figure 4-1.

Outcome champions are individuals that are charged with the assessment and evaluation of a single outcome; this provides reasonable workload levels and promotes ownership in the continuous program improvement process and its accomplishments. These champions are clustered together in outcome groups to leverage similarities in educational strategies and assessment methods as well as to establish a synergistic assessment environment. The student outcomes are grouped as follows (additional detail on our assessment organization is provided in Criterion 6, Section E):

- Outcome Group (a), (b), (k) – Student outcomes (a), (b), (k)
- Outcome Group (c), (d), (e), (g) – Student outcomes (c), (d), (e), (g)
- Outcome Group (f), (h), (i), (j) – Student outcomes (f), (h), (i), (j)

Course coordinators are responsible for the execution of individual courses and charged with the assessment and evaluation of that course. Each course taught in the department has an assigned coordinator.
The identification of performance indicators, assessment methods as well as the subsequent evaluation and actions are guided in part by the Program Assessment and Evaluation Matrix presented in Figure 4-2. This matrix was the primary means by which outcome champions initially defined the assessment process that has been used in the department. Each outcome champion created a strategy for promoting, assessing and evaluating their outcome by answering the questions in each column. In the matrix, the performance criteria (also called performance indicators) can be used as metrics for outcome attainment. The implementation strategy designates program activities that should support the performance indicators and leads to an effective educational strategy for the students’ attainment of each outcome. Assessment methods are then identified and an assessment timeline is formulated. The outcome champions are encouraged to identify, where possible, a minimum of three assessment methods per performance indicator with at least one being a direct assessment method. The assessment timeline is at the discretion of the outcome champion, but should conform to a cycle of no greater than three years. The feedback discussion ensures that the focus remains on “closing the loop” for program improvement. This full cycle includes assessment (data gathering and preparation), evaluation of this data, formulation of recommended actions, and a follow-up strategy to assess and evaluate the impact of these actions (as can be seen in the “Blue & Gold” loops of Figure 4-1). While the peer-reviewed guidance of Figure 4-2 was an invaluable tool in developing our assessment program, the resulting process and timeline can be unique to each individual outcome. These are presented later in this section in a format similar to that shown by the template of Figure 4-3.
### PROGRAM ASSESSMENT AND EVALUATION MATRIX

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Performance Criteria</th>
<th>Implementation Strategy</th>
<th>Assessment</th>
<th>Evaluation</th>
<th>Logistics</th>
<th>Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>At graduation, what should your students know and be able to do? If the outcomes are met, will the objectives be met?</td>
<td>Is the performance criteria specific, clear and measurable? Is it confirmable through evidence? Outcomes may have multiple performance criteria. If all the performance criteria are met, will the outcomes be met?</td>
<td>How will the performance criteria be met? What program activities (curricular and co-curricular) help you meet each performance criteria?</td>
<td>What assessment tools will you use to collect data? How will you collect data?</td>
<td>How will you interpret and evaluate the data? How will you know that the performance criteria have been met?</td>
<td>When will you measure? How often? Who will collect and interpret the data and report the results?</td>
<td>Who needs to know the results? How can you convince them the performance criteria (and therefore outcomes and objectives) were met? How can you improve your program and your assessment process?</td>
</tr>
</tbody>
</table>

*Based on Program Assessment and Evaluation Matrix © B.M. Olds and R. L. Miller, 1999 Used with permission*

**Figure 4-2. Program Assessment and Evaluation Matrix**

**Student Outcome:**

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>Educational Strategies</th>
<th>Method(s) of Assessment</th>
<th>Where data are collected</th>
<th>Length of assessment cycle (yrs)</th>
<th>Year(s)/semester of data collection</th>
<th>Target for Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Assessment Results 20XX:**

**Evaluation and Actions 20XX:**

**Assessment Results 20XX:**

**Evaluation and Actions 20XX:**

**Figure 4-3. Template used for reporting student outcome assessment plan and activities.**

Course coordinators work closely with the outcome champions and the department’s Curriculum Committee to actualize the educational strategies of the program. The Curriculum Committee
meets monthly during the academic year to coordinate curriculum development tasks and
publishes its direction in formal minutes and electronic guidance to the course coordinators (both
of which will be available during the site visit).

Among the course coordinator’s responsibilities is the assemblage of a Course Assessment Tool
(CAT). The standard CAT template is provided in Appendix E. While individual outcome
champions are increasingly supplementing the CAT with their own assessment methods, it
continues to serve as one of the main assessment tools for the department and is the primary
mechanism for mapping the student outcomes into our curricula. In each CAT, the coordinator
develops a course-level set of objectives that is then cross-correlated with the student outcomes
via the ‘Course Objectives (CO) Relationship to Student Outcomes’ matrix. Various assessment
methods are used in the classroom to assess student attainment of the course objectives and
average scores are provided in a table that accompanies the CAT. Over time, the CAT has also
been used by the outcome champions to introduce other, outcome-specific assessment methods
(e.g. course coordinator surveys) that are discussed in more detail in the individual student
outcome reports.

The implementation of outcome groups that took place in Academic Year 2007-2008 was a
specific response to concerns about the sustainability of an assessment process that had relied
almost exclusively on the CAT. During that year, all of the outcome groups revisited the
methods for assessing their outcomes. Many of the Outcome Champions had noted that the CAT
was often ineffective in providing useful data. The goal was to determine whether the CAT
could continue to serve as an effective tool for each outcome. Much of the assessment effort
during that year focused on the time-consuming process of developing more sustainable and
more effective assessment methods and tools for each outcome. While many Outcome
Champions concluded that the CAT would still be used in some form, many concluded that other
methods would be more effective and many of the additional tools now in place are a direct
result of that effort.

Additional department assessment methods include (but are not limited to):

- Course coordinator survey – each course coordinator is asked to complete a survey
document as part of the CAT. This survey is assembled and updated as needed by the
appropriate outcome champions.

- Capstone mentor tool (also referred to as the “Faculty Survey” in some student
  outcome write-ups) – each capstone senior design mentor is asked to complete this
rubric on his/her student design students. Developed and introduced this year, this
assessment tool provides outcome champions with a direct measure of student
attainment of many of their performance indicators in the student’s final semester.
The scale used is 0-4 where 0 represents poor or unacceptable performance and 4
represents exceptional performance. A copy of the rubric is provided in Appendix E.

- Laboratory survey – students are asked for a self-evaluation, mainly in quantitative
  form, of their laboratory skills. Currently only seniors are asked to respond to this
survey upon graduation. An example of the laboratory survey is included in
Appendix E.
• Deficiency survey – designed to quantify the deficiencies regarding outcomes (a), (b), and (k). All majors courses course coordinators are asked to respond to this survey once a year. Formally titled the “We Are Deficient on Outcomes (a), (b), and (k) … Or Are We?” survey. An example of the Deficiency survey is included in Appendix E.

• Senior survey – administered online through the Blackboard system to our department’s graduating seniors. This is survey is conducted and compiled by the Assessment Chair.

• Student performance at design competitions – our students occasionally participate in regional or national engineering design competitions (e.g. Solar Splash, Microbot competition, etc.).

• Performance of Trident scholars – our department routinely has had student(s) participating in the prestigious student-research-oriented Trident Scholar program. In many aspects, the product of this program can be seen to be roughly equivalent to graduate level research.

• Documented student involvement in extra-curricular activities – we maintain a logbook of extra-curricular student activities such as IEEE events.

• Documented student research projects – our department occasionally has additional student research activity such as student participation in the Bowman Scholar program.

In accordance with the individually determined outcome assessment schedules, assessment data is gathered throughout the academic year by both outcome champions and course coordinators. This data is reviewed and analyzed by outcome champions and their associated outcome groups. Results, observations, and recommendations are periodically briefed to the department and reported annually to the Department Chair and the Assessment Chair. Specific observations and recommendations are also formally provided to the department during “kick-off” meetings prior to the start of each semester. Action items are coordinated through the Department Chair and/or the Curriculum Committee, as appropriate.

In addition to the previously-mentioned CAT, course coordinators complete a course report that includes a course syllabus, learning objectives, course policy statement, course website, lab/project assignments, exams, samples of student work and recommendations for course improvements. Course coordinators also consider pertinent outcome champion recommendations and Curriculum Committee direction (which are summarized electronically for the course coordinators). These tasks are outlined in the department’s Course Coordinator Checklist (provided in Appendix E). In addition, each month two to three course coordinators present briefings at the department meeting, making use of the course assessment tool to update

35 Academic Dean & Provost Instruction 1531.68, Academic Dean & Provost Notice 1531
36 Academic Dean & Provost Notice 1531
the faculty on changes that may have taken place since the last briefing. All program elective courses are briefed at least once every two years while required courses are briefed every year. When taken in aggregate, these course coordinator functions educate the faculty on course offerings, encourage accountability, and facilitate the liaison between outcome champions and course coordinators.

The program improvement process within the department remains a “living, breathing process” that reflects the changing needs of our program, our outcome champions, and our course coordinators. The flexibility in this approach maintains faculty engagement since their concerns and recommendations often form the basis of process modification. For example, the outcome champions found that the initial CAT format lacked sufficient actionable data. The CAT was revised and subsequent feedback was positive. The responsibility and control delegated to outcome champions keeps the assessment process dynamic and enables rapid adaptation of faculty input. In a similar manner, our process also responds to externally-provided feedback from such sources as:

- The institution-wide Assessment Committee review of the department’s annual assessment report for the Academic Dean.
- Examination by our external visiting committee – this formal review takes place roughly mid-way through our accreditation cycle and serves as an internal evaluation; last completed in the spring of 2009.
- Routine participation in the cyclical ABET Accreditation process and its associated informational forums.

As an externally-driven example, in the summer of 2011, the Electrical Engineering student outcomes were relabeled from (1) – (11) to the ABET construct of (a) – (k) and the verbiage was adjusted slightly to match verbatim the ABET published student outcomes. This action was inspired in large part by “best practices” discussed during the 2011 ABET Symposium and its associated workshops.

Documentation of the Student Outcome Assessment Process

Multiple process iterations that included extensive faculty feedback and subsequent revision resulted in the adoption of an Outcome Champion Notebook that was standardized to provide an easy, consistent format for showcasing outcome champion efforts and program improvements. Outcome group leaders brief the department leadership and provide written summary on an annual basis. This forms the foundation for the department’s annual assessment report to the Academic Dean. Outcome champions brief the department on a cycle that aligns with their assessment timeline. Finally, a presentation at the department offsite meeting each August discusses assessment progress and plans for the upcoming academic year. This documentation (including the Outcome Champion Notebooks) is not included with this self-study submission, but will be available during the subsequent site visit.

37 Academic Dean and Provost Instruction 5400.1 Annual Reporting of Assessment Progress
Ongoing Program Improvement Process Initiatives

Ongoing initiatives include the incorporation of FE Exam results into the program assessment process and a renewed emphasis on quality versus quantity. The former was partially in response to an observation made by the 2009 Visiting Committee which recommended “institutional funding and requirement for all engineering majors to take the Fundamentals of Engineering Examination before graduation.” The latter has resulted in revised educational strategies and assessment timelines across many of our outcomes. The outcome champions ensure that their performance indicators are reinforced across a number of courses, but are only assessing the student attainment of the pertinent student outcome in a select few. Details of both of these initiatives are provided in Section C of this criterion.

Individual student outcome summary reports

It is worth emphasizing again that while the standards and process described above are maintained across all of the student outcomes, the assessment methods and timeline for each outcome is intentionally left to the discretion of the individual outcome champions. Our experience is that this flexibility promotes ownership and produces a process that is specifically and effectively tailored to the needs of each of the individual student outcomes.

We now provide a summary of the individual student outcome write-ups for student outcomes (a) through (k) of Criterion 3. These summaries are intended to be brief and focus largely on the recent assessment cycle and results. Where applicable, they include preliminary results using the newly developed Capstone Mentor Tool. The full write-ups are included in Appendix E. These full write-ups provide additional detail (including the full process table of Figure 4-3 for each outcome), supporting documentation as appropriate, and illustrate the continuous improvement process across multiple assessment cycles.

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38 Program Review Board Comments, 2009 External Visiting Committee
Student Outcome (a): An ability to apply knowledge of mathematics, science, and engineering

- Overview: Electrical Engineering students are marginally attaining this outcome. Our target of 90% is ambitious and results through the 2010-2011 cycle indicate approximately 79% of the students are achieving this. The initial Capstone Mentor Tool results do indicate though that the percentage of students achieving a basic level of competence in this outcome is still relatively high (generally above 90%). Basic math and troubleshooting skills are areas of concern, though. The latter is consistent with the findings of student outcomes (b) and (k). A number of initiatives have been put in place including the introduction of a new department policy restricting students to the use of FE-approved calculators only (which provide limited algebraic manipulation capabilities).

- Outcome Champion: Assistant Professor Justin Blanco

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>Method(s) of Assessment</th>
<th>Where data are collected</th>
<th>Length of assessment cycle</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Can produce engineering estimates and approximate solutions by applying basic understanding of algebraic relationships, calculus concepts, and scientific principles.</td>
<td>Faculty Survey</td>
<td>EE411, EE414, EC415</td>
<td>3 Years</td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>Student Survey</td>
<td>All seniors</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CATs</td>
<td>EE411, EE414, EC415</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Can apply fundamental engineering and logical skills in troubleshooting and debugging tasks.</td>
<td>Faculty Survey</td>
<td>EE411, EE414, EC415</td>
<td>3 Years</td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>Student Survey</td>
<td>All seniors</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CATs</td>
<td>EE411, EE414, EC415</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Can apply fundamental math and science principles in modeling or simulating electrical or computer engineering systems.</td>
<td>Faculty Survey</td>
<td>EE411, EE414, EC415</td>
<td>3 Years</td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>Student Survey</td>
<td>All seniors</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CATs</td>
<td>EE411, EE414, EC415</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Assessment Results 2010-11: A review of Course Assessment Tools (CATs) and the Deficiencies survey was conducted. Across the ten courses for which data were available (EE221, EE241, EE242, EE320, EE322, EE354, EE361, EE372, EE411, and EE414), which include sophomore through senior offerings, instructors reported on average that at least 79% (1-4 scale average = 1.550 ± 0.341) of students met course objectives related to Outcome A. In EE344 algebra skills were found to be improved, even with lower QPR students. At the same time, it was noted in EE 221 that students still rely too heavily on their calculators for basic mathematic computations. Weak calculus skills were observed in EE 372. In EE 241, students struggled less with small signal analysis for BJTs, but still with op-amp design circuits and non-ideal behavior in op-amps. In EE 361 it was found that some students learn the equations to describe the behavior of the hardware by rote, and that this sometimes leads to their inappropriate application. EE 362 students had trouble working in multiple arithmetic bases. They were required to shift frequently from binary to hexadecimal to decimal. Most ultimately found ways to manage, however. In EE 420, revisiting phasor fundamentals was painful for students as were 3-phase power formulas. In EE 426, students favored trial and error over design equations and calculations. The most widespread observation related to Outcome A, however, was a lack of fundamental troubleshooting skills among students.

Evaluation and Actions 2010-11: It was again recommended that instructors consider offering exams that prohibit the use of calculators. We also suggested several means to address poor troubleshooting skills: 1) As part of laboratory exercises, present students with circuits or pieces of code that do not function according to specification and have them investigate why; 2) Add a troubleshooting lesson into the 1st semester of the senior design course (EE411); and 3) For design projects that require building large systems, create deliverables involving smaller subsystems that require well-defined troubleshooting and validation steps for each phase. We concluded that the
only way to truly measure how well fundamental skills like troubleshooting are grasped is with a pre-test/post-test approach. EE322 uses the “Signals and Systems Concept Inventory” to determine how much improvement students have made in grasping fundamental concepts during the course. A generic troubleshooting pre-test/post-test given each year in the major would help us better track student progress in this area.

**Preliminary Assessment, Evaluation, and Actions 2012:** 2011 was the first year in which the CE major was awarded and data are now being collected that permit the quantitative distinguishing of EE and CE student performance. Pre-assessment cycle results from a newly created faculty survey (the “Capstone Mentor Tool”), broken out by performance indicator and major, are shown in the table below (remember that 0 represents poor performance while 4 is extremely good performance in an area). The mean outcome (a) score (average of the individual performance indicator scores) was 2.53/4.00 for EE majors and 3.08/4.00 for CE majors, suggesting a potential gap in performance between students in the two major tracks, with CE students outperforming EE students on all indicators for the outcome. Linearly mapping these preliminary averages to percentages gives an outcome A achievement score of 60.6% for EE students and 71.6% for CE students, below the overall 90% target for performance for the outcome (see detail in Appendix E). If we use a minimum expected level of attainment on the Capstone Mentor Tool of 2.0 (this in general equates to demonstrated basic ability but with significant room for improvement – question-specific detail can be found in the rubric used for the Capstone Mentor Tool which can be found in Appendix E), we see in the table below the percentage of students attaining this basic level of competence. Again, we see the shortfall in the student’s ability to perform troubleshooting and debugging tasks. Whether these early trends, including the gap in performance between EE and CE students are statistically significant will be clear by the next assessment cycle, at which point a more detailed evaluation of results will be carried out and corresponding recommendations for action made.

Action has recently been taken on the FE-approved calculator initiative. Following the student outcome briefings during the June 2012 Department Meeting and upon the recommendation of the outcome (a) champion, a motion was raised to limit electrical and computer engineering student use of calculators to only FE-approved calculators throughout the electrical and computer engineering curriculums. The course coordinators that had tried this during the fall and spring semesters related their experiences and the department voted. The motion was passed and the Department Chair subsequently signed into effect the departmental notice (ECEDEPTNOTE 100 ECE Departmental Policy on Calculators) which can be found in Appendix F. Assessment will be conducted over the next several cycles to determine the effectiveness of this initiative.

<table>
<thead>
<tr>
<th>Performance Indicator</th>
<th>Minimum expected level of attainment</th>
<th>Students attaining this minimum level</th>
<th>Electrical Engineering Student Average (0-4 scale, n=22)</th>
<th>Computer Engineering Student Average (0-4 scale, n=22)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student’s ability to produce engineering estimates and approximate solutions by applying understanding of algebraic relationships, calculus concepts, and scientific principles</td>
<td>2.0</td>
<td>EE: 21/22 (95%) CE: 14/15 (93%)</td>
<td>2.71</td>
<td>2.97</td>
</tr>
<tr>
<td>Student’s ability to fundamental engineering and logical skills in troubleshooting and debugging tasks.</td>
<td>2.0</td>
<td>EE: 16/22 (73%) CE: 15/15 (100%)</td>
<td>2.55</td>
<td>3.13</td>
</tr>
<tr>
<td>Student’s ability to apply fundamental math and science principles in modeling or simulating electrical or computer engineering systems.</td>
<td>2.0</td>
<td>EE: 20/22 (91%) CE: 15/15 (100%)</td>
<td>2.32</td>
<td>3.13</td>
</tr>
</tbody>
</table>
**Student Outcome (b):** An ability to design and conduct experiments, as well as to analyze and interpret data.

- **Overview:** Electrical Engineering students are marginally attaining this outcome although there are concerns in the students’ ability to perform troubleshooting. This is consistent with the findings of student outcomes (a) and (k). Preliminary results differentiating electrical and computer engineering students seem to indicate that the electrical engineering students are performing lower across the board. For the recent Capstone Mentor Tool data, more than 70% of the students are attaining a basic level of competence in this outcome (with the exception of one indicator). Actions that have been put into place and are being evaluated include an increase in the percentage of the final course grade that depends on laboratory work as well as the introduction of additional laboratory practical examinations and laboratory quizzes.

- **Outcome Champion:** CDR Chas Hewgley, USN

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>Method(s) of Assessment</th>
<th>Where data are collected</th>
<th>Length of assessment cycle</th>
<th>Target (in development)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Develop a hardware test plan to verify a hypothesis or validate a design</td>
<td>Deficiency survey</td>
<td>EE414, EC415</td>
<td>3 years</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td>EE414, EC415 project gradesheet</td>
<td>EE414, EC415</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>student survey</td>
<td>Blackboard online system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Use simulation to develop models of engineering processes or circuits</td>
<td>Deficiency survey</td>
<td>EE414, EC415</td>
<td>3 years</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td>EE414, EC415 project gradesheet</td>
<td>EE414, EC415</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>student survey</td>
<td>Blackboard online system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Use test equipment to locate and correct hardware errors and collect experimental data</td>
<td>Deficiency survey</td>
<td>EE414, EC415</td>
<td>3 years</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td>EE414, EC415 project gradesheet</td>
<td>EE414, EC415</td>
<td></td>
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<tr>
<td></td>
<td>student survey</td>
<td>Blackboard online system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Interpret or verify the hardware or software data using engineering analysis and theory</td>
<td>Deficiency survey</td>
<td>EE414, EC415</td>
<td>3 years</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td>EE414, EC415 project gradesheet</td>
<td>EE414, EC415</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>student survey</td>
<td>Blackboard online system</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Assessment Results 2009-2011:** Until recently, the educational strategy and assessment method in use for this student outcome followed the “all classes, all the time” approach. Assessment data were gathered at the conclusion of each majors course in Electrical Engineering and Computer Engineering using several methods. The Course Assessment Tool is a form completed by the Course Coordinator, and contains broad questions spanning all student outcomes. The Deficiency survey is also completed by the course coordinator, but is specific to student outcomes (a), (b), and (k). Also, student surveys were distributed that contained questions for the students concerning their perceived level of proficiency in a laboratory setting.

**Evaluation and Actions 2009-2011:** The data collected during these years were analyzed rather qualitatively; however, several process improvements were implemented based on the findings during these years. The chief issue identified through the assessment process was a weakness on the part of the students to diagnose and correct errors in hardware or equipment setup – internal discussions of this issue label this the “debugging” or “troubleshooting” issue. The assessment method that most clearly highlights this issue is the student survey. Statements such as “if my circuit doesn't work the first time, then I'm pretty much lost” have spurred the outcome group to consider ways of incorporating formal instruction in troubleshooting methods into the curriculum. The course and form for this additional topic is still being considered; however, the concrete steps that have been taken to improve these lab skills
include: increasing the percentage of the final course grade that depends on laboratory work, including laboratory practical examination in courses, and including laboratory quizzes.

**Preliminary Assessment, Evaluation, and Actions 2012:** In November, 2011, it was decided to make changes in the performance indicators, educational strategies, and methods of assessment. One of the main reasons for this change was that under the “all courses, all the time” assessment system, much more data was being collected that could be effectively analyzed. Several cycles of student and instructor surveys were collected, but we found it difficult to manage the volume of data. The assessment process was quickly becoming increasingly time-intensive and unsustainable. Accordingly, it was decided to try more specific means. It was decided that lab practices and techniques should be introduced in the majors courses that are common to both electrical engineering and computer engineering majors in their third-class (sophomore) year. These courses are EE221 (basic circuits), EE241 (electronics), and EC262 (digital logic). These laboratory techniques and procedures will be reinforced in the courses that are common to both electrical engineering and computer engineering majors in their second-class (junior) year. These courses are EE322 (signals and systems), EE354 (communications systems), and EC361 (microprocessor-based design). The assessment for laboratory techniques and procedures will occur during the first-class (senior) year, when the students are required to put their laboratory skills to use as part of the capstone design class. The student surveys will still be collected online, and will span the scope the students' laboratory experience; however, the Deficiency survey (for faculty), and the project gradesheets that will be collected as part of the assessment process will be specific to the capstone design class, EE414, and EC415. Currently, quantitative criteria are being developed with which to analyze survey and gradesheet results. These criteria will take the form of “rubrics”.

Even though the planned assessment for this student outcome is not scheduled to occur until 2013, due to the introduction of the new Senior Mentor Tool with the capability to separate data by Electrical Engineering and Computer Engineering majors, an opportunity presented itself to take a very preliminary look at some of the data. If we use a minimum expected level of attainment on the Capstone Mentor Tool of 2.0 (this in general equates to demonstrated basic ability but with significant room for improvement – question-specific detail can be found in the rubric used for the Capstone Mentor Tool which can be found in Appendix E), we see in the table below the percentage of students attaining this basic level of competence. It bears further attention that the scores of the Computer Engineering majors were uniformly higher than those of the Electrical Engineering majors.

<table>
<thead>
<tr>
<th>Minimum expected level of attainment</th>
<th>Students attaining this minimum level</th>
<th>Electrical Engineering Students (avg. with scale 0-4)</th>
<th>Computer Engineering Students (avg. with scale 0-4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student's ability to apply fundamental engineering and logical skills in troubleshooting and debugging tasks.</td>
<td>2.0 EE: 16/22 (73%) CE: 15/15 (100%)</td>
<td>2.43</td>
<td>3.13</td>
</tr>
<tr>
<td>Student's use of modern prototyping and debugging skills of electrical or computer engineering problems.</td>
<td>2.0 EE: 16/22 (73%) CE: 14/15 (93%)</td>
<td>2.38</td>
<td>3.13</td>
</tr>
<tr>
<td>Student's use of simulation to develop models of engineering processes or circuits.</td>
<td>2.0 EE: 16/21 (76%) CE: 13/15 (87%)</td>
<td>2.44</td>
<td>2.97</td>
</tr>
<tr>
<td>Student's ability to develop a hardware test plan to verify a hypothesis or validate a design.</td>
<td>2.0 EE: 15/22 (68%) CE: 13/15 (87%)</td>
<td>2.41</td>
<td>2.73</td>
</tr>
<tr>
<td>Student's use of test equipment to locate and correct hardware errors and collect experimental data.</td>
<td>2.0 EE: 20/22 (91%) CE: 14/14 (100%)</td>
<td>2.68</td>
<td>2.75</td>
</tr>
<tr>
<td>Student's ability to verify data using engineering analysis and theory.</td>
<td>2.0 EE: 18/22 (82%) CE: 13/14 (93%)</td>
<td>2.49</td>
<td>3.08</td>
</tr>
</tbody>
</table>
Student Outcome (c): An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

- Overview: Electrical Engineering students are attaining this outcome. Preliminary results differentiating electrical and computer engineering students seem to indicate that the electrical engineering students are performing lower across the board, though. This requires additional data to confirm, but has the attention of the outcome champion. The outcome champion is developing a number of process changes to gain more insight into this disparity.

- Outcome Champion: Associate Professor Brian Jenkins

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>Assessment Methods</th>
<th>Where data are collected</th>
<th>Assessment cycle length</th>
<th>Target for Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Define problem, identify constraints, develop specifications</td>
<td>Mentor Evaluation</td>
<td>EE414,EC415</td>
<td>2 year</td>
<td>&gt;90% of all students meet each indicator</td>
</tr>
<tr>
<td></td>
<td>Oral Appraisal</td>
<td></td>
<td></td>
<td>All evaluation averages &lt; 2.0</td>
</tr>
<tr>
<td></td>
<td>Faculty Evaluation (CAT)</td>
<td>EC361,EE411</td>
<td></td>
<td>Scale: 1 = met</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 = partly met</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 = not met</td>
</tr>
<tr>
<td>ii) Conceptualize and analyze solutions</td>
<td>Mentor Evaluation</td>
<td>EE414,EC415</td>
<td>2 years</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oral Appraisal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Faculty Evaluation (CAT)</td>
<td>EE221/241/411,EC262/361</td>
<td></td>
<td></td>
</tr>
<tr>
<td>iii) Project management, prototype implementation, test, and debug</td>
<td>Mentor Evaluation</td>
<td>EE414,EC415</td>
<td>2 years</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oral Appraisal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Faculty Evaluation (CAT)</td>
<td>EE221/241/411,EC262/361</td>
<td></td>
<td></td>
</tr>
<tr>
<td>iv) System integration and verification</td>
<td>Mentor Evaluation</td>
<td>EE414,EC415</td>
<td>2 years</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oral Appraisal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Faculty Evaluation (CAT)</td>
<td>EC361,EE411</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Current Cycle Assessment Results (AY2010-2012): As described in the Prior Cycle Evaluation and Actions (found in the detail of Appendix E), the previous method for assessing this outcome was deemed to need improvement by the new (in fall 2009) outcome champion. The previous method did not clearly assess and document whether the design skills (i.e., performance indicators) needed for success as an electrical or computer engineer were being taught adequately throughout the curriculum. Hence, the assessment efforts for this outcome during the first few semesters of this assessment cycle were focused on defining a new method by which to assess this outcome. Note that the new assessment methods for this outcome also more effectively document the application of realistic constraints within an engineering design process (a concern that was noted at the last ABET visit).

As a result of this effort, faculty have evaluated this outcome for the previous academic year using a new Design Matrix in the CAT. Data was gathered for courses taught during the spring semester (EE241, EE411/4 and EE415), as well as for one course taught during the fall semester (EC262). In the future, data will be gathered in the CAT for the courses shown above every other year. Some of the Design Matrices from spring 2011 and fall 2011 are included in the appendix. The design skills identified in the Design Matrix map directly to the Performance Indicators shown above. Note also, as of fall 2011, student outcome 3 is now referred to as student outcome (c).

In addition, data was gathered at the end of the 1/C capstone courses in spring 2012 in two manners. The outcome champion performed an appraisal of the oral presentations given by all the 1/C students during the ECE Capstone Design Conference. In addition, the mentors evaluated each Performance Indicator and provided their feedback using the Mentor Assessment Tool (i.e., with spreadsheet entries provided by each capstone mentor for each student). The results for the oral appraisal and the mentor evaluation are included in the Outcome (c) notebook.

A tabular summary of the data from each assessment method follows. First, it is clear that the vast majority of the students do consider realistic constraints in their capstone design project. More than 90% of the graduates for both the EE and CE majors met each indicator to some degree, as desired. (The data in the upper portion of the table
reflect the number of students that fall into the identified categories.) Also, the evaluation averages for each indicator were < 2.0, as desired, for all performance indicators except for indicator iv) when assessed with the CAT, for which a score of 2.25 was measured (see data below). This implies that this indicator was only marginally met, and that student ability to perform system integration and verification needs improvement. Note that this assessment occurred before the capstone project selection process was changed to occur earlier in the program (during spring 2/C year). Assessment of this indicator during the mentor evaluation and the oral appraisal demonstrate that student ability has improved for the most recent graduating class. Further assessment cycles will be needed to verify if this trend continues.

<table>
<thead>
<tr>
<th>Performance Indicator</th>
<th>i)</th>
<th>ii)</th>
<th>iii)</th>
<th>iv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale</td>
<td>EE</td>
<td>CE</td>
<td>EE</td>
<td>CE</td>
</tr>
<tr>
<td>1.0-1.5 Students fully meeting indicator</td>
<td>9</td>
<td>7</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>1.51-2.0 Students partly meeting indicator</td>
<td>11</td>
<td>8</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>2.01-2.5 Students marginally meeting indicator</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2.51-3.0 Students not meeting indicator</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of students: evaluated/total</td>
<td>22/26</td>
<td>15/15</td>
<td>22/26</td>
<td>15/15</td>
</tr>
<tr>
<td>Mentor Evaluation Avg (1/C)</td>
<td>1.69</td>
<td>1.63</td>
<td>1.55</td>
<td>1.53</td>
</tr>
<tr>
<td>Oral Appraisal Avg (19 EE, 10 CE @ EOY)</td>
<td>1.22</td>
<td>1.3</td>
<td>1.26</td>
<td>1.3</td>
</tr>
<tr>
<td>CAT Avg (1/C – 3/C)</td>
<td>1.5 (1/C)</td>
<td>2.0 (all)</td>
<td>1.5 (all)</td>
<td>2.25 (1/C)</td>
</tr>
</tbody>
</table>

Current Cycle Evaluation and Actions (AY2010-2012): The new assessment process used for this outcome has been effective in identifying strengths and weaknesses in the design process. It is evident that the Outcome (c) is being attained based on the results. The Performance Indicators (skill set) listed above are being emphasized to some degree throughout the program, so that all students gain some exposure to all of the skills, and > 90% of the students in both majors meet each indicator to some degree. It does appear that a significant number of EE majors are struggling to meet indicator iii). This should be monitored in future assessment cycles, as it is difficult to draw conclusions based on the data collected from only one year. As data from future semesters is obtained, it should become evident how to interpret the data. Based on this evaluation, recommendations and other suggested changes to the assessment process are as follows:

- May need greater mentor involvement earlier in fall semester 1/C year to improve EE and CE student performance on indicator i)
- Must validate expected improvement in indicator iv) due to recent changes in capstone project selection process
- Continue monitoring indicator iii) in future cycles to verify if performance by EE majors is actually that much lower than CE
- Further development is needed to streamline the assessment process for this outcome (greater use of data processing tools, across multiple cycles)

Lastly, changes were made to the wording of this outcome during the summer 2011. The wording now conforms more precisely to the wording of ABET outcome (c). The Oral Appraisal assessment method was changed to account for this rewording and provided the necessary assessment data.
**Student Outcome (d): An ability to function on multidisciplinary teams.**

- **Overview:** Electrical Engineering students are attaining this outcome although preliminary results indicate that they are performing slightly below computer engineering students.
- **Outcome Champion:** CDR Hewitt Hymas, USN

### Performance Indicators Table

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>Method(s) of Assessment</th>
<th>Where data are collected</th>
<th>Length of assessment cycle</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Percent of Midshipmen Participating on Multi-Disciplinary Projects</td>
<td>Professor Evaluation</td>
<td>EE411/EE414/EC415</td>
<td>1 year</td>
<td>30-40%</td>
</tr>
<tr>
<td>2. Ability to Define Team’s Goals in a Multi-Disciplinary Environment</td>
<td>Peer Evaluation of Team Performance on Senior Project</td>
<td>EE411/EE414/EC415</td>
<td>1 year</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td>Project Mentor Evaluation</td>
<td>EE411/EE414/EC415</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Ability to Communicate with Team Members from Other Disciplines</td>
<td>Peer Evaluation of Team Performance on Senior Project</td>
<td>EE411/EE414/EC415</td>
<td>1 year</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td>Project Mentor Evaluation</td>
<td>EE411/EE414/EC415</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Ability to Participate and Contribute to Accomplishment of Team’s Goals in a Multi-Disciplinary Environment</td>
<td>Peer Evaluation of Team Performance on Senior Project</td>
<td>EE411/EE414/EC415</td>
<td>1 year</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td>Project Mentor Evaluation</td>
<td>EE411/EE414/EC415</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Supporting figures for the following assessment results can be found in the detailed write-up of Appendix E.

**Assessment Results 2009:** Based on the assessment of Academic Year 2009-2010 data, participation in multi-disciplinary projects dropped from above 30% to 18%.

**Evaluation and Actions 2009:** After some investigation it was discovered that students in other engineering departments were selecting their projects the spring semester prior to the senior year and this was preventing many of our majors from participating on other engineering department projects. To correct this, the ECE Department changed the project selection process in AY2010-11 to align with the other engineering departments.

**Second-Cycle Results 2010-2011:** Data from the AY2010-11 Academic Year was assessed indicating that participation in multi-disciplinary teams has increased and actions taken above appear to have corrected the problem. This also addressed comments made by a visiting team in 2009.

**Assessment Results 2011-2012:** More than 30% of the Midshipmen participated in multi-Disciplinary projects, which is in-line with past participation. New this year was a survey sent to graduates of the Naval Academy. When these results are compared to the same survey question included in the senior survey, we find the results are comparable with above 70% of the respondents stating they were prepared to function on a multi-disciplinary team. AY2010-11 is the first year the “agree” response was split into “strongly agree” and “agree.” Also new this year was a modification to the Senior Survey. In an effort to further assess the ability to function on a multi-disciplinary team four new questions were added, three of which assessed the Midshipmen’s opinion of their senior project team performance. 96% felt they possessed the ability to function on multi-disciplinary teams. In assessing their team’s performance, above 70% felt their team could function in a multi-disciplinary environment.
Finally, the senior project team mentors were asked to assess their team’s performance using the same questions in the Capstone Mentor Tool. The results are shown below. The following scale was used in this assessment:

- 0 – Demonstrated no ability
- 2 – Demonstrated suitable skills and abilities
- 4 – Demonstrated abilities that were commendable and should be used as an example for others

The results show that the class averages were slightly above the target of 2, with computer engineering (ECE) majors performing slightly better than electrical engineering (EEE) majors.
Student Outcome (e): An ability to identify, formulate, and solve engineering problems.

- Overview: Electrical Engineering students are marginally attaining this outcome. Our Tier 1 target is admittedly ambitious and our outcome champion’s current evaluation is that many of our students are reaching the Tier 2 level. Tier definitions can be found in the full write-up in Appendix E. Initial Capstone Mentor Tool results do indicate that in general more than 80% of the students are achieving a basic level of competence in this outcome. While data is somewhat limited for the new tier system, findings suggest that we need an improved focus on teaching the engineering problem solving process in the electrical engineering curriculum. Significant work has been done in recent years on revising and strengthening the senior capstone design experience and the outcome champion is now turning his attention to a number of courses earlier in the curriculum to further improve attainment of this outcome. In preparation for this fall’s course offerings, our outcome champion is meeting with instructors of core EEE and ECE courses (EE221, EE242, and EE322) in order to discuss methods and ideas for teaching, improving, and evaluating student’s engineering problem-solving skills.

- Outcome Champion: Assistant Professor Chris Anderson

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>Method(s) of Assessment</th>
<th>Where data are collected</th>
<th>Length of assessment cycle</th>
<th>Target for Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Recognize information given, existing parameters and definitions within the problem statement.</td>
<td>Homework</td>
<td>EE221/241/EC244</td>
<td>2 Years</td>
<td>Tier 1</td>
</tr>
<tr>
<td>2. Define end state, solution method and identify relevant equations.</td>
<td>Homework</td>
<td>EE221/241/EC244</td>
<td>2 Years</td>
<td>Tier 1</td>
</tr>
<tr>
<td>3. Communicate solution in a neat and organized logical process or method.</td>
<td>Homework</td>
<td>EE221/241/EC244</td>
<td>2 Years</td>
<td>Tier 1</td>
</tr>
</tbody>
</table>

Assessment Results AY2010-11: A more focused evaluation and analysis of ECE course CATs and Course Reports was performed, but still mainly resulted in qualitative data. The results of the data gathering can be found in the document “SPRING10 Outcome5_report.doc” which will be available during the site visit. The result of our evaluation can be found in the document “Academic Year 2011 Outcome 5 Wrapup.doc” which will be available during the site visit. Our assessment again generally indicated students were performing at the Tier 3 level, although we noted Tier 2 performance in Indicator 3. The techniques implemented in EE354 turned out to be too much for a single course, so the decision was made to have EE354 focus on reinforcing this outcome via labs only and emphasize the other aspects in separate courses.

Evaluation and Actions AY2010-11: Even with our set of assessment criteria, we discovered that the results we collected were again qualitative in nature. As a result, we developed a quantitative rubric that we will be distributing in 2012 to course instructors so that they can assess student performance on one or more assignments during the course of the semester (discussed further below). We also presented program-level recommendations to our Outcome Group and initiated discussion within the group on how best to teach rigorous problem-solving skills within the department. As a result, we will be providing examples of Tier 1 Homework and Labs to instructors that
teach and reinforce this outcome, and will formulate a plan with each instructor on how best to emphasize this outcome in their course.

Our Engineering Problem-Solving Assessment Rubric was developed and will be used by us to assess students’ mastery of the engineering problem solving process, which is different from the design process, laboratory troubleshooting process, or problem-solving product. Essentially, we break the problem-solving process down into five major categories: Problem Identification, Engineering Formulation, Mathematical Calculations, Logical Progression, and proper use of supporting Figures and Graphs. Subsets of each of these are used to determine student performance on each of our specific performance indicators; taken as a whole, they indicate overall student mastery of our outcome. Course coordinators where our outcome is assessed are instructed to select one type of problem (whether homework, lab, or exam), and assess each individual student’s performance under each category of our rubric. The results are then averaged together for each specific problem-solving category, subset of categories, and rubric as a whole. These results are then used to determine what Tier Level students are performing at according to our “ABET Outcome (e) Performance Targets” summary document. The Student Outcome (e) Assessment Rubric, the Student Outcome (e) Assignment Assessment, the Student Outcome (e) Targets, and Student Outcome (e) Performance Measurement Assignments can all be found in the Outcome (e) supporting material in Appendix E.

**Third-Cycle Results 2012:** For 2012, three quantitative assessment tools were used to evaluate student attainment of Outcome (e): the Engineering Problem-Solving Assessment Rubric was used to evaluate 2/C student performance on an EE354 Exam 2 question (where the question was designed in part to evaluate their attainment of Outcome (e)), the Capstone Mentor Tool (accessed on 16 June 2012), used to assess 1/C student performance on aspects of Outcome (e) over the duration of their Senior Design experience, and the EEE and ECE Graduating Senior Survey. The summary results are as follows, and raw data can be found in the J: drive assessment folder (an archive of the EE354 assessment can be found under J: Assessment/Outcome Group - c, d, e, g (3, 4, 5, 7)/Outcome e (5)/AY2012 Raw Data which will be available during the site visit). Note that the table provides average performance for each program (EEE and ECE) in addition to which Outcome (e) Performance Tier (Tier 1, Tier 2, and Tier 3) categorized the student performance. In this table, the higher the score, the better the student performance. Conversely, the lower the Tier, the better the performance.

<table>
<thead>
<tr>
<th>Outcome (e) Problem-Solving Category</th>
<th>EE354 Exam Rubric Scale 1-4</th>
<th>Capstone Mentor Tool Rubric Scale 0-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program</td>
<td>EEE</td>
<td>ECE</td>
</tr>
<tr>
<td>Problem Identification</td>
<td>2.71 (T2)</td>
<td>2.50 (T2)</td>
</tr>
<tr>
<td>Engineering Formulation</td>
<td>2.57 (T2)</td>
<td>2.25 (T3)</td>
</tr>
<tr>
<td>Calculations</td>
<td>2.25 (T2)</td>
<td>2.40 (T3)</td>
</tr>
<tr>
<td>Logical Progression</td>
<td>2.63 (T2)</td>
<td>2.57 (T2)</td>
</tr>
<tr>
<td>Figures and Graphs</td>
<td>2.25 (T3)*</td>
<td>2.33 (T3)*</td>
</tr>
</tbody>
</table>

* Figures were not required to solve the problem, but a proper figure greatly assisted with the Engineering Formulation.

We can get insight into the percentage of students that are attaining a basic level of competence in this outcome by taking a closer look at the Capstone Mentor Tool. In the table below, we use a minimum expected level of attainment on the Capstone Mentor Tool of 2.0. This in general equates to demonstrated basic ability but with significant room for improvement (question-specific detail can be found in the rubric used for the Capstone Mentor Tool which can be found in Appendix E).
<table>
<thead>
<tr>
<th>Student’s ability to define a technical problem (e)</th>
<th>Minimum expected level of attainment</th>
<th>Students attaining this minimum level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.0</td>
<td>EE: 19/22 (86%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CE: 13/15 (87%)</td>
</tr>
<tr>
<td>Student’s ability to formulate a well-defined end-state and developing a methodology and strategy for reaching that end-state (e)</td>
<td>2.0</td>
<td>EE: 17/22 (77%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CE: 13/15 (87%)</td>
</tr>
<tr>
<td>Student’s ability to carry out the logical progression necessary to reach an engineering problem end-state and provide meaningful documentation of the solution. (e)</td>
<td>2.0</td>
<td>EE: 20/22 (91%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CE: 15/15 (100%)</td>
</tr>
</tbody>
</table>

On the Graduating Senior Survey, the following questions related to Outcome (e) were asked:

1. "I possess an ability to identify, formulate, and solve engineering problems.": 52% Strongly Agree, 40% Agree
2. "I possess an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.": 52% Strongly Agree, 32% Agree
3. “My education has prepared me for solving real world engineering problems.”: 40% Strongly Agree, 48% Agree

While the indirect measurement indicates EEE and ECE students perceive themselves as having good engineering problem-solving skills, the two direct measurements in 2012 indicate that EEE and ECE students are performing at the Tier 2/Tier 3 level. These results are consistent with our Qualitative results from AY 2009, 2010, and 2011, however, caution should be exercised in interpreting the data in that we only have two quantitative data points for our outcome.

**Evaluation and Actions 2012:** Our results indicate that engineering problem-solving is something that needs to be reinforced in both the EEE and ECE curriculum. We presented these findings at the ECE Department Meeting on 21 May 2012, and recommended meeting with instructors of core EEE and ECE courses (EE221, EE242, and EE322) in order to discuss methods and ideas for teaching, improving, and evaluating student’s engineering problem-solving skills.
**Student Outcome (f): An understanding of professional and ethical responsibility.**

- **Overview:** Electrical Engineering students are marginally attaining this outcome. The significant finding is that our students’ knowledge and use of engineering standards needs to be improved. Initial use of the Capstone Mentor Tool appears to indicate that 60-70% of the students are attaining a basic level of competence in terms of use and understanding of engineering standards and codes of ethics. Students do score well in general ethics and professional standards understanding, though, which can be seen as a product of the military officer development environment. The outcome champion is currently developing a plan of action to address this shortcoming through increased exposure to engineering standards and the IEEE Code of Ethics throughout the curriculum.

- **Outcome Champion:** LCDR C. J. Flaherty, USN

### Performance Indicators

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>Method(s) of Assessment</th>
<th>Where data are collected</th>
<th>Length of assessment cycle (yrs)</th>
<th>Target for Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Seniors demonstrate an understanding of professional and ethical responsibility.</td>
<td>ESIT</td>
<td>EE411</td>
<td>Annually</td>
<td>Average ESIT N2 score of 3.5 or higher</td>
</tr>
<tr>
<td></td>
<td>Graduating Class grades in NE203- Ethics and Moral Reasoning for the Naval Leader and NL400- Law for the Junior Officer.</td>
<td>Course grades as documented in MIDS</td>
<td>Annually</td>
<td>Students achieve an average grade of B or better.</td>
</tr>
<tr>
<td></td>
<td>Graduating Senior Survey: seniors believe that their education has provided them with an understanding of professional and ethical responsibility.</td>
<td>EE414/EC415</td>
<td>Annually</td>
<td>80% or more graduating Seniors respond “Agree” or “Strongly Agree” to those questions related to an understanding of professional and ethical responsibility</td>
</tr>
<tr>
<td>2. Students provide thoughtful and well-reasoned responses to case studies intended to spur critical thinking on ethics and professional responsibility.</td>
<td>Capstone Mentor Survey</td>
<td>EE414, EC415</td>
<td>Annually starting in 2012</td>
<td>Average rating of at least 3.0 on Outcome F entries</td>
</tr>
<tr>
<td></td>
<td>Self-study: “59-Story Crisis” and IEEE Code of Ethics</td>
<td>EE221</td>
<td>Annually</td>
<td>75% of students provide responses evaluated as “good” by faculty</td>
</tr>
<tr>
<td></td>
<td>Self-study: “Goodrich Aircraft Brake Scandal”</td>
<td>EE241</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Self-study: “Zappo”</td>
<td>EE322</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Self-study: “Incident at Morales” video and group discussion.</td>
<td>EE411</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Supporting documentation and description of all tools can be found in the detailed write-up in Appendix E.

**Assessment Results 2009-2012:** The analyzed ESIT scores which can be found in the full write-up of Appendix E indicate an increasing trend from class to class, as the use of case studies was introduced, but still show the students performing below the target of 3.5. Of interest is that the N2 score of the ECE majors of the Class of 2010, who took the ESIT without any of the engineering-specific ethics curriculum in place, is approximately the same as the pre-curriculum score for the ECE majors of the Class of 2012. Also of note is that the N2 score increased for each class in which more engineering-specific ethics curriculum was introduced. The Class of 2010 had none, the Class
of 2011 did only the “Incident at Morales” study during their senior design course, and the Class of 2012 did all of the case studies. In each case, the score increased as additional studies were added to the curriculum.

All Naval Academy students must take two core non-engineering courses relevant to Outcome F. The first course, NE203 Ethics and Moral Reasoning for the Naval Leader is “structured around classical and contemporary writing in moral philosophy.” NL400 Law for the Junior Officer “provides a broad survey of military law applicable to the junior officer.” Taken together, the two courses form a foundation for thinking about moral, ethical, and societal issues. Our assessment of these courses is to simply report the grade point averages of the Electrical Engineering and Computer Engineering students. Students average above a 3.0 in NE203 and NL400 year-after-year.

Four statements on that senior survey pertain to Outcome (f). The four statements were added to the survey starting with the Class of 2009. The tables provided in the full Appendix E write-up demonstrate that the scores have improved since 2009 and are well above the target of 80% or more of the responses to each statement be “Agree” or higher. With the exception of the Class of 2009, this goal has been met for the past three Classes.

We can look closely at the Capstone Mentor Tool, to get insight into the percentage of students that are attaining a basic level of competence in this outcome. In the table below, we use a minimum expected level of attainment on the Capstone Mentor Tool of 2.0 (this in general equates to demonstrated basic ability but with significant room for improvement). Results for the Class of 2012 (the first year the CMT was used) are shown. Results are separated by Electrical and Computer Engineering majors (EE and CE, respectively). The number in parenthesis in the table show the number of students for which results were collected. There were 26 EE students and 15 CE students subject to the survey for 2012. Students dual majoring in both EE and CE are included in both the EE and CE columns. These results indicate that 80% of the CE students are attaining a basic level of competence in this outcome but the percentage of EE students is much lower. The rather low scores may be in large part due to a deficiency in our design courses, namely a lack of emphasis on the role and use of standards.

<table>
<thead>
<tr>
<th>Item</th>
<th>Minimum expected level of attainment</th>
<th>Students attaining this minimum level</th>
<th>EE Average</th>
<th>CE Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student is aware of the IEE code of ethics</td>
<td>2.0</td>
<td>EE: 9/15 (60%) CE: 4/5 (80%)</td>
<td>1.6 (15)</td>
<td>2 (5)</td>
</tr>
<tr>
<td>Does the student consider the IEE code of ethics when making technical decisions</td>
<td>2.0</td>
<td>EE: 8/15 (53%) CE: 4/5 (80%)</td>
<td>1.53 (15)</td>
<td>2 (5)</td>
</tr>
<tr>
<td>Student is aware of engineering standards that might apply to their problem</td>
<td>2.0</td>
<td>EE: 14/19 (74%) CE: 8/9 (89%)</td>
<td>1.95 (19)</td>
<td>2.44 (9)</td>
</tr>
<tr>
<td>Does the student consider standards when making technical decisions</td>
<td>2.0</td>
<td>EE: 13/19 (68%) CE: 8/10 (80%)</td>
<td>1.84 (19)</td>
<td>2 (10)</td>
</tr>
</tbody>
</table>

**Evaluation and Actions 2009-2012:** The target performance of achieving an average N2 score of 3.5 or higher on the ESIT is based on the current scoring data analyzed, the maximum theoretical score possible, and scoring results reported in the ESIT paper. The maximum theoretical N2 score is 6.9. In the published testing data, students with no ethics instruction experience had an average N2 score of 2.63 and students with ethics experience had an average N2 score of 3.33. The score of 3.5 was deemed a reasonable and achievable goal for students at the Naval Academy, who are generally more exposed to dealing with issues of responsibility than other college students. Although the increasing N2 score trend is encouraging, we do not yet meet the target performance score of 3.5. We are currently discussing a shift in focus for the case studies to make them more effective learning experiences and to stop attempting to use them as methods of assessment. The current target performance will be re-evaluated annually as additional data is gathered.
The case studies were originally intended to serve as both educational tool and assessment method. To support the assessment function, we had intended to develop an evaluation rubric for the assignment-based case studies (all those except for “Incident at Morales”). However, it was deemed that, with ESITs, surveys, and ethics course grade collection already in place, the addition of case studies as assessment method was overkill and unduly labor-intensive. As such the evaluation of the case studies as performance indicator was never completed and will be removed for the coming years. The current focus in regards to case studies is to enhance their educational effect by providing more feedback to the students.

The removal of case studies as performance indicator would leave this outcome with only one performance indicator. For next year, separating an understanding of professional responsibility from an understanding of ethical responsibility each into their own performance indicators will be considered. Methods of assessment more specifically applicable to professional responsibility (as opposed to professional and ethical responsibility) would then also be developed.

The target for performance in NE203 and NL400 course grades has consistently been met by ECE majors, their grades averaging 3.2 or better in these courses.

The target for performance as measured by the Senior Survey has been met for the ECE majors of the Classes of 2010 through 2012. The EE majors of the Class of 2009 did not meet the target of performance for 3 of the 4 relevant questions. This may be attributed to the increased focus in ethics instruction in the later classes.

The results of the Capstone Mentor Tool with respect to students awareness of standards and their applicability has recently (within the last few months) highlighted an important area for future adjustments to our curriculum and assessment process. Currently, engineering standards are only officially covered in the curriculum during the senior design course. The two assessment questions on the Capstone Mentor Tool relating to standards represent our first attempt to measure whether or not the students have developed an understanding of their existence and potential applicability. Our results so far indicate that they have not. A review of other student outcomes indicates that understanding of use and applicability of standards is not assessed elsewhere, although it could potentially fall under broader interpretations of Outcomes (c) and (k) as well as Outcome (f). Separating the performance indicators for Outcome (f) into those supporting an understanding of professional responsibility and those supporting an understanding of ethical responsibility would create a logical home for assessing an understanding of the use and applicability of standards in general (namely under professional responsibility). Given the low scores on our assessment in this area, it may be necessary to address standards more thoroughly throughout the Electrical and Computer Engineering curriculum by incorporating them into several other courses.
**Student Outcome (g): An ability to communicate effectively.**

- **Overview:** Electrical Engineering students are attaining this outcome although there is concern particularly with the students’ writing ability. To this end, the outcome champion is working on the introduction of formal and standardized guidelines and grading rubrics for laboratory and project reports as well as engineering notebooks throughout the curriculum.
- **Outcome Champion:** CAPT Kevin Rudd, USN, Ph.D.

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>Method(s) of Assessment</th>
<th>Where data are collected</th>
<th>Length of assessment cycle</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Able to write effectively</td>
<td>Course Coordinator analysis of graded writing assignments and project proposal</td>
<td>EE411 CAT</td>
<td>3 Years</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td>Outcome Champion analysis of student evaluations</td>
<td>EE411 Student Feedback forms.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Able to document work completely and accurately</td>
<td>Course Coordinator analysis of lab books</td>
<td>EE411 CAT, EE414/EC415 CAT</td>
<td>3 Years</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td>Course Coordinator analysis of graded project proposal</td>
<td>EE411 CAT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Able to present work to an informed audience</td>
<td>Project advisor review of project report and presentation.</td>
<td>EE414/EC415 CAT, EE414/EC415 course records.</td>
<td>3 Years</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td>Course Coordinator analysis of faculty and student presentation surveys</td>
<td>EE414/EC415 CAT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Assessment, Evaluation and Actions 2006 — 2010:** During a review of CATs for 2006 there were a number of changes recommended; most of the recommended changes were accepted with one rejection. These changes were primarily documentation-based and did not include any substantive course-change recommendations. One comment in subsequent review in 2009 highlights a deficiency in collecting student work samples; this deficiency has since been corrected. A later review in 2011 showed that there were inconsistencies in how different courses were evaluating their contribution to Student Outcome (g). Based on these evaluations we have revised the assessment and evaluation plan to focus on the senior-design capstone courses, EE411 and EE414/EC415. This change was made to allow evaluation of student culminating accomplishments in this outcome area rather than evaluating a range of assignments from earlier courses which cover different aspects of communications but do not have the uniform requirements or standards. During this period there were discussions within the group and with faculty involved in laboratory courses about developing common standards for laboratory and engineering notebooks and reports; although there was strong interest in improving the standards and rigor associated with assessing laboratory and engineering notebooks and reports, because of different expectations from both courses and instructors, no progress was made on this topic.

**Assessment Results 2011:** This cycle began assessment and evaluation using the new assessment and evaluation plan that examines students in their senior-design capstone courses. Student writing met the performance target in final work products (EE411 Course Objective 6) but slipped when students focused on project work (EE414/EC415 Course Objective 6); students did not meet the performance target for the writing assignments during the course. For those who wrote anything on the topic in their student-feedback surveys (these are archived for each faculty member), writing assignments were fairly-universally panned in student evaluations; it appeared that the general consensus was that writing was not important for a design project and should be reduced/eliminated—this position is consistent with other feedback that the only part of the course that should be kept was the design project itself, not project management or other non-project activities. Overall, documentation started off well and met the performance target (EE411 Course Objective 3) but also slipped when students focused on project work (EE414/EC415 Course Objective 1). Student presentations met the performance target (EE411 Course Objective 5 and EE414/EC415 Course Objective 7). The Capstone Mentor Tool results indicate that students barely met the
target of performance for documentation and presentation methods\textsuperscript{39} (question 19: 2.77 average), writing ability\textsuperscript{40} (question 26: 2.73 average), and presentation ability\textsuperscript{41} (question 27: 2.93 average); these values were slightly below their Electrical Engineering counterparts (3.06, 2.91, and 3.02 averages, respectively). We can also use these initial results from the Capstone Mentor Tool to get insight into the percentage of students that are attaining a basic level of competence in this outcome. In the table below, we use a minimum expected level of attainment on the Capstone Mentor Tool of 2.0. This in general equates to demonstrated basic ability but with significant room for improvement (question-specific detail can be found in the rubric used for the Capstone Mentor Tool which can be found in Appendix E).

<table>
<thead>
<tr>
<th>Minimum expected level of attainment</th>
<th>Students attaining this minimum level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student’s use of modern documentation and presentation methods for electrical or computer engineering problems.</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Student's ability to write effectively, completely, and accurately.</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Student's ability to present work effectively, completely, and accurately.</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Evaluation and Actions 2011:** Sample assignments in the EE411 CAT shows that student reports are complete and with reasonable quality indicating that students achieved appropriate writing skills; sample papers can be found in the EE411 CAT. What appears missing from the students is an understanding of the importance of the writing assignments and the specific skills that each assignment was intended to develop; going forward, all courses with writing requirements, but especially in EE411, should emphasize the relationship of writing to success in both engineering in general and the Navy or Marine Corps in particular; this change would enable the students to understand the reason behind these writing assignments. To this end, during 2012 we will revisit the question of setting formal standards for laboratory and engineering notebooks and reports which will be flexible enough to apply to all levels of courses as well as the individual preferences of course coordinators and individual instructors. Whether these standards mandate specific format requirements or are more general guidelines will depend on faculty consensus; however, the standards will include basic rubrics to standardize application of the standard to student work at all levels. Another issue is that there are currently no copies of the faculty and student presentation surveys provided in the 2011 EE414/EC415 CAT. Going forward, at a minimum, copies of these surveys for representative project presentations should be included in the CAT to document performance. To ensure that these recommendations provide sufficient information without undue complication for the Course Coordinators, there should be an out-of-cycle assessment and evaluation in 2012 so that any necessary corrections to the assessment and evaluation plan for this outcome can be made before the next scheduled assessment and evaluation in 2014.

\textsuperscript{39} Student’s use of modern documentation and presentation methods for electrical or computer engineering problems.

\textsuperscript{40} Student's ability to write effectively, completely, and accurately.

\textsuperscript{41} Student's ability to present work effectively, completely, and accurately.
**Student Outcome (h):** The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

- **Overview:** Electrical Engineering students are attaining this outcome. Of note, though, students performed below the performance targets in both the Engineering and Science Issues Test (ESIT) and Capstone Mentor Tool results. The latter is a new assessment method this year so the outcome champion plans to gather a multi-year sample set prior to taking action. In the former, students appear to be struggling with the format of the test and the outcome champion plans to lead students through the example problem included in the ESIT’s instructions.

- **Outcome Champion:** Major Chris Mayer, USAF

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>Method(s) of Assessment</th>
<th>Where data collected</th>
<th>Assessment cycle length</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sensitivity and alertness to factors affecting engineering designs.</td>
<td>ESIT</td>
<td>EE411</td>
<td>Annual</td>
<td>Class avg N2-Score ≥ 3.5</td>
</tr>
<tr>
<td></td>
<td>ESIT</td>
<td>EE411</td>
<td>Annual</td>
<td>Class avg P-Score ≥ 0.5</td>
</tr>
<tr>
<td></td>
<td>Capstone Mentor Survey</td>
<td>EE414 &amp; EC415</td>
<td>Annual</td>
<td>Average rating ≥ 3.0 on Outcome H entries</td>
</tr>
<tr>
<td>2. Engendered awareness of the role engineers play in the world and vice-versa.</td>
<td>Grades in NE203 &amp; NL400</td>
<td>Course grades from MIDS</td>
<td>Annual</td>
<td>Class average QPR of ≥ 3.0 in both NE203 and NL400</td>
</tr>
<tr>
<td></td>
<td>Senior Survey</td>
<td>End of program feedback session</td>
<td>Annual</td>
<td>≥ 80% respond “Agree” or better to statements about Outcome H</td>
</tr>
</tbody>
</table>

The details of the AY2011-12 assessment results as well as the assessment results, evaluation, and actions for prior cycles can be found in the detail of Appendix E.

**Evaluation and Actions 2012:**

*Performance Indicators (PIs)*

The PIs included in this report are, admittedly, not ideal as they were developed to fit the educational strategies and assessment tools available to us, especially those that resulting from the 2009 Outcome H plan. Now wiser, we see the potential benefits of reshaping the PIs to more specifically address Outcome H. For example, adding PIs like “The student is able to identify economic issues with an engineering solution.” and “The student can articulate the impact of changes in a design with regards to the environment.” would allow us a finer degree of resolution. Methods for assessing these new types of PIs and setting targets of performance will have to be carefully considered in terms of load on the faculty and students, impact to courses (already filled to the brim), and technique. Currently, the case studies seem the best vehicle for deploying new PIs of this type; the questions they ask could be adapted to specifically address the new PIs. This would require us to cross-link case study questions against the PIs and develop both new questions and a method to evaluate responses. More on case studies next.

*Case Studies*

The case studies were originally intended to expose the students to new ideas and encourage them to think in hopes that ESIT scores would improve between 3/C and 1/C applications. Assessing the case studies was expected to be imprecise and tedious, but it turned out to be worse than expected. We meant to develop an evaluation rubric for the assignment-based case studies (all those except for “Incident at Morales” which has a facilitated discussion).
However, the skimpy nature of many of the student responses leads us to believe that a detailed rubric would be overkill. Stepping back from that, we considered (and experimented with) evaluating the level of thought and analysis shown in the students’ responses using a simple three point scale (low, medium, high). Details on this can be found in the Outcome 8 Executive Summary for 2010-2011. However, even this level of evaluation was not satisfying.

Another problem with the short answer format is that the wide range of answers makes it difficult to evaluate responses. One idea that would fix that and remove the need for a rubric is to change the case study questions to a multiple choice format in which the choices are generated by “experts. Ultimately, it was decided to continue to give the case studies in their current format for the next couple of years at least. If the ESIT scores don’t improve as hoped, or if more data is needed, the case studies can be rethought and revamped.

There are also doubts about the usefulness of evaluating the case studies without any feedback to the students (with “Morales” being the exception). The already tight course schedules and busy daily schedules of our students makes scheduling a feedback session exceedingly difficult and adds yet another thing to busy midshipmen schedules. While one hopes that exposure to the case studies has some benefit in and of itself, a feedback session would certainly have greater impact.

Additionally, case study results need to be separated by degree program (EE and CE) in the future.

ESIT (supports PI #1)
With over 100 ESITs given thus far, we believe that the ESIT is a useful tool for Outcome H. However, we are seeing a high number of ESITs in which it appears that the student did not understand how to complete the rating and rankings. Sometimes this results in rejected ESITs (using criteria suggested by the ESIT authors). Other times it simply results in poor P-Scores and N2-Scores. Given the low numbers of students in the Department’s degree programs, this is troubling. To address this we will begin to systematically lead students through the example problem included in the ESIT’s instructions. This will ensure that they understand at least the mechanics of the exam. The added instruction must not give away, or hint at, the true nature of what the ESIT is measuring. Additionally, ESIT results need to be separated by degree program (EE and CE) in the future.

Capstone Mentor Tool (support PI #1)
The target of performance has been initially set to $\geq 3.0$. The Class of 2012 was the first and only class so far to be subjected to the tool. Of the five Outcome H items measured by the tool, only CE students met the performance target for just one item. Due to the lack of data (only one year’s worth of students) and the somewhat arbitrary 3.0 performance threshold, this metric needs to be tracked for some years before any decisions are made.

Performance in NE203 and NL400 (supports PI #2)
Performance targets are being met. We see no need to change anything about this item at this time.

Senior Survey (supports PI #2)
Performance targets being met.

Course Coordinator Surveys and Information Gleaned from Course Assessment Tools.
The Course Coordinator Surveys and information culled from the Course Assessment Tools (CATs) are, at present, our best method for determining which courses address, however minimally, Outcome H material. Survey results are being filed away for future reference, but are otherwise not being used. Looking forward, the Coordinator Surveys and CATs could form the basis for identifying opportunities to insert more Outcome H material into our courses. Perhaps a Performance Indicator and a Target for Performance could be created that challenges the Department to reach some level of Outcome H coverage in our courses (e.g., a Target of Performance might be 70% of courses spend at least an hour a semester on Outcome H topics). For the present time, we plan to keep collecting data from the Course Coordinator Surveys and the CATs. The effort is minimal and provides some data about the status of Outcome H with respect to course content. Results need to be separated by degree program (EE and CE) in the future.
**Student Outcome (i): A recognition of the need for, and an ability to engage in life-long learning.**

- **Overview:** Electrical Engineering students are attaining this outcome.
- **Outcome Champion:** Associate Professor Samara Firebaugh

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>Method(s) of Assessment</th>
<th>Where data are collected</th>
<th>Length of assessment cycle (yrs)</th>
<th>Target for Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pursuit of formal education beyond the academy.</td>
<td>Senior Survey</td>
<td>1/C spring survey</td>
<td>1 year</td>
<td>10% immediately immediately, 50% eventually</td>
</tr>
<tr>
<td></td>
<td>Graduate Survey</td>
<td>Survey administered by Division</td>
<td>3 years</td>
<td>25%</td>
</tr>
<tr>
<td>2. Demonstration of the ability to independently learn a technical subject through self-study.</td>
<td>CATs</td>
<td>Filled out by course coordinators at end of each semester</td>
<td>1 year</td>
<td>80% on relevant course objectives</td>
</tr>
<tr>
<td></td>
<td>Independent Study Notebook</td>
<td>Filled out by project mentors for EE49X</td>
<td>1 year</td>
<td>10% of class involved</td>
</tr>
<tr>
<td></td>
<td>Senior Survey</td>
<td>1/C spring survey</td>
<td>1 year</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td>Capstone Mentor Survey</td>
<td>Survey of capstone/ independent study mentors in Spring</td>
<td>1 year</td>
<td>&gt;3.0 average (on scale of 0-4)</td>
</tr>
<tr>
<td>3. Awareness of cutting edge technology and research.</td>
<td>CATs</td>
<td>Filled out by course coordinators at end of each semester</td>
<td>1 year</td>
<td>80% on relevant course objectives</td>
</tr>
<tr>
<td></td>
<td>Independent Study Notebook</td>
<td>Filled out by project mentors.</td>
<td>1 year</td>
<td>10% of class involved</td>
</tr>
<tr>
<td>4. Demonstration of intellectual curiosity.</td>
<td>Capstone Mentor Survey</td>
<td>Collected from capstone/ independent study mentors in Spring</td>
<td>1 year</td>
<td>&gt;3.0 average (on scale of 0-4)</td>
</tr>
<tr>
<td></td>
<td>Senior Survey</td>
<td>1/C spring survey</td>
<td>1 year</td>
<td>&gt;80%</td>
</tr>
</tbody>
</table>

**Evaluation and Actions 2007-2010:**
The rate at which our students went on to graduate school was considered satisfactory—there are restrictions for the number of graduates from USNA who are eligible to go immediately to graduate school due to service requirements, and our majors are disproportionately well-represented among the students who are permitted to attend. Furthermore, the high self-reported rate of intent to eventually continue formalized schooling is excellent. In contrast, the intellectual curiosity and independent study skills survey results were below our targets, so we focused our efforts on improving these areas.

Our main strategy was to increase the extent of project-based-learning in our curriculum. Open-ended projects were added to and expanded in courses throughout the curriculum—the robot project in EE221 and EC262, the design project in EC262, the Altoid-tin electronics project in EE241, the PIC design project in EC361, projects in major electives like EE426. Capstone was renovated to push project selection up into the 2/C Spring—allowing more time for project development. Project options were updated by reaching out to the technological community for ideas.
We also made smaller changes, such as requiring the EE News assignment as part of the introductory courses, which requires students to survey popular science literature and report on an advance related to electrical engineering that interests them. Also, all capstone students were required to locate technical articles via a reference database such as INSPEC or IEEE Explore so that they would learn these tools. We also continued to support midshipmen seeking to pursue independent study projects, but made no new initiatives to increase independent study participation.

Assessment Results 2011/2012:

Senior Survey Results:
- 5/29 (17%) were planning to go immediately to graduate school
- 28/29 (97%) plan to eventually go to graduate school
- 27/29 (93%) agree with “My education has increased my ability to independently learn a new subject from self-study”
- 25/29 (86%) agree with “My education has increased my intellectual curiosity.”

There were 25 EEE majors and 12 ECE majors in the Class of 2011—their survey results were not differentiated. The 78% survey completion rate was better than in prior years.

Graduate Survey Results (2012):
- 21/21 (100%) said that they recognize the importance of lifelong learning.
- 14/21 (67%) said that they were “quite well” or “very well” prepared by their education for independently learning a subject through self-study. An additional 5/21 (23%) said that they were “adequately” prepared.
- 6/21 (28.5%) had continued their education beyond USNA, 17/21 (81%) intended to continue it further.

CAT results:
- 7/17 course coordinators report that “current issues and need for lifelong learning introduced through anecdotal comments during lecture.”
- 5/17 course coordinators report that “students complete at least one assignment that requires them to investigate current issues or use popular media sources.”
- 1/17 course coordinators took their class to a research conference.
- 3/17 course coordinators brought in outside speakers.
- 8/17 course coordinators report that “students complete one or more projects that require them to work independently, identify and locate resources and teach themselves a new topic.
- 7/17 course coordinators assert that “the course emphasizes emerging technologies and therefore inherently demonstrates how technology evolves and the need for lifelong learning.”

Project Notebook results: The number of independent study students per year remained fairly constant at 2-4 students per year. We had three students pursuing independent study in the class of 2011—one Trident scholar and two Bowman scholars.

Mentor Assessment Tool results:
- For EEE
  - Intellectual curiosity rating of 2.7/4 with 22 students evaluated
  - Ability to independently acquire knowledge rated at 2.5/4 with 22 students evaluated
- For ECE
  - Intellectual curiosity rating of 3.2/4 with 15 students evaluated
  - Ability to independently acquire knowledge rated at 3.2/4 with 15 students evaluated

Evaluation and Actions 2011/2012:

Our rates for students going on to graduate school continue to be satisfactory, particularly given the limitations placed by the institution on students pursuing immediate graduate work. There is clear improvement in the students self-expression of intellectual curiosity and self-identification of the ability to learn independently. However, self-assessment of the latter measure is suspect. In 2012 we implemented an additional assessment tool that will ask faculty to assess the intellectual curiosity and independent learning skills of our graduating 1/C. The results of this tool indicate that we are slightly below target for intellectual curiosity and ability to independently acquire knowledge for the EEE majors and slightly above our target for ECE majors. More time and data is required to establish a trend.
Student Outcome (j): Upon graduation students will have a knowledge of contemporary issues.

- Overview: Electrical Engineering students are attaining this outcome.
- Outcome Champion: Assistant Professor Hau Ngo

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>Method(s) of Assessment</th>
<th>Where data are collected</th>
<th>Length of assessment cycle (yrs)</th>
<th>Target for Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Demonstrates the awareness of major issues facing the country and the world.</td>
<td>Extracurricular activity notebook and Forrestal lecture series</td>
<td>Filled out by speaker or field trip sponsor</td>
<td>1 year</td>
<td>25% of class involved</td>
</tr>
<tr>
<td>1/C survey</td>
<td>Filled out by 1/C midshipmen in Spring</td>
<td>1 year</td>
<td>80%</td>
<td></td>
</tr>
<tr>
<td>2. Demonstrates ability to discuss new and novel issues related to field of study.</td>
<td>CATs</td>
<td>Filled out by course coordinators</td>
<td>1 year</td>
<td>70% of relevant course objectives</td>
</tr>
<tr>
<td>1/C survey</td>
<td>Filled out by 1/C midshipmen in Spring</td>
<td>1 year</td>
<td>80%</td>
<td></td>
</tr>
<tr>
<td>Graduate survey</td>
<td>Administered by division</td>
<td>3 years</td>
<td>80%</td>
<td></td>
</tr>
<tr>
<td>3. Demonstrates the ability to formulate an engineering solution through self learning of current developments related to field of study.</td>
<td>1/C survey</td>
<td>Filled out by 1/C midshipmen in Spring</td>
<td>1 year</td>
<td>80%</td>
</tr>
<tr>
<td>Final reports in EC361</td>
<td>EC361</td>
<td>1 year</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>Project proposals in EE411</td>
<td>EE411</td>
<td>1 year</td>
<td>70%</td>
<td></td>
</tr>
</tbody>
</table>

Assessment Results 2009:

1/C Survey Results:
- 15/15 (100%) of responses indicated that their education has given them a good knowledge of contemporary technical issues. This number represents 45% of the class of 2008 responding.

CATs Results:
- 10/17 CATs indicated that outcome J was linked to at least one course objectives. 34/45 (75.5%) of the linked objectives showed that the students met the course objectives.

There were 5 guest speakers who gave technical talks to ECE students in four different courses. There were 14 students participating in a field trip to NSA and Scitor Corp.

Evaluation and Actions 2009-2011:
Prior to 2009, the outcome champion determined from assessment data which performance indicators have been met. This task was achieved by reviewing the CATs and maintaining a list of topics and invited speakers related to electrical and computer engineering filed. Overall, our assessment is that contemporary issues are emphasized in many ECE courses throughout the curriculum and other extracurricular activities. CAT results of courses that introduced and reinforced current technological trend indicated that our students successfully demonstrated knowledge of contemporary issues.

One key observation obtained from the assessment process was that the CATs did not clearly show how Outcome (j) was linked to the course objectives. In addition, many courses included labs or assignments or design projects that add breadth to the student’s knowledge of contemporary issues, but were not linked to Outcome (j) in CATs. For example, many courses such as EE242, EE361 and EE414 included open-ended projects that required students to perform background research and innovative ideas to solve a problem.
We made changes to the CAT template to include a course coordinator survey that clearly indicated how Outcome (j) was linked to the course objectives. In order to add breadth to the student’s knowledge of contemporary issues, we also requested changes to the curriculum to include ECE in the news assignment in EE221. In addition, students were required to include a background information section addressing contemporary issues in their EC361 final reports and EE411 capstone proposals.

**Assessment Results 2011:**

1/C Survey Results:

- 26/29 (90%) of responses agreed or strongly agreed that their education has given them a good knowledge of contemporary technical issues. This number represents 70% of the class of 2011.

CATs Results:

- 12/17 (70%) course coordinators indicated that contemporary issues were discussed in their classes. Specifically,
  - 5 of these courses introduced contemporary issues during lectures
  - 2 of these courses introduced contemporary issues through assignments
  - 1 course introduced contemporary issues by exposing students to guest speakers
  - 4 of these courses introduced contemporary issues through independent projects
  - 5 of these courses emphasized emerging technologies.

All students attended 4 Forrestal lectures which bring well-known leaders to speak at the Academy during AY 2011. In addition, the number of guest speakers and field trips introduced in ECE classes was around 1-3 per year.

**Evaluation and Action 2011-2012:**

Once again, the overwhelming majority of our student responses indicated that their education gave them a good knowledge of contemporary issues. Our program continued to demonstrate an emphasis on contemporary issues as evidenced by the results of the course coordinator survey. Our students also gained knowledge of contemporary issues in numerous lectures and field trips. Based on course coordinators’ evaluations of course objectives that are linked to knowledge of contemporary issues, our students demonstrated satisfactory attainment of this outcome. Additionally, a new mentor evaluation tool was developed and implemented in Spring 2012 to evaluate students’ attainment for Computer Engineering (CE) students and Electrical Engineering (EE) students separately. The results of this evaluation tool indicated that CE and EE students’ attainment was good. This tool provides direct measures for indicators 1 and 3. Translating the 0-4 number scale to percentages, the evaluation results for both indicators showed satisfactory student attainment of this outcome (CE: 91.6%, EE: 90% for indicator 1; CE: 100%, EE: 86.3% for indicator 3).

The curriculum changes to EE221, EC361 and EE411 that we requested were approved and implemented in AY2012. This year, we included the final reports in EC361, EE411, and EE414/EC415 as our assessment tools. We developed and implemented a set of criteria and rubrics that were used to obtain more direct and quantitative assessment results from the final reports in EC361, EE411, and EE414/EC415.
**Student Outcome (k): An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.**

- **Overview:** Electrical Engineering students are attaining this outcome although there are concerns in the students’ ability to perform troubleshooting. This is consistent with the findings of student outcomes (a) and (b) and actions for this outcome also include the increased emphasis on laboratory work of outcome (b) and the FE-approved calculator initiative of outcome (a).

- **Outcome Champion:** Associate Professor Ryan Rakvic

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>Method(s) of Assessment</th>
<th>Where data are collected</th>
<th>Length of assessment cycle (yrs)</th>
<th>Target for Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Demonstrates the proper use of modern equipment for design in electrical or computer engineering tasks.</td>
<td>Deficiency Survey</td>
<td>EE411,EE414, EC415</td>
<td>3 Years</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td>Laboratory Survey</td>
<td>EE411,EE414, EC415</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CATs</td>
<td>EE411,EE414, EC415</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Demonstrates modern techniques for measuring and simulating electrical or computer engineering problems.</td>
<td>Deficiency Survey</td>
<td>EE411,EE414, EC415</td>
<td>3 Years</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td>Laboratory Survey</td>
<td>EE411,EE414, EC415</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CATs</td>
<td>EE411,EE414, EC415</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Demonstrates modern prototyping and debugging skills of electrical or computer engineering problems.</td>
<td>Deficiency Survey</td>
<td>EE411,EE414, EC415</td>
<td>3 Years</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td>Laboratory Survey</td>
<td>EE411,EE414, EC415</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CATs</td>
<td>EE411,EE414, EC415</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Utilizes modern documentation and presentation methods for electrical or computer engineering problems.</td>
<td>Deficiency Survey</td>
<td>EE411,EE414, EC415</td>
<td>3 Years</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td>Laboratory Survey</td>
<td>EE411,EE414, EC415</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CATs</td>
<td>EE411,EE414, EC415</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Evaluation and Actions 2010-11:** Improvements have been implemented in several courses to improve lab skills and to place more weight on laboratory skills. For example, lab practicals are now being administered in EE221, EE241, EE320, and EE354. Pre and post-exams are being used in EE322. Formal reports are being emphasized in EE241, EC361, EE354, and in EE414/EC415. Lab notebooks are being emphasized in EE221, EE241, and EE414/EC415. The students are being exposed to many simulation programs and programming languages to support the lab activities, and they are given opportunities to build systems and take measurements. There is some concern as to whether there are enough creative open-ended projects for the students to engage prior to their senior design projects. EC361 provides such an experience but the students find this course very difficult as of late. Troubleshooting/debugging is probably the area that remains the biggest concern. The process for addressing it has been incremental but probably requires more curriculum-wide comprehensive attention. That is, some focused attention must be placed here. The Group Leader suggests that a small task group should be formed consisting of the course coordinators from EE221, EE241, EE242, and EE361 to establish an integrated approach to providing some formal instruction on debugging and providing additional opportunities to practice. It is also recommended that more courses use pre and post lab quizzes to concretely document lab skill proficiency. It is also believed that the idea of providing a separate lab grade should be revisited by the curriculum committee. This would raise expectations on the students that the lab performance is valued. Having more technical support and planning inventory to allow for
more lab exercises to be done individually would also help. With regards to assessment, the group leader feels that
the group needs to meet a bit more often, need to establish a better way to track performance on formal lab reports,
need to establish a way to interpret lab practical results, and need to figure out a way to track relevant data emerging
from the Course Surveys. The Group Leader wants course coordinators to continue to administer lab practicals,
insist upon formal reports (providing the students with opportunities to edit and correct poor work), provide
opportunities for students to use their lab notebooks for quizzes or future work, and use FE-approved calculators to
complete homeworks, lab assignments, and exams.

Assessment Results (direct measures) 2011-12: This assessment is not yet completed at this time, and will be
updated before classes in the fall of 2012. The Deficiency survey, the Laboratory Survey and the Course Assessment
Tools (CAT) are all being used. The Deficiency Survey is now also complemented by the end of year capstone
mentor assessment tool. This tool is now being collected for the EE414/EC415 courses and directly corresponds
to the new performance indicators of this outcome. It allows us to collect data for Electrical and Computer Engineers
separately. The Laboratory Survey, which is included as part of the supplementary material of outcome A, is
completed by graduating seniors. CATs were also collected for all courses.

Evaluation and Actions 2011-12: Prior to the upcoming semester, our outcome group meeting to discuss our
actions and complete our evaluation will take place in the fall of 2012. Here we will discuss the data that has already
been collected. The Capstone Mentor Tool allows us to directly measure the performance indicators for electrical
engineers and computer engineers separately. The following table presents the results thus far for electrical and
computer engineering students for the four performance indicators. The scale is 0-4 with 4 being the best and the
average is presented. As can be seen, the data indicates that both electrical and computer engineering students are
well above a 2.0 average for all performance indicators for this outcome. We can also use the Capstone Mentor
Tool to get insight into the percentage of students that are attaining a basic level of competence in this outcome.
The minimum expected level of attainment on the Capstone Mentor Tool of 2.0 in general equates to demonstrated
basic ability but with significant room for improvement (question-specific detail can be found in the rubric used for
the Capstone Mentor Tool which can be found in Appendix E).

The laboratory survey confirms our evaluations from previous years. 80% of the students feel excellent with their
design work, but less than 30% of them feel excellent about debug and documentation of their work. However,
more than 75% of those queried feel that they are at least good at debugging and documentation.

<table>
<thead>
<tr>
<th>Minimum expected level of attainment</th>
<th>Students attaining this minimum level</th>
<th>Electrical Engineering Students (avg.with scale 0-4)</th>
<th>Computer Engineering Students (avg.with scale 0-4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstrates the proper use of modern equipment for design in electrical or computer engineering tasks.</td>
<td>2.0</td>
<td>EE: 22/22 (100%) CE: 15/15 (100%)</td>
<td>3</td>
</tr>
<tr>
<td>Demonstrates modern techniques for measuring and simulating electrical or computer engineering problems.</td>
<td>2.0</td>
<td>EE: 21/21 (100%) CE: 12/12 (100%)</td>
<td>3.214</td>
</tr>
<tr>
<td>Demonstrates modern prototyping and debugging skills of electrical or computer engineering problems.</td>
<td>2.0</td>
<td>EE: 16/22 (73%) CE: 14/15 (93%)</td>
<td>2.273</td>
</tr>
<tr>
<td>Utilizes modern documentation and presentation methods for electrical or computer engineering problems</td>
<td>2.0</td>
<td>EE: 22/22 (100%) CE: 12/15 (80%)</td>
<td>3.061</td>
</tr>
</tbody>
</table>
C. Continuous Improvement

Describe how the results of evaluation processes for the program educational objectives and the student outcomes and any other available information have been used as input in the continuous improvement of the program. Indicate any significant future program improvement plans based upon recent evaluations. Provide a brief rationale for each of these planned changes.

The Electrical Engineering program improvement process emphasizes the fundamental tenet of “closing the loop” as illustrated in Figure 4-1. This encompasses the attainment of the student outcomes and program educational objectives as well as the formulation and review process of both. It can be seen throughout the student outcome summaries of Section B and the full write-ups in Appendix E. It can also be seen, in what is arguably the best example, in the description of the evolution of our capstone senior design experience in Criterion 5. In this section, we offer several additional illustrative examples of program improvement initiatives that have been implemented or are in the process of being implemented.

Example – Incorporation of robotics project in introductory courses

1. Identification of problem through assessment and evaluation of data

The first ECE courses taken by an Electrical or Computer Engineering major at USNA are the sophomore fall offerings of EE221 Introduction to Electrical Engineering I and EC262 Digital Systems. Assessment data gathered and evaluated by the champions of Student Outcome (a) (ability to apply knowledge of mathematics, science, and engineering) and Student Outcome (b) (an ability to design and conduct experiments as well as to analyze and interpret data) coupled with student feedback on teaching evaluation forms in these introductory courses identified an opportunity to improve and strengthen the relationship of course material to “real world” applications. Data from the Fall 2008 Course Assessment Tools (CAT) for both EE221 and EC262 (at the time designated as EE242) indicated weak student performance on meeting Outcomes (a) and (b) (at the time designated Program Curricular Outcomes 1 and 2 respectively). Of the two courses, instructor comments in the CATs indicated that the students regularly enjoyed and were complimentary of their learning process achieved in the EC262 Digital Systems course; while they did not appreciate nor have the same educational success with the learning process in EE221 Introduction to Electrical Engineering I. Seizing upon this issue and the timely inputs from theses outcome champions in the spring of 2008, a collaborative effort was launched to address these concerns.

Identified problem: Weak ability on the part of the students to link course material (fundamental concepts of electrical engineering) to relevant, real-world (experimental) applications.

2. Proposed action

In the spring of 2009, assessment team members and relevant course instructors informally brainstormed potential solutions which ultimately focused on a thematic-based project approach to address this identified problem while concurrently stimulating student interest. Discussion centered on cohesively tying the topical content of these two courses together through this
common project. Various ideas were discussed including projects involving model rocketry, remote-controlled helium zeppelins, and autonomous digitally-controlled robots. The rocket had a disadvantage due to the inherent pyrotechnics while the dirigible would require large quantities of helium. The decision was made to pursue the digitally-controlled autonomous robot.

This concept was formalized into a proposal that was brought forward to the Department Curriculum Committee in Spring 2009 and unanimously approved. During this curriculum meeting, other faculty seized upon the opportunity to build upon this initiative in other courses as well including the course coordinators of EC361 Microprocessor-based Design and EE411 Senior Design.

**Proposed Action:** *Introduce a student design project spanning two introductory EE/EC courses for building and controlling a robot.*

3. Implementation of proposed action

The robot project was initiated in the Fall of 2009, and initially spanned the two concurrent introductory courses, a third year course (EC362 Computer Architecture), and the fourth year capstone course (EE411 Electrical and Computer Engineering Design I). Most of the impact to the curriculum made by this project is observable in the introductory courses. This project brings design to the introductory level and sets the foundation that students will build on in later courses. The change in the curriculum is similar to changes implemented at Duke University42, but differentiates itself by tying the two introductory courses together. The introductory circuits course, EE221, develops the hardware (the “brawn”), while the introductory digital logic course, EC262, programs the controller (the “brain”).

In the first semester course on circuit analysis, EE221, the robot platform is fabricated which drives the students to apply their basic knowledge of mathematics, science, and engineering to a ‘real-world’ situation. In total, six hours of class and laboratory time are specifically dedicated to the project. Three additional laboratory periods are spent on experiments that are helpful for the project; biasing a light emitting diode (LED), signal processing of sensor data, and a sensor controlled motor operating circuit. For the robot project, students are permitted to work in teams of up to three and each team is given the opportunity to select a design objective, speed or endurance, for their robot. Documentation is required that details the necessary assembly instructions as well as individual component datasheets for the sensors, batteries, transistors, and motors. A preprogrammed FPGA containing a line following state machine is supplied to the students (although several students have opted to use their own state machine designs). Students are expected to make design decisions on selecting the battery, wheel size, and motors to be used in their project to best meet their design objective. Project deliverables are a functioning robot and complete design project report documenting the team’s experience. The culmination of the project was a course-wide competition in which the students competed across all class sections for a grade bonus based on their design objectives. Testing of the speed objective was

accomplished on a course consisting of several curves, and the endurance objective was tested on course designed as a large oval.

The first semester course on digital logic, EC262 (formerly EE242), lays down the foundation for FPGAs, microcontrollers, and programming thus allowing the students to program the “brains” of the robot. Students are given three specific projects with regard to the robot. The first project covers a combinational logic line follower. After the robot demonstrates its ability to navigate a serpentine course, it is presented with a course requiring 90° turns, and due to the build of the robot, the sensors will leave the line and the robot will become “lost.” This brings the students to the next project: creating a state machine line follower. With this project, students create a state machine that remembers the robot is turning even when the robot loses contact with the line. The final part of the project is creating a state machine that will allow the robot to avoid objects without the assistance of the line. Once an object is detected in front of the robot, the robot should turn 90°. In the case where the robot is in a corner, it will turn out of the corner.

4. Follow-up assessment and evaluation of data for implemented action

To gather student data an eight-question questionnaire was given to all students. The questions can be found in Table 4-2. Data was also gathered from the CATs for both course offerings of EE221 and EC262 for Fall 2009 and Fall 2010. For the former, students rated each question on a scale of 1 (Strongly disagree) to 5 (Strongly agree). The averages can be found in Figure 4-4.

<table>
<thead>
<tr>
<th>Question</th>
<th>The project increased my understanding of:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basic Electrical and Computer Engineering Fundamentals.</td>
</tr>
<tr>
<td>2</td>
<td>Biasing components for proper operation.</td>
</tr>
<tr>
<td>3</td>
<td>Datasheets.</td>
</tr>
<tr>
<td>4</td>
<td>Applications of FPGAs to real world problems.</td>
</tr>
<tr>
<td>5</td>
<td>Programming VHDL.</td>
</tr>
<tr>
<td>6</td>
<td>Concepts I learned in this project I will apply to future projects.</td>
</tr>
<tr>
<td>7</td>
<td>This project highlighted design tradeoffs.</td>
</tr>
<tr>
<td>8</td>
<td>I enjoyed this project.</td>
</tr>
</tbody>
</table>

Table 4-2. Questionnaire used for assessment of EE221/EC262 Robotics Project
An evaluation of this data indicated that students have encountered several challenges as well as successes throughout this project. Properly biasing the line sensors has proven to be the most difficult part of the project. Reading datasheets provided an additional challenge. The positive experiences include the use of lab notebooks to review topics from previous labs and developing troubleshooting techniques. Instructors have also noticed a more proficient understanding of VHDL. Most groups successfully completed the “brawn” part of the robot project and competed in the course-wide challenge.

The students expressed a positive experience on this project even though it required numerous hours of work outside of the allotted class time. The instructors observed that the students were extremely motivated by this real-life example. Overall, students voluntarily had a marked increase in their lab time.

Student quantitative and qualitative data on all levels of the project has been positive. Data from the CATs for both course offerings of EE221 and EC262 for Fall 2009 and Fall 2010 indicated that this project was well received by the students, and furthermore resulted in improved student performance for Outcomes (a) and (b) as directly measured by each course’s instructor. Additionally, the students were asked if the project should be continued in future course offerings, and there was a 100% agreement that the project should be continued.

Given the success of our experience with this project, an American Society of Engineering Education Conference paper was written and presented at the 2010 annual ASEE symposium. 43  

1. **Identification of problem through assessment and evaluation of data**

During the spring of 2007, the Outcome (a) Champion (then denoted as Outcome (1)) and his wingman gathered assessment data for the end-of-year Executive Summary for student outcome (a). Preliminary Course Assessment Tools (which has since been completely superseded by the CAT based on feedback of our assessment process) and Course Assessment Tools (CATs) were reviewed and faculty members were interviewed about their perception of how their students fared with respect to the fundamental principles of math, science and engineering. On 24 May 2007, the Outcome (a) Champion made a presentation during the ECE department meeting that highlighted a concern noted in our students in their basic math skills. The summary slide that identified the concern during this presentation is shown in Figure 4-5. There was general consensus among the faculty was that our students relied too heavily on their calculators and did not have a solid grasp of fundamental math principles.

**Mids & Fundamentals**

- Feedback: we find the mids are lacking when it comes to:
  - Integrals, derivatives, algebra
    - What an integral represents – area under a curve
    - What a derivative represents – slope of a curve
    - How to solve simultaneous equations
    - How to manipulate scientific notation (e.g., 10e6/5e6)
    - How to manipulate logarithms (change base, log plots, decibels)
    - How to manipulate complex values (polar to rect. conversion, magnitude, phase)
    - Exponential functions (e.g., plot e^{kt}, 1-e^{kt})
- They have become too reliant on their calculator for fundamental math
  - Math department teaches mids to rely on their calculators for everything, and teach to the calculator
  - Math dept should focus on mids learning the fundamentals, not learning the calculator

![Figure 4-5. Outcome (a) briefing, 24 May 2007](image)

**Identified problem:** Weak ability on the part of the students to perform fundamental math concepts without utilizing their issued calculators (TI Voyage). This included basic calculus (integration and differentiation) and algebra.

2. **Proposed action**

The root cause of this concern appeared to have its origin in the freshman calculus courses, where most (but not all) of the math teachers extensively used the powerful TI calculator in their calculus classes to cover more material. At the time of that department presentation, the outcome champion suggested that the ECE Department coordinate with other engineering
departments to suggest to the Math Department that they forego the use of this calculator in their calculus classes. This initiative did not resonate in the division at the time and the concern was also noted in the 2008 Executive Summary for student Outcome (a).

During the 2008-2009 academic year, the ECE Department and Math Department established liaisons with each other (ECE: Assoc. Prof. Rob Ives, Math: Professor Mitch Baker) to ensure that the math service courses provided to our department were satisfactory. The topic of calculator usage by the Math Department in the calculus courses was discussed and the following was reported in the 2009 Executive Summary for student Outcome (a):

“I do note a continuing reliance of the students on their high-powered calculators to solve problems I would like to see them work by hand (e.g., integrals, derivatives); without the calculator, they are sometimes in a bind. I am the new liaison with the Math department, and reiterated this point to their liaison to the ECE department (Prof. Mitch Baker). He states that there are basically two camps in the Math department; those that proclaim that using the calculator actually enhances their ability to teach the students calculus/diff eqs, because they can teach more topics; and those that believe that the only way to teach calculus for them to learn it is by doing problems by hand over and over. Our department seems to be allies with the latter group, but the system as is [sic] is so entrenched in the Math department that it may be impossible to change.”

As mentioned in the same 2009 Executive Summary, a proposal was presented to the ECE department at an end-of-semester meeting:

“What we can do is force the mids to use their calculators less, such as not allowing them on quizzes or exams. We can also give problems that have variables in them only so there is no computation. Also, we can give them the type of problem where data/results are presented, and the students are to interpret the results. I can do this in EE322 and EE354 (when I teach it), but it is up to other professors to follow my lead. I understand that in some cases, the calculator is vital.”

It was recognized that calculators are an essential part of an engineer’s education. We noted that a calculator that a student can bring to the Fundamentals of Engineering (FE) exam is a capable one, but does not blindly solve equations.

**Proposed Action:** Require FE-approved calculators in Electrical and Computer Engineering program courses instead of the issued calculator.

3. **Implementation of proposed action**

In the fall of 2010, a decision was made to “as much as possible” require the use of FE-approved calculators in our computationally intensive Electrical and Computer Engineering major courses.

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44 2009 Executive Summary for Student Outcome (a)
45 2009 Executive Summary for Student Outcome (a)
Two such courses that agreed to pilot the new requirement were EE241 Electronics I and EE322 Signals and Systems. A sample course policy statement from EE322 is as follows:

“Calculators: New policy! Our department is in the process of changing its policy on how calculators will be allowed. On quizzes and exams, if you choose to use a calculator (calculators are always optional), you must use one of the calculators approved for use on the Fundamentals of Engineering Exam (FE). These are listed at: http://www.ncees.org/Exams/Exam-day_policies/Calculator_policy.php. These run in price as low as $15. Whatever you choose to use on the quizzes/exams, I suggest you also use for your homework/labs so that you get the required familiarization.”

4. Follow-up assessment and evaluation of data for implemented action

As noted in the student outcome (a) summary in the previous section, review of Course Assessment Tools (CATs) and the Deficiency survey was conducted. Across the ten courses for which data were available (EE221, EE241, EE242 EE320, EE322, EE354, EE361, EE372, EE411, and EE414), which include sophomore through senior offerings, instructors reported on average that at least 90% of students met course objectives related to Outcome (a). In EE344 algebra skills were found to be improved, even with lower QPR students. At the same time, however, it was noted in EE221 that students still rely too heavily on their calculators for basic mathematic computations.

While further assessment is ongoing, in February 2012, a memo was sent to all ECE Department faculty requesting information about courses in which the proposed solution to require FE-approved calculators had been implemented. Instructors were asked to qualitatively describe the impacts of the change. The general take away from this memo-based survey was that even when instructors did not explicitly ban non-FE approved calculators, they often made didactic or curricular changes in the spirit of the ban. For example, in EE241 which required FE-approved calculators in 2011 but not in 2012, more algebraic problems that do not lend themselves to solution with a calculator now appear on exams and quizzes.

Additional action has recently been taken on the FE-approved calculator initiative. Following the student outcome briefings during the June 2012 Department Meeting and upon the recommendation of the outcome (a) champion, a motion was raised to limit electrical and computer engineering student use of calculators to only FE-approved calculators throughout the electrical and computer engineering curriculums. The course coordinators that had tried this during the fall and spring semesters related their experiences and the department voted. The motion was passed and the Department Chair subsequently signed into effect the departmental notice (ECEDEPTNOTE 100 ECE Departmental Policy on Calculators) which can be found in Appendix F. Assessment will be conducted over the next several cycles to determine the effectiveness of this initiative.

46 From course report, EE322, Fall 2010
Example – Revision of Program Educational Objectives

1. Identification of problem through assessment and evaluation of data

In 2009, the Electrical Engineering program received a recommendation for a revision of the program educational objectives resulting from the program review conducted by our External Visiting Committee. Specifically, the External Visiting Committee noted in its summary report:

   ABET objectives and outcomes are not as clear as they need to be. There appears to be some confusion between objectives and outcomes. For example, on page 10 of self-study report, several objectives and outcomes. Objective 2 is nearly identical to Outcome 7 and Objective 5 looks like Outcome 9. Also, on page 15 of self-study, “Some outcome champions are introducing rubrics… and requests for the institutional research department to survey the Navy fleet.” indicates confusion between outcomes and objectives. A survey of the Navy fleet would address an objective rather than an outcome. Additionally, Outcome 8 seems to be an abbreviated version of ABET Criterion 3 Outcome (h) – Outcome 8 is missing the economic and environmental components. These are important as ABET has a renewed focus on the clarity of outcomes and objectives.47

The assessment team evaluated these findings and found two major points to be addressed: (1) the program lacked a clear understanding of the differences between outcomes and objectives and (2) the program educational objectives were unclear and not properly defined.

Identified problems: (1) Inadequate understanding of outcomes versus objectives. (2) Improperly cast program educational objectives.

2. Proposed action

To address problem (1), the inadequate understanding of outcomes versus objectives, the assessment team developed a three-pronged approach:

(1) the Assessment Chair would attend ABET-sponsored forums to gain better insight into the program educational objectives and their relationship to the student outcomes

(2) the assessment team would initiate dialogue among both the division and its other departments to gain consensus and promote further understanding of the program educational objectives

(3) the assessment team would educate the student outcome champions and other program faculty on the insight gained from (1) and (2)

Once problem (1) was addressed, the assessment team proposed to address problem (2), the evaluation that the current program education objectives were improperly cast, by revising the program educational objectives using the process described in Criterion 2, Section E.

47 2009 Program Review Report submitted by External Visiting Committee
Proposed Actions: (1) Gain better understanding of program educational objectives through attendance at ABET forums and division-wide dialogue, and then educate our program faculty on the insight gained and (2) revise the program educational objectives in light of this new understanding.

3. Implementation of proposed action

The assessment team requested and received funding which enabled the Assessment Chair to attend the 2011 ABET Symposium and an associated workshop on program assessment. At these events, the roles and relationships between student outcomes and program educational objectives were thoroughly discussed and numerous examples of both were examined.

Beginning as early as the summer of 2010, our division embarked on a division-wide examination of the program educational objectives identified for each program. A rigorous and animated set of discussions ensued throughout the next year as the departments wrestled with the merits of various proposals and counterproposals. In Fall 2011, a consensus was reached that each program should adopt individual program educational objectives following the guideline and “best practices” gleaned for the attendance at the 2011 ABET Symposium.

As the division was reaching consensus, the Electrical and Computer Engineering Department assessment team pursued a series of educational presentations to the department faculty at monthly departmental meetings and the Fall 2011 kick-off department meeting. These presentations focused on student outcomes, program educational objectives and the importance of closing the “assessment-evaluation-action-assessment loop.”

Following the process described in Criterion 2, Section E, the assessment team proposed the following revised program educational objectives at the 17 October 2011 Department Meeting:

Three to five years after graduation the Department of Electrical and Computer Engineering expects its graduates to be Navy or Marine Corps officers who:

1. Possess a fundamental knowledge in engineering, basic sciences, humanities, and social sciences; coupled with an expertise in Electrical or Computer Engineering that enables them to solve both well- and ill-defined shipboard, squadron or tactical Navy and Marine Corps engineering problems.
2. Are able to work independently and with others, effectively using oral and written communication skills.
3. Recognize the need to continually update their knowledge and skills and are engaged in life-long learning.
4. Know and practice their ethical and professional responsibilities as embodied in the United States Navy core values.48

Both written and oral feedback was solicited from the department faculty which included a number of Navy and Marine Corps officers. This feedback was unanimously positive and the set

48 http://www.usna.edu/ee
of proposed program educational objectives was approved and subsequently posted on the department website.

4. *Follow-up assessment and evaluation of data for implemented action*

This initiative is ongoing and the follow-up assessment is still in work. Follow-up data to assess the impact of this action will be gathered during the upcoming ABET Accreditation visit and during the next Alumni Survey (2015) by including a set of questions that rate the importance of the new set of PEOs to the current assignment of the respondent.

**Significant future program improvement**

A number of significant improvements to the Electrical Engineering program are underway and can be found throughout the student outcome summaries of the previous section. Rather than repeating those here, we instead highlight a couple of process-oriented initiatives that span across all of the outcomes.

Based on “best practices” discussions at the 2011 ABET Symposium and the 2011 ABET Conference, the program is working to incorporate the Fundamentals of Engineering (FE) Exam into our program improvement process. This effort also dovetails nicely with a finding from the 2009 External Visiting Committee that recommended that funding be provided to allow all electrical and computer engineering students to take the FE Exam as the exam not only “initiates the professional engineer licensing process but also serves as an excellent assessment tool.”

While the funding to support mandatory participation remains unidentified, a number of our students do take the exam annually and a military faculty member in the department (a Professional Engineer himself) is spearheading our efforts to fold the exam into our program improvement process. He is advocating participation in the exam among the students and is working close with our student outcome champions to utilize the data available from the National Council of Examiners for Engineering and Surveying (NCEES) as a direct assessment method to measure student attainment of specific outcomes.

A second ongoing initiative focuses on the quality, volume and usefulness of the data gathered in our assessment process. Based in large part on “best practices” discussed at the 2011 ABET Symposium, the 2011 ABET Conference, and their associated workshops, this initiative is designed to ensure that the program improvement process remains both effective and sustainable. The department assessment team is discussing the importance of quality over quantity with a renewed emphasis on performance indicators and sustainable assessment timelines. This has already given rise to the improved reporting format found in Figure 4-3. In addition a number of ideas are being evaluated and implemented by the outcome champions that will improve the quality of both the assessment data and the evaluation and action phases that make use of this data. These proposals can be seen throughout the individual student outcome summary reports of the previous section.

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49 Program Review Board Report, 2009 External Visiting Committee
We are also working on improving our assessment of our program educational objectives. To date, we rely chiefly on our visiting committee and our graduate survey. While the latter is admittedly an indirect method of assessment, for the moment it is the only practical assessment method available. This is due in large part to the constraints associated with the military chain of command, who is the sole employer of our graduates. In an effort to obtain additional relevant and accurate data through another direct method of assessment, we continue to explore with the military chain of command options for an employer-type survey. We hope to gain approval for a reasonable version of this approach sometime in the future. In addition, we are also exploring the possibility of forming an industrial advisory board similar to that found at peer civilian institutions. While this would not provide direct feedback on our graduates as future Navy and Marine Corps officers, it would give us some insight into their potential effectiveness as engineers in industry. It would also have the added benefit of strengthening our program’s ties with local industries.

Finally, the department is actively encouraging its senior faculty members to become ABET Program Evaluators to increase program improvement expertise within the department as well as to provide much needed manpower to support accreditation efforts within the electrical engineering community.
CRITERION 5. CURRICULUM

A. Program Curriculum

1. Complete Table 5-1 that describes the plan of study for students in this program including information on course offerings in the required curriculum in the form of a recommended schedule by year and term along with maximum section enrollments for all courses in the program over the two years immediately preceding the visit. If there is more than one curricular path, Table 5-1 should be provided for each path. State whether you are on quarters or semesters and complete a separate table for each option in the program.

The United States Naval Academy operates within a traditional semester format. Students are required to finish in four years, barring extreme circumstances. Included in Table 5-1 is the course of study for the Electrical Engineering program. (Tables 5-1 through 5-4 are included at the end of this Criterion due to their size.) The program-specific four-year matrix of courses (divided by semester) is shown in Table 5-2 for the Class of 2012. It should be noted, that a recent Navy directive requires that all midshipmen, beginning with the Class of 2015, take two courses in cyber security at USNA. The Class of 2015 matrix reflects an introductory cyber security course (SI110 Cyber Security I) taught by the Computer Science Department in the freshman year. The ECE Department has been tasked to teach the second cyber security course (EC310) in the students’ junior year. The first official offering will be for the Class of 2015 in AY2013-14. While the course is still under development, we anticipate that there will be some changes to the existing Electrical Engineering matrix to ensure that all the EC310 identified topics are covered within the program. More details can be provided at the site visit.

2. Describe how the curriculum aligns with the program educational objectives.

As designed, the curriculum aligns with the program educational objectives via the student outcomes. In the event that graduates are failing to attain a given program educational objective, this objective is tied back to the corresponding student outcomes using the mapping of outcomes to objectives shown in Table 3-1. The appropriate outcome champions will then evaluate and act on this data accordingly.

3. Describe how the curriculum and its associated prerequisite structure support the attainment of the student outcomes.

The alignment between attainment of the student outcomes and the curriculum is included in the educational strategies defined for a particular student outcome and is addressed by the individual student outcome write-ups in Criterion 4, Section B. The mapping between the specific courses and the outcome(s) they support is summarized in Table 5-3. This table indicates the courses in which a particular outcome is introduced (I), reinforced (R), or assessed (A). By reinforced, we mean that while the course addresses the performance indicators associated with the student outcome and the course coordinator and student outcome champion must liaison closely, no assessment is conducted for purposes of the evaluating student attainment of the outcome.
4. Attach a flowchart or worksheet that illustrates the prerequisite structure of the program’s required courses.

A flowchart showing the prerequisite requirements for the required Electrical Engineering course sequence is shown in Table 5-4.

5. Describe how your program meets the requirements in terms of hours and depth of study for each subject area (Math & Basic Sciences, Engineering Topics, and General Education) specifically addressed by either the general criteria or the program criteria.

The general criteria specifies the following:

The curriculum requirements specify subject areas appropriate to engineering but do not prescribe specific courses. The faculty must ensure that the program curriculum devotes adequate attention and time to each component, consistent with the outcomes and objectives of the program and institution.

In this section, we will address each curricular area individually and show how the Electrical Engineering program meets the requirements in terms of hours and depth of study specifically addressed by both the general criteria and the program criteria.

**Curricular Area: Math and Basic Sciences**

The general criteria identifies the following requirement in this curricular area:

*The professional component must include: (a) one year of a combination of college level mathematics and basic sciences (some with experimental experience) appropriate to the discipline. Basic sciences are defined as biological, chemical, and physical sciences.*

The program criteria adds the following requirement:

*The curriculum must include probability and statistics, including applications appropriate to the program name; mathematics through differential and integral calculus; sciences (defined as biological, chemical, or physical science);*

*The curriculum for programs containing the modifier “electrical” in the title must include advanced mathematics, such as differential equations, linear algebra, complex variables, and discrete mathematics.*

These requirements are met by the courses listed below for the class of 2015, with the designator (recitation hours-laboratory hours-credit hours) following each course:

- SC111 Foundations of Chemistry I (3-2-4)
- SC112 Foundations of Chemistry II (3-2-4)
- SP211 General Physics I (3-2-4)
- SP212 General Physics II (3-2-4)
- SM121 Calculus I (4-0-4)
In total, this curricular area consists of 31 recitation hours and 8 laboratory hours for a total of 35 credit hours to complete. This total exceeds the one-year (32 credit hour) requirement.

Curricular Area: Engineering Topics

The general criteria identifies the following requirement in this curricular area:

*The professional component must include: (b) one and one-half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student's field of study. The engineering sciences have their roots in mathematics and basic sciences but carry knowledge further toward creative application. These studies provide a bridge between mathematics and basic sciences on the one hand and engineering practice on the other. Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs.*

The program criteria adds the following:

*engineering topics (including computing science) necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components*

These requirements are met by the courses listed below (for the Class of 2012), with the designator (recitation hours, laboratory hours, credit hours) following each course:

- EE221 Introduction to Electrical Engineering I (3-2-4)
- EE241 Electronics I (3-2-4)
- EE242 Digital Systems (3-2-4) (now EC262)
- EE320 Introduction to Electrical Engineering II (2-2-3)
- EE322 Signals and Systems (3-2-4)
- EE354 Modern Communication Systems (3-2-4)
- EE361 Microcomputer-Based Design (3-2-4) (now EC361)
- EE372 Engineering Electromagnetics (3-2-4)
- EE411 Electrical and Computer Engineering Design I (2-2-3)
- EE414 Electrical Engineering Design II (0-4-2)
- Major Elective 1* (3-2-4), (3-0-3), (2-4-4), (2-2-3), or (4-0-4)
- Major Elective 2* (3-2-4), (3-0-3), (2-4-4), (2-2-3), or (4-0-4)
- Major Elective 3* (3-2-4), (3-0-3), (2-4-4), (2-2-3), or (4-0-4)
- ES300 Naval Weapons Systems (3-0-3)
- ES410 Control Systems and their Application to Weapons (3-2-4)
EM316 Thermo-Fluid Sciences I (3-0-3)
EM317 Thermo-Fluid Sciences II (2-2-3)
SI204 Introduction to Computer Science (3-2-4)

* The eligible courses available for meeting the Major Elective requirements are:

- EC404 Operating Systems (3-2-4)
- EC436 Introduction to Computer Networks (3-2-4)
- EC462 Superscalar Processor Design (3-0-3)
- EC463 Microcomputer Interfacing (2-4-4)
- EE342 Electronics II (3-2-4)
- EE344 Solid State Power Electronics (3-2-4)
- EE420 Electric Machines and Drives (3-2-4)
- EE426 Fundamentals of Electronic Instrumentation (2-2-3)
- EE431 Advanced Communication Theory (3-2-4)
- EE432 Digital Signal Processing (3-2-4)
- EE433 Wireless and Cellular Communications Systems I (3-2-4)
- EE434 Wireless and Cellular Communications Systems II (3-2-4)
- EE435 Biometric Signal Processing (3-2-4)
- EE451 Electronic Properties of Semiconductors (3-0-3)
- EE472 Fiber Optical Communications (3-2-4)
- EE485*, EE486*, EE487*, or EE488* Advanced Topics in Electrical Engineering: *multiple section and credit hour offerings possible to facilitate individual instructor/student learning plans (2-2-3), (3-0-3), (4-0-4), or (3-2-4)
- ES418 Optimal Control and Estimation (3-0-3)
- SI455 Advanced Computer Networks (3-0-3)
- SP436 Acoustics (3-2-4)
- SP438 Optics (3-2-4)

In total, this curricular area consists of 48 recitation hours and 28 laboratory hours for a total of 62 credit hours to complete. This total exceeds the one and one half years (48 credit hour) requirement.

Curricular Area: General Education

The general criteria identifies the following requirement in this curricular area:

*The professional component must include: (c) a general education component that complements the technical content of the curriculum and is consistent with the program and institution objectives.*

This requirement is met by the courses listed below, with the designator following each course:

- NL110 Preparing to Lead (2-0-2)
- NN101 Introduction to Navigation (1-2-2)
- NS101 Fundamentals of Seamanship (1-2-2)
In total, this curricular area consists of 37 recitation hours and 10 laboratory hours for a total of 42 credit hours to complete. Of this total, 16 recitation hours and 10 laboratory hours for a total of 21 credit hours are prescribed courses focused specifically on professional development and skills for a Navy or Marine Corps officer. The remaining 21 recitation hours and 21 credit hours are allotted for courses in the humanities or social sciences.

6. Describe the major design experience that prepares students for engineering practice. Describe how this experience is based upon the knowledge and skills acquired in earlier coursework and incorporates appropriate engineering standards and multiple design constraints.

The Electrical Engineering design experience culminates in a two-semester design project-based sequence during the senior year. Comprised of EE411 Electrical and Computer Engineering Design and EE414 Electrical Engineering Design II, this senior capstone design course sequence has undergone extensive improvements over the past several years. To properly contextualize our approach to our students’ major design experience, we present an abbreviated historical perspective on how the senior design course sequence has evolved.

As originally offered, the first semester course, EE411, focused primarily on design techniques and used a number of prepared laboratory exercises to reinforce the material taught in the lecture. It exposed and re-familiarized students with test equipment and troubleshooting techniques. The lecture material consisted of the design process, ethical case studies, and reviewed material from power supplies to amplifiers. The laboratory exercises were mostly analog in nature. During the course, students used the knowledge gained through the design process lecture material to select their capstone projects, conduct background research, and put together a capstone project proposal to be presented at the end of the semester. This capstone project was the one they would design and build in EE414, the second course in the senior capstone design course sequence. Most of these projects were student conceived and they would solicit a faculty member(s) to act as their mentor for the spring semester. EE411 culminated in capstone project proposal presentations to the department faculty and accompanying written project proposals.
During the follow-on course, EE414, the students spent most of their effort building the project with the goal of having a working design complete by the end of the semester. A final report on the project was included at the end of the semester. At the time of the original offering, both EE411 and EE414 were typically taught by the same faculty member. While the faculty mentors did not receive any teaching credit for EE414, they did provide grading input to the EE414 course instructor. In most cases, the capstone design projects were done by individual students, with very few teams.

The capstone sequence culminates with a final report and project presentations to the faculty. Originally, these final presentations were scheduled for each individual project in after-school and lunch-period time slots that spanned about two weeks. Most presentations were attended by the capstone instructor, the project mentors, and one to two other faculty members. Through this method, most faculty would observe four or more capstone presentations. In addition, the capstone instructor, department chair, and associate department chair would have attended all or nearly all of the presentations and would also review all of the final reports. Following the completion of the presentation period, the faculty would meet as a group to discuss the projects and determine the project awards. This meeting, therefore, served as the assessment tool for the capstone sequence. The faculty consensus on the capstone sequence based on this discussion was captured, as interpreted by the design course coordinator, in the EE414 final course report. Improvements have since been made to the assessment process for capstone design as well as to the sequence itself as detailed below.

A consistent concern in the capstone review discussions was that the projects varied widely in their complexity and in their success. Allowing students to choose a project without much guidance from the faculty often led to less than satisfactory results. Often the project was either overly complex and thus not completed on time or it was overly simple and did not provide a rigorous design experience for the student. Much of this problem could be attributed to lack of faculty engagement. The faculty mentors were involved only after project topics had been chosen by the students, and the mentors were often not assigned according to their expertise in the specific area of research related to the project, but instead because the student had prior experience with the instructor and enjoyed working with them. Faculty also received little credit for them. Consequently, many of the projects were more complex analog projects which mimicked the prepared laboratories in EE411. Also, while the lectures for the course discussed the design process, they did not introduce formalized design methods such as building objective trees, using pairwise comparison charts, formulating design metrics and requirements; and functional decomposition. These tools are essential to efficiently refining and succeeding in an initially broad and open-ended project. In the absence of faculty guidance and instruction in formalized design methods, the students often floundered with their projects.

**AY2004-05:**

The initial attempt to modify the course was to have two instructors teach EE411. The intent was to inject an instructor with a different background (in this case, a communications and signal processing background) into the mix and increase the variety of projects. The follow-on assessment discussion among the faculty indicated, though, that the quality of the capstone design project work did not improve. This was found to be due to the fact that students, in selecting their sections, did not consider their own research and project interests. As a result
students who had an interest in a communications project, for example, were in the power/analog instructor’s section. At this point, formalized design methods were not yet being introduced. The design process was taught informally by the instructor and did include the principles of functional decomposition and consideration of design trade-offs, but not in a formalized way.

**AY2006-09:**

The next iteration was to go back to a single instructor but to introduce a wider variety of laboratories in EE411. The students practiced their design sequence steps in the smaller more well defined labs while working on their capstone project in parallel. An example of the new laboratories added to the course, the lighthouse project forced the students to choose between one of three implementations. They were required to do paper designs for two and use the techniques for selecting a design taught in class to choose and build one of these designs. Project selection criteria, student teams and peer evaluations were also introduced into the course. Each capstone project now had to be a hardware design (previously, we had allowed some software-based capstone projects) and each had to have an input, some type of processing, and an output.

A textbook that presented formalized design methodologies, engineering standards, and the formulation of realistic constraints, was added. The students were also trained for the first time in engineering standard practices such as formulating an objective tree and developing design requirements with realistic and quantitative targets for performance. Lecture material was added to the course to specifically address the formulation of design requirements including meeting relevant engineering standards.

The shift to allowing group projects has facilitated a greater variety of project options and also makes it easier for faculty members to be engaged. The capstone coordinator also sought increased faculty input into the project offerings. This was done through one-on-one discussions and suggestions of ways that various faculty members could formulate student projects that were based on the faculty members’ research interests. The faculty members were then asked to mentor the projects that fit their interests, resulting in greater mentor engagement (measured by the number of hours that the students spent with their project mentors over the course of the semester). The follow-on assessment discussion among the faculty indicated that while problems were still encountered, they were more limited in nature and the quality of many of the capstone projects improved. Many of the faculty still felt, however, that the projects did not achieve the desired level of depth, or result in the nicely packaged final prototypes for which we hoped. There also remained concerns about the variability of project quality.

**AY2010-present:**

Over the last couple of years, four significant changes have been made to the fall semester design course (EE411) that has dramatically improved the quality of the senior design experience. First, faculty members now provide an overview of proposed projects to the students in the spring semester of their junior year. This has a number of advantages: it allows for student project groups to all be assigned the same capstone section, it creates an overlap window for the juniors who have selected continuing projects to learn from the seniors currently engaged in those projects, it provides the opportunity for students to begin their design over the summer during an
internship, it puts our capstone sequence on the same schedule as the mechanical engineering
capstone sequence and the capstone track for the systems honors track making collaboration
easier, and it allows for the faculty to make use of the “sweep up” funding generally available at
the end of the year to stock up on supplies that are needed for the projects to come. With this
change students “hit the ground running” in the fall. The students are expected to choose a
project from the list provided although they can develop their own by writing up a proposal prior
to the project selection deadline. Some projects are, by their nature, open ended, such as the
“Jedi Mind Tricks” project from AY2012 which challenged students to make some productive
use of a new EEG system, but most students choose one of the many pre-defined, well-scoped
projects and most get their first choice.

Second, to address concerns about the quality of student writing, a technical writing textbook
was added to the course, along with a number of technical writing exercises. The course now
includes two revision cycles for the proposal. Faculty feedback has noted the improvement in
writing quality.

Third, the design textbook was shifted to Dym & Little which is the textbook used by both
mechanical engineering and systems engineering at USNA. This textbook introduces the
students to engineering standards and practices, and includes tools like the “House of Quality”
which were not in the previous textbook. This change, along with the shift to earlier project
selection described above, better supports multidisciplinary project teams. As can be seen in the
current project list included at the end of this subsection in Table 5-5 (as a reminder, Tables 5-1
through 5-4 are included at the end of this Criterion due to their size), many of our majors now
participate in multi-disciplinary projects. In a few cases (i.e. the “Cockpit of the Future” and
“Portable Wind Power” projects shown in Table 5-5) our students even enroll in a capstone
course offered by another engineering department in lieu of EE411. The use of a common
textbook among engineering departments gives the students in these groups a common language
and design methodology.

Finally, students are now allotted more time in EE411 to work on their project than in previous
offerings. The course is still two lecture hours with a two hour lab, but now the labs are directed
towards protoyping some piece of the chosen project. The lecture remains focused on project
definition, formulation of engineering requirements, the design process, engineering standards,
professional ethics and engineering project management. One intermediate result in EE411 is
that the quality of the project proposal presentations has greatly improved according to feedback
from the faculty mentors. Students now lay out a more detailed timeline and often begin project
construction before the fall semester ends. An added benefit is that this allows them to put in
parts requests prior to December break.

Several changes have also been introduced in second semester capstone design course, EE414.
With the introduction of the Computer Engineering major, there is now a second semester design
course specifically for Computer Engineers (EC415). For both second semester courses (EE414
and EC415), the faculty mentors are now formally assigned individual student sections. This
allows more direct control of the project, including managing the progress and assigning the
student grades. Instructors now receive teaching credit for EE414 or EC415. Also, we have
created a dedicated day assigned as the senior design conference. Faculty and midshipmen are
encouraged to attend throughout the day. In addition, majors courses of all year groups are
encouraged to attend the conference during their class periods. Also, faculty who are not presently serving as capstone mentors are assigned to the “Capstone Awards Committee” with an obligation to attend all of the talks. The larger audience and increased faculty attendance “raises the stakes” for the seniors (in a way that is more effective than grades for a soon-to-graduate senior who already has a job). Furthermore, this conference exposes the juniors and sophomores to what will be expected of them in their future. Faculty feedback on project quality and student progress has been unanimously positive.

Increased faculty attendance at the final presentations has also improved the effectiveness of the end-of-year capstone discussion as an assessment tool. However, we plan to create a better tool this year by implementing a set of rubrics. Faculty will be given a structured rubric to use during the conference presentations. The intent of this rubric is to standardize the grade evaluation and determination among the various projects and mentors. A second rubric is being developed in coordination with our outcome champions to target assessment of student attainment of our program’s student outcomes.

Other significant design experiences are available to our students through the Bowman and Trident Scholar programs. These highly selective programs are accessible to our advanced students who are sufficiently ahead in their required course work for the major. Due to the high level of achievement and extensive workload expected in the Trident program, students selected as Trident Scholars are generally excused from EE411. These students spend significant time in the development of their project proposal during their junior spring semester and must orally defend their proposal to both an engineering division-wide committee and an institution-wide committee of professors. The program is highly selective and only a well-prepared and presented proposal is accepted. This rigorous standard and the many hours of one-on-one instruction with the mentor team are seen as more than sufficient to meet the intent of the capstone sequence for developing the skills to navigate a large project. Also, since their projects are already well defined before they even begin the 1/C year, the Trident scholars would be out-of-sync with the capstone course. If a Trident project, however, were deemed to not contain an element of design, however, that student would be required to separately complete EE411 and EE414/EC415 with a different project.

The Bowman program is newer and less rigorous than the Trident Scholar program. Bowman scholars are required only to add one independent study course to their matrix. Originally, the Bowman program operated completely independently from capstone; Bowman scholars simply had to complete two projects. However in practice this was unsatisfactory, because it is difficult for midshipmen (or anyone) to focus on multiple open-ended technical projects while facing the usual glut of daily deadlines. Both capstone and Bowman research projects suffered under this approach. More recently we have allowed Bowman scholars to essentially use the same project for both their independent study and capstone, but we asked them to define separate deliverables for the two courses with the help of their mentors. For example, one current Capstone/Bowman project, “Too Hot to Handle,” involves a study of energy efficiency and minimization strategies for biometric algorithms operating on smart phones. The capstone project focuses on the energy efficiency of known algorithms while the independent study focused on designing new biometric algorithms. The capstone project resulted in a conference paper. This approach has led to better projects but has its own issues. For example, it can be problematic when a student falls below
performance expectations to determine how to set the grades. The best approach is an issue of current discussion in the department.

Table 5-5. The Class of 2012 capstone projects, students and mentors.

<table>
<thead>
<tr>
<th>NAME</th>
<th>Project Working Title</th>
<th>Mentor Team</th>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOWERY</td>
<td>Budget Volt</td>
<td>Sellami/ Magnotta (Salem consulting)</td>
<td>Electric cars appear to be the wave of the future. Can we make one for less than $5K? This project challenges the students to build an electric car from a pre-existing dune buggy chassis (electric motor and transmission already attached). Students could focus on the battery power system, instrumentation for the driver, or the addition of a solar charging system.</td>
</tr>
<tr>
<td>SONCINI</td>
<td>The G.I. Spelunker</td>
<td>Firebaugh</td>
<td>Capsule endoscopy (the camera pill) is the current gold standard diagnostic procedure for imaging the small bowel in cases of suspected small bowel pathology, with approximately one million procedures having been performed to date. A major limitation of current systems is the fact that it is impossible to perform therapeutics (biopsy, drug delivery), with a major technical obstacle being the ability to maneuver a capsule within the small bowel. This project will explore methods for propelling and “steering” a capsule endoscope, with the goal of producing a prototype system.</td>
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<td>YEN</td>
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<td>MCINTYRE</td>
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<td>MARION</td>
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<td>POLIVY</td>
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<tr>
<td>PESKOSKY</td>
<td>Optical Neural Probe</td>
<td>Firebaugh/ Jenkins</td>
<td>Optical probes allow for much greater precision in probing neural activity. However, more work is needed on the optical neural probe interface to facilitate the use of such probes in studies in situ. This project would look at improvements to the manufacture and packaging of neural probes that would allow them to be used in a larger array of experiments.</td>
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<td>ENGLE</td>
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<tr>
<td>ZELMAT</td>
<td>Cockpit of the Future (Administered by EME)</td>
<td>Hamilton (EME)/ O’Marra (WSE)</td>
<td>Large, Boeing-sponsored competition among service academies to design cockpit of the future.</td>
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<td>AARON</td>
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<tr>
<td>CREMEAN</td>
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<tr>
<td>TINKHAM</td>
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<tr>
<td>FLORA (teamed with 3 systems engineering majors)</td>
<td>Untethered Microrobot Control</td>
<td>Firebaugh/ Piepmeier (WSE)</td>
<td>Microfabrication technology has allowed for the dramatic miniaturization of sensors and actuators to the size scale of individual cells, which has many potential applications in medicine, surveillance, and microassembly. This project would explore these capabilities through participation in the 2012 Mobile Microrobots competition. This competition challenges design teams to design and build a micro-scale robot that can perform a series of micromanipulation and microassembly tasks. Students will also have the opportunity to attend the competition, which is affiliated with the International Conference for Robotics and Automation (ICRA), which will be in Minnesota from May 14-18.</td>
</tr>
<tr>
<td>GOETZ</td>
<td>Optically-Controlled Reconfigurable Antennas</td>
<td>Mechtel/ Jenkins</td>
<td>The goal of this project is to design and implement an anatenna system using microstrip and optical switching that will cover a wider band of frequencies and allow beam shaping while not causing noise such as is associated with electronic or mechanical switching.</td>
</tr>
<tr>
<td>KINNEY</td>
<td>Portable Wind Power (Administered by EME)</td>
<td>Flack (EME)/ Flaherty</td>
<td>Expeditionary forces and recreational backpackers are increasingly carrying electronic gear such as cell phones and GPS units around in the field. There is a shortage of 120V outlets in the field making charging these devices difficult. There are limited products on the market that address this need and most are based on solar power. The goal of this project is to design and test a rugged, portable wind power generation system suitable for use by recreational backpackers and expeditionary groups. The system would need to lightweight and capable of charging common electronics (cell phones, iPods and GPS units) carried by a typical group.</td>
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<td>MILDEN</td>
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<td>BERTSCHINGER</td>
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<tr>
<td>VALLEJOS</td>
<td>Quadricopter</td>
<td>Rudd/Ngo/Rakvic</td>
<td>This project seeks to enhance the capability of a surveillance drone by adding a facial or iris recognition sub-system to this mobile platform. Team may combine with Trombetta’s project.</td>
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</tbody>
</table>
| SONG              | Surveillance and                       | Rudd/Ngo/Rakvic                        | Building an unmanned vehicle is easy. (Buying it off the shelf is even...
<table>
<thead>
<tr>
<th>NAME</th>
<th>Project Working Title</th>
<th>Mentor Team</th>
<th>Project Description</th>
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<tbody>
<tr>
<td>TROMBETTA</td>
<td>More Drone</td>
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<td>easier! Making it do something really useful is the challenge. Develop a next-generation surveillance (and more …) platform. Operate solo or in a swarm. Use video and various sensors to locate, identify, track, and constructively kill a target. It flies out of the box, but what it ultimately does is entirely up to you. Are you up to the challenge?</td>
</tr>
<tr>
<td>JANTZEN</td>
<td>Electrical to Roundy Roundy</td>
<td>Salem</td>
<td>The goal for this project is to create a project for future ECE students relating to the design and implementation of an H-bridge motor controller system.</td>
</tr>
<tr>
<td>MURTHY</td>
<td>Tidal Power: Green Energy Offshore Power Source</td>
<td>Flaherty/ Luznik (EME)</td>
<td>The goal of this project is to design and implement a renewable energy source that takes advantage of the energy stowed in waves, and can power a moderately sized client.</td>
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<tr>
<td>TORTORICH</td>
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<td>Expeditionary forces and recreational backpackers walk long distances, dissipating large amounts of mechanical energy. This project will explore whether this energy, which would otherwise be wasted, can be harvested and be used to charge useful portable electronic gear such as cell phones, radios, or GPS units.</td>
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<td>DEANE</td>
<td>Shoe Power</td>
<td>Wooten/ Firebaugh</td>
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<tr>
<td>PRATTS</td>
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<td>This project will be conducting research into the energy consumption of biometric algorithms on handheld mobile devices. As an example, the project may investigate facial and/or iris recognition software that has been written for use on devices such as smart phones or tablets.</td>
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<tr>
<td>GALE</td>
<td></td>
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<td>The goal of this project is to design and implement a brain to computer interface (BCI) which will allow medically disabled or handicapped users to operate a computer screen. The system will utilize the user’s brainwaves to allow the user to select letters and characters.</td>
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<tr>
<td>HOYLE</td>
<td>Too Hot to Handle</td>
<td>Ravkic/ Ives</td>
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<td>SANDERS</td>
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<td>THORNE</td>
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<td>The goal of this project is to develop a processing bottle to unify 8 underwater instruments critical to the statistical turbulent characterization of estuarine and coastal waters. The current ECTOP lacks synchronicity, unification and stay time.</td>
</tr>
<tr>
<td>HACK</td>
<td>Jedi Mind Tricks</td>
<td>Firebaugh</td>
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<td>HERBERT</td>
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<td>BRASSEA</td>
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<tr>
<td>DUFFY</td>
<td>Estuary Coastal Turbulence Observation Package (ECTOP) Digital Unification</td>
<td>Ngo/ Murphy/ Luznik (EME)</td>
<td>The goal of this project is to develop a processing bottle to unify 8 underwater instruments critical to the statistical turbulent characterization of estuarine and coastal waters. The current ECTOP lacks synchronicity, unification and stay time.</td>
</tr>
<tr>
<td>INGLIS</td>
<td>Wireless Network Security</td>
<td>Walker/ Anderson</td>
<td>This project explores methods for adding security to wireless networks.</td>
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<tr>
<td>JONES</td>
<td>An (Almost) Free GSM Base Station</td>
<td>Anderson</td>
<td>GSM is the most prominent protocol for cellular networks, encompassing around 80% of all telecommunication devices. Unfortunately, GSM networks are run almost entirely by cellular providers aiming to make a profit, and as a result are directed at areas that are going to offer the largest return on investment. This leaves more rural areas typically without decent cellphone coverage. The goal of this project is to implement a low-cost GSM base station that could serve functionally in a rural area or is capable of boosting cell phone reception in areas that are suffering (namely Bancroft Hall)</td>
</tr>
</tbody>
</table>
7. If your program allows cooperative education to satisfy curricular requirements specifically addressed by either the general or program criteria, describe the academic component of this experience and how it is evaluated by the faculty. Not applicable.

8. Describe the materials (course syllabi, textbooks, sample student work, etc.), that will be available for review during the visit to demonstrate achievement related to this criterion. (See the 2011-2012 APPM Section II.G.6.b.(2) regarding display materials.)

Available material for review during the site visit will include Course Reports containing: Course Policy, Course Policy Addendum, Textbooks, Course Syllabus, Learning Objectives, Website Files, Special Notes and Handouts, Quizzes, Tests, and Sample Student Work.

B. Course Syllabi
In Appendix A, include a syllabus for each course used to satisfy the mathematics, science, and discipline-specific requirements required by Criterion 5 or any applicable program criteria.
<table>
<thead>
<tr>
<th>Course</th>
<th>(Department, Number, Title)</th>
<th>Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE.²</th>
<th>Curricular Area (Credit Hours)</th>
<th>Engineering Topics Check if Contains Significant Design (√)</th>
<th>General Education</th>
<th>Other</th>
<th>Last Two Terms the Course was Offered: Year and, Semester, or Quarter³</th>
<th>Maximum Section Enrollment for the Last Two Terms the Course was Offered³</th>
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<td>Fall 12, Spr 12</td>
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<td>Fall 11, Fall 12</td>
<td>24 / 24</td>
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<td>Curricular Area (Credit Hours)</td>
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<td></td>
<td>Fall 12, Spr 12</td>
<td>21 / 24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE, EE411, Electrical &amp; Computer Engineering Design I</td>
<td>3√</td>
<td></td>
<td></td>
<td></td>
<td>Fall 11, Fall 12</td>
<td>16 / 11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE, EL1, Major Elective I</td>
<td>3</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>EE, EL2, Major Elective I</td>
<td>3</td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Fourth Year, Spring Term:</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NS, NS42X, Junior Officer Practicum (new course)</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>ES, ES300, Naval Weapons Systems</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>Fall 12, Spr 12</td>
<td>26 / 24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HH, HM SS2, Humanity Social Science Elective 2</td>
<td>3</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>EM, EM317, Thermo-Fluid Sciences II</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>Fall 12, Spr 12</td>
<td>18 / 24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE, EE414, Electrical Engineering Design II</td>
<td>2√</td>
<td></td>
<td></td>
<td></td>
<td>Spr 11, Spr 12</td>
<td>3 / 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE, EL3, Major Elective III</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTALS-ABET BASIC-LEVEL REQUIREMENTS</td>
<td>35</td>
<td>62</td>
<td>24</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>OVERALL TOTAL CREDIT HOURS FOR THE DEGREE</td>
<td>139</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PERCENT OF TOTAL</td>
<td>25.1%</td>
<td>44.6%</td>
<td>17.3%</td>
<td>12.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. **Required** courses are required of all students in the program, **elective** courses (often referred to as open or free electives) are optional for students, and **selected elective** courses are those for which students must take one or more courses from a specified group.
2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the maximum enrollment in each element. For selected elective courses, indicate the maximum enrollment for each option.
3. Year indicated is “Academic Year ending” (e.g., Fall 12 indicates fall semester of the academic year ending in 2012).

Instructional materials and student work verifying compliance with ABET criteria for the categories indicated above will be required during the campus visit.
Table 5-2. Class of 2012 Electrical Engineering Matrix

<table>
<thead>
<tr>
<th>4/C Fall</th>
<th>4/C Spring</th>
<th>3/C Fall</th>
<th>3/C Spring</th>
<th>2/C Fall</th>
<th>2/C Spring</th>
<th>1/C Fall</th>
<th>1/C Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>NS101 (2-0-2)</td>
<td>NN101 (1-2-2)</td>
<td>NE203 (3-0-3)</td>
<td>NN200 (1-2-2)</td>
<td>NS300 (0-2-1)</td>
<td>NL310 (3-0-3)</td>
<td>NL400 (2-0-2)</td>
<td>NS42X (0-2-1)</td>
</tr>
<tr>
<td>FUNDAMENTALS OF SEAMANSHIP</td>
<td>INTRODUCTION TO NAVIGATION</td>
<td>ETHICS &amp; MORAL REASONING FOR THE NAVAL LDR</td>
<td>NAVIGATION AND PILOTING</td>
<td>NAVAL WARFARE</td>
<td>LEADERSHIP: THEORY AND APPLICATIONS</td>
<td>LAW FOR THE JUNIOR OFFICER</td>
<td>JO PRACTICUM</td>
</tr>
<tr>
<td>SC111 (3-2-4)</td>
<td>SC112 (3-2-4)</td>
<td>SP211 (3-2-4)</td>
<td>SP212 (3-2-4)</td>
<td>HH2XY (3-0-3)</td>
<td>HH216 (3-0-3)</td>
<td>HUM SS I (3-0-3)</td>
<td>HUM SS II (3-0-3)</td>
</tr>
<tr>
<td>FOUNDATIONS OF CHEMISTRY I</td>
<td>FOUNDATIONS OF CHEM II</td>
<td>GENERAL PHYSICS I</td>
<td>GENERAL PHYSICS II</td>
<td>HISTORY ELECTIVE</td>
<td>THE WEST IN THE MODERN WORLD</td>
<td>LANGUAGE OR SOCIAL SCIENCE ELECTIVE</td>
<td>LANGUAGE OR SOCIAL SCIENCE ELECTIVE</td>
</tr>
<tr>
<td>SM121 (4-0-4)</td>
<td>SM122 (4-0-4)</td>
<td>SM221 (4-0-4)</td>
<td>SM212 (4-0-4)</td>
<td>ES410 (3-2-4)</td>
<td>EM316 (3-0-3)</td>
<td>EM317 (3-0-3)</td>
<td></td>
</tr>
<tr>
<td>CALCULUS I</td>
<td>CALCULUS II</td>
<td>CALCULUS III WITH VECTOR FIELDS</td>
<td>DIFFERENTIAL EQUATIONS</td>
<td>CONTROL SYSTEMS LABORATORY</td>
<td>THERMO-FLUID SCIENCES I</td>
<td>THERMO-FLUID SCIENCES II</td>
<td></td>
</tr>
<tr>
<td>HE111 (3-0-3)</td>
<td>HE112 (3-0-3)</td>
<td>SM313 (3-0-3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RHETORIC AND INTRO TO LITERATURE I</td>
<td>RHETORIC AND INTRO TO LIT II</td>
<td>PROBABILITY WITH APPL TO EE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HH104 (3-0-3)</td>
<td>FP130 (3-0-3)</td>
<td>EE221 (3-2-4)</td>
<td>SI204 (3-2-4)</td>
<td>EE322 (3-2-4)</td>
<td>EE354 (3-2-4)</td>
<td>EE411 (2-2-3)</td>
<td>EE414 (0-4-2)</td>
</tr>
<tr>
<td>AMERICAN NAVAL HISTORY</td>
<td>U. S. GOV'T</td>
<td>INTRODUCTION TO ELECTRICAL ENGINEERING I</td>
<td>INTRO TO COMPUTER SCIENCE</td>
<td>SIGNALS AND SYSTEMS</td>
<td>MODERN COMMUNICATIO N SYSTEMS</td>
<td>ELECT &amp; COMP ENG DESIGN I</td>
<td>ELECTRICAL ENG DESIGN II</td>
</tr>
<tr>
<td>NL110 (2-0-2)</td>
<td>EE242 (3-2-4)</td>
<td>EE241 (3-2-4)</td>
<td>EE320 (2-2-3)</td>
<td>EE372 (3-2-4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PREPARING TO LEAD</td>
<td>DIGITAL SYSTEMS (*now EC262)</td>
<td>ELECTRONICS I</td>
<td>ENGINEERING ELECTROMAGNE TICS</td>
<td>ELECTRICAL ELECTIVE I (varies, 3-4 credits)</td>
<td>ELECTRICAL ELECTIVE II (varies, 3-4 credits)</td>
<td>ELECTRICAL ELECTIVE III (varies, 3-4 credits)</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>18</td>
<td>19</td>
<td>18</td>
<td>18</td>
<td>17/18/19</td>
<td>15/16</td>
<td></td>
</tr>
</tbody>
</table>

Total Credits include Plebe Year: 139/140/141/142
Table 5-3. Mapping of courses to student outcomes.

<table>
<thead>
<tr>
<th>SO\CRS</th>
<th>SOPHOMORE (3/C)</th>
<th>JUNIOR (2/C)</th>
<th>SENIOR (1/C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FALL</td>
<td>SPRING</td>
<td>FALL</td>
</tr>
<tr>
<td>EE221</td>
<td>I</td>
<td>RA</td>
<td>RA</td>
</tr>
<tr>
<td>EE242</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>SI204</td>
<td>I</td>
<td>RA</td>
<td>RA</td>
</tr>
<tr>
<td>EE241</td>
<td>I</td>
<td>RA</td>
<td>RA</td>
</tr>
<tr>
<td>EE322</td>
<td>I</td>
<td>RA</td>
<td>RA</td>
</tr>
<tr>
<td>EE320</td>
<td>I</td>
<td>RA</td>
<td>RA</td>
</tr>
<tr>
<td>EE361</td>
<td>I</td>
<td>RA</td>
<td>RA</td>
</tr>
<tr>
<td>EE371</td>
<td>I</td>
<td>RA</td>
<td>RA</td>
</tr>
<tr>
<td>EE411</td>
<td>I</td>
<td>RA</td>
<td>RA</td>
</tr>
<tr>
<td>ELEC1</td>
<td>I</td>
<td>RA</td>
<td>RA</td>
</tr>
<tr>
<td>ELEC2</td>
<td>I</td>
<td>RA</td>
<td>RA</td>
</tr>
<tr>
<td>ELEC3</td>
<td>I</td>
<td>RA</td>
<td>RA</td>
</tr>
</tbody>
</table>

I - Introduce, R - Reinforced, A - Assessed
Table 5-4. Class of 2012 Electrical Engineering Prerequisite Matrix

<table>
<thead>
<tr>
<th>Sophomore</th>
<th>3/C Fall</th>
<th>3/C Spring</th>
<th>Junior</th>
<th>2/C Fall</th>
<th>2/C Spring</th>
<th>Senior</th>
<th>1/C Fall</th>
<th>1/C Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE221</td>
<td>INTRODUCTION TO ELECTRICAL</td>
<td>EE241</td>
<td>EE322</td>
<td>EE354</td>
<td></td>
<td></td>
<td>EE411</td>
<td></td>
</tr>
<tr>
<td>ENGINEERING I</td>
<td>ELECTRONICS I</td>
<td>(3-2-4)</td>
<td>(3-2-4)</td>
<td>(3-2-4)</td>
<td></td>
<td></td>
<td>(2-2-3)</td>
<td>(0-4-2)</td>
</tr>
<tr>
<td>Prerequisite: SM121 - Calculus I</td>
<td>Prerequisite: EE221 - Introduction to Electrical Engineering I or EE331 - Electrical Engineering I</td>
<td>Prerequisite: EE241 - Electronics I or EC244 ELECTRONICS/ ELECTROMECHANICS or Approval of Department Chair</td>
<td>Prerequisite: EE322 - Signals and Systems or Approval of Department Chair</td>
<td>Prerequisite: 1/C Standing in EEE or ECE or Approval of Department Chair</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE242*</td>
<td>DIGITAL SYSTEMS</td>
<td>S204</td>
<td>EE320</td>
<td>EE372</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*now EC262</td>
<td>Prerequisite: None</td>
<td>(3-2-4)</td>
<td>(2-2-3)</td>
<td>(3-2-4)</td>
<td></td>
<td></td>
<td></td>
<td>(varies, 3-4 credits)</td>
</tr>
<tr>
<td>Prerequisite: None</td>
<td>INTRO TO COMPUTER SCIENCE</td>
<td>INTRO TO ELECTRICAL ENGR II</td>
<td>Prerequisite: EE221 - Introduction to Electrical Engineering I</td>
<td>Prerequisite: SP212 - General Physics II or SP222 - Electricity and Magnetism I</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE361*</td>
<td>MICROCOMP-BASED DESIGN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ELECTRICAL ELECTIVE II (varies, 3-4 credits)</td>
<td></td>
</tr>
<tr>
<td>*now EC361</td>
<td>Prerequisite: EE242 - Digital Systems or EE313 - Logic Design and Microprocessors or EE332 - Electrical Engineering II or EE334 - Electrical Engineering and IT Systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Prerequisite: Based upon Course selected</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ELECTRICAL ELECTIVE II (varies, 3-4 credits)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Prerequisite: Based upon Course selected</td>
<td></td>
</tr>
</tbody>
</table>
CRITERION 6. FACULTY

In this criterion, we present the faculty of the Electrical Engineering program at the Naval Academy. We begin by noting that while the Electrical Engineering program and Computer Engineering program are distinct degree-granting programs, there is significant overlap in the core curricula of the programs and they share a number of common electives. Not surprisingly, the vast majority of Electrical and Computer Engineering Department faculty teach and interact with students in both programs. For the purposes of this report, we will largely include all department faculty in our discussion and results except where it is instructive to segregate them by their primary area of instruction and research. Most notably, we employ this segregated approach to demonstrate that the faculty-to-student and faculty-to-advisee ratios reflect adequate faculty size in the Electrical Engineering program.

Due to their size, Table 6-1 Faculty Qualifications and Table 6-2 Faculty Workload Summary are provided at the end of this criterion. Appendix B contains faculty resumes for all current Electrical and Computer Engineering Department faculty members.

A. Faculty Qualifications

Describe the qualifications of the faculty and how they are adequate to cover all the curricular areas of the program. This description should include the composition, size, credentials, and experience of the faculty. Complete Table 6-1. Include faculty resumes in Appendix B.

Composition of Faculty

The US Naval Academy’s unique educational mission requires a balanced mixture of both civilian and military faculty members. This balanced breakdown is clearly reflected in the composition of the Electrical and Computer Engineering Department.

The civilian faculty cohort maintains the long-term educational continuity of our program. In general, the majority of our civilian faculty are tenured or tenure-track. They are augmented by a small set of non-tenure-track faculty comprised of Visiting Professors, Distinguished Chairs, and, as needed, adjunct faculty members. At the start of Academic Year 2011-2012, the civilian faculty of the Electrical and Computer Engineering Department consisted of one tenured Full Professor, eight tenured Associate Professors, three tenure-track Assistant Professors, two special Chairs, one Visiting Professor, and five Adjunct Professors. As we discuss in greater detail in Section C of this criterion, rank composition of our faculty continues to be a challenge as we will have only two Full Professors in the department at the start of Academic Year 2012-2013.

50 At the time of the submission of this report, the department has one Full Professor and another selected for promotion to Full Professor. The promotion of the latter will be effective August 2012.
The military faculty provides a unique, mission-specific educational perspective to our future officers. They can be grouped into three primary categories. The first are senior military officers (rank of commander and above) with doctoral degrees and significant military experience. They are typically assigned to the Naval Academy for a minimum of three years and are often actively involved in subject matter research. Permanent Military Professors (PMPs) are a subset of this senior group who are permanently assigned to the Naval Academy (normally six to ten years until they reach statutory retirement at the end of their military careers). These PMPs not only conduct research in their field of expertise, but they also compete for academic promotion. The second group consists of rotational military instructors with master’s degrees that are assigned to the Naval Academy for two to three years. These are typically junior officers (Navy ranks of lieutenant and lieutenant commander or Marine Corps ranks of captain or major), although there are also some senior officers as well. The third group of officers are a hybrid of the first two groups. They are Junior Permanent Military Professors (JPMPs) of rank lieutenant commander and hold a master’s degree. They are permanently assigned to the Naval Academy, typically conduct research in their field of expertise, and are often pursuing a doctoral degree. At the start of Academic Year 2011-2012, the Electrical and Computer Engineering Department had four senior military officers with doctoral degrees (including 2 PMPs), 15 rotational military instructors, and two JPMPs.

Faculty composition for the last six years is shown in Table 6-3 (recall that we have included Tables 6-1 and 6-2 at the end of this criterion due to their size). While faculty size in the department has remained relatively constant, the ratio of military faculty to civilian faculty has slowly risen. This reflects the institution-wide effort to reach a 50/50 split (294 military faculty and 294 civilian faculty) and reduce the need for adjunct faculty by increasing the number of military officers. As can be seen, for the academic year 2011-2012, the Electrical and Computer Engineering Department faculty had a total of 40 members.

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>2011-12</th>
<th>2010-11</th>
<th>2009-10</th>
<th>2008-09</th>
<th>2007-08</th>
<th>2006-07</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civilian Faculty:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full Professors</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Associate Professors</td>
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<td>7</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Assistant Professors</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Special Chairs</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Visiting Professors</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Adjuncts</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Military Faculty:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Military (PhD)</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Military (EE/MS)</td>
<td>17</td>
<td>17</td>
<td>18</td>
<td>16</td>
<td>16</td>
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</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>40</td>
<td>41</td>
<td>39</td>
<td>40</td>
<td>41</td>
</tr>
<tr>
<td>Military:Civilian Ratio</td>
<td>1.11</td>
<td>1.11</td>
<td>1.16</td>
<td>0.86</td>
<td>0.90</td>
<td>0.86</td>
</tr>
</tbody>
</table>

Table 6-3. Faculty Composition of Electrical and Computer Engineering Department
Size of Faculty

In addition to faculty workload which is addressed in the next section, we use two primary metrics to evaluate the adequacy of the size of our faculty: the student-to-faculty ratio and the number-of-sections-to-faculty ratio. Based on these metrics, we have found the size of the faculty in our Electrical Engineering program to be adequate. The supporting data and evaluation follows.

We evaluate the overall size of the department faculty by examining the student-to-faculty ratio and the number-of-sections-to-faculty ratio across all courses taught by the department. These include several courses that are taught to all students outside of the electrical and computer engineering programs. The overall student-to-faculty ratio and the overall section-to-faculty ratios are shown in Tables 6-4 and 6-5. The average student-to-faculty ratio across all courses taught by the department over the last six years is 32.49 while the average number of sections, per semester, for a faculty member is 1.9.

To evaluate the adequacy of the size of the faculty specific to the Electrical Engineering program, we examine: (1) the student-to-faculty ratio for all Electrical and Computer Engineering Department students and faculty (both electrical and computer engineering) and (2) the student-to-faculty ratio for electrical engineering students and faculty members focused on instruction and research in electrical engineering. The latter provides important insight, for example, on the support a student can expect to receive when the student is selecting their senior design project while the former provides a measure of the interaction a student can expect in the majority of their courses. The student-to-faculty ratio for students in the Electrical Engineering program are shown in Table 6-4. The average student-to-faculty ratio for students within the department over the last six years is 2.37 across all ECE students and faculty. To calculate a representative student-to-faculty ratio within the Electrical Engineering program alone, we need to artificially segregate the faculty. Based on course assignments and research, we find that at the start of Academic Year 2011-2012, there were 13 faculty members who primarily teach the Electrical Engineering majors and another five whose course load includes some (but not a majority) of Electrical Engineering sections. The program had 61 enrolled students during this time which leads to a student-to-faculty ratio in the Electrical Engineering program of 4.69 during this academic year.

We find these to be reasonable ratios reflecting the opportunity for our faculty members to directly interact with their students. This finding is further supported by the fact that students taking courses within the department rarely cite instructor non-availability as a concern in their end-of-course evaluations.
Credentials of Faculty

Here, we examine the education and professional registration of our faculty. Table 6-6 provides a breakdown of the highest degree held by our faculty members for the last four academic years. The average split between Ph.D. and M.S. degrees in the department is 43% to 52%. Given the unique focus of a military academy and the need to teach a large number of electrical engineering core course sections to non-engineering students, this ratio has been found to meet the needs of our students. In addition, our department currently has five certified professional engineers and two engineers in training.

Table 6-4. Student-to-faculty ratio for all students and for ECE students.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE faculty members</td>
<td>40</td>
<td>40</td>
<td>41</td>
<td>39</td>
<td>40</td>
<td>41</td>
</tr>
<tr>
<td>Total number of students taught</td>
<td>1312</td>
<td>1406</td>
<td>1316</td>
<td>1313</td>
<td>1228</td>
<td>1284</td>
</tr>
<tr>
<td>Number of ECE students taught</td>
<td>91</td>
<td>98</td>
<td>109</td>
<td>90</td>
<td>93</td>
<td>92</td>
</tr>
<tr>
<td>Overall student-to-faculty ratio</td>
<td>32.80</td>
<td>35.15</td>
<td>32.10</td>
<td>33.67</td>
<td>30.70</td>
<td>31.32</td>
</tr>
<tr>
<td>ECE student-to-faculty ratio</td>
<td>2.28</td>
<td>2.45</td>
<td>2.66</td>
<td>2.31</td>
<td>2.33</td>
<td>2.24</td>
</tr>
</tbody>
</table>

Table 6-5. Number-of-sections-to-faculty ratio for all courses taught.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE faculty members</td>
<td>40</td>
<td>40</td>
<td>41</td>
<td>39</td>
<td>40</td>
<td>41</td>
</tr>
<tr>
<td>Total number of sections taught</td>
<td>80</td>
<td>83</td>
<td>82</td>
<td>77</td>
<td>66</td>
<td>71</td>
</tr>
<tr>
<td>Overall section-to-faculty ratio</td>
<td>2.00</td>
<td>2.08</td>
<td>2.00</td>
<td>1.97</td>
<td>1.65</td>
<td>1.73</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>2011-12</th>
<th>2010-11</th>
<th>2009-10</th>
<th>2008-09</th>
<th>4-year Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE faculty members</td>
<td>40</td>
<td>40</td>
<td>41</td>
<td>39</td>
<td>40</td>
</tr>
<tr>
<td>PhD degrees</td>
<td>18</td>
<td>17</td>
<td>17</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Engineer degrees</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>MS degrees</td>
<td>20</td>
<td>21</td>
<td>22</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>Percentage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PhD degrees</td>
<td>45%</td>
<td>43%</td>
<td>41%</td>
<td>46%</td>
<td>44%</td>
</tr>
<tr>
<td>Engineer degrees</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>MS degrees</td>
<td>50%</td>
<td>53%</td>
<td>54%</td>
<td>49%</td>
<td>51%</td>
</tr>
</tbody>
</table>

Table 6-6. Highest academic degrees held by ECE Department faculty members.
**Experience of Faculty**

While no degree concentration areas are offered within the Electrical Engineering program, our faculty possesses a wide-breadth of topical expertise and experience within electrical and computer engineering which ensures a competent and qualified set of course offerings. The faculty relationship to the topical coverage of our program as well as their research interests and affiliations is provided in Table 6-7. Our Electrical Engineering students have the opportunity to gain experience in many sub-disciplines including communication systems, signal processing, fiberoptics, power, and semiconductors. Specific faculty qualifications, credentials, and experience are presented in Table 6-1 and in the faculty resumes found in Appendix B.

To be effective teachers and mentors at the undergraduate level, our long-term faculty members (both civilian and permanent military professors) are expected to maintain a currently relevant subject matter expertise. To this end, these faculty members are required to engage in an active research program and are allotted dedicated research time on a weekly basis. It is expected that these efforts will produce both conference and journal level presentations and publications by the faculty members. Last year alone, as shown in Table 6-8, our faculty members presented 17 conference papers and published 10 peer-reviewed journal articles. Details of these accomplishments can be found in the individual faculty vitaes of Appendix B.

Finally, we should again emphasize that the Naval Academy prides itself as a top-notch undergraduate teaching institution. Institutional leadership encourages our faculty members to routinely share their teaching strategies, techniques and methodologies through published articles in educational-related conferences and journals. Recent examples among our Electrical and Computer Engineering faculty included 14 pedagogical articles over the last six years as seen in Table 6-8.
<table>
<thead>
<tr>
<th>Topical coverage</th>
<th>Research Areas</th>
<th>Research Collaborators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chris Anderson</td>
<td>Communications</td>
<td>Wireless and RF measurements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Univ of Missouri, VA Tech, Worcester Poly Tech, NRL, ONR, NASA, GA Tech, AFIT</td>
</tr>
<tr>
<td>Justin Blanco</td>
<td>Signal processing, statistics</td>
<td>Biomedical signal processing/nerural engineering</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New faculty, none established yet</td>
</tr>
<tr>
<td>Samara Firebaugh</td>
<td>Engineering design, instrumentation, semiconductor</td>
<td>Integrated chemical analysis, microrobotics, RF microsystems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Woods Hoke Oceanographic Institution</td>
</tr>
<tr>
<td>Rob Ives</td>
<td>Signal processing, biometrics</td>
<td>Image processing, pattern recognition, biometrics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>National Security Agency</td>
</tr>
<tr>
<td>Brian Jenkins</td>
<td>Circuits, electronics, fiberoptics</td>
<td>Fiber optics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ONR, APL</td>
</tr>
<tr>
<td>Chris Mayer</td>
<td>Operating systems</td>
<td>Operating systems, algorithms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Air Force Institute of Technology</td>
</tr>
<tr>
<td>Deborah Mechtel</td>
<td>Electromagnetism</td>
<td>Broadband planar antennas and smart structures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Naval Sea Systems Command</td>
</tr>
<tr>
<td>Hau Ngo</td>
<td>Computer architecture and interfacing</td>
<td>Computer architecture, biometrics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>National Security Agency</td>
</tr>
<tr>
<td>Ryan Rakvic</td>
<td>Computer architecture and interfacing</td>
<td>Microarchitecture, parallel processing, embedded design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>National Security Agency</td>
</tr>
<tr>
<td>Kevin Rudd</td>
<td>Advanced computer architecture and parallel computing</td>
<td>Computer architecture, low power and high performance computing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Johns Hopkins Applied Physics Laboratory</td>
</tr>
<tr>
<td>Tom Salem</td>
<td>Electronics, circuits</td>
<td>Power electronic components and systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>U.S. Army Research Laboratory</td>
</tr>
<tr>
<td>Antal Sarkady</td>
<td>Communications</td>
<td>Acoustics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>U.S. Naval Research Laboratory</td>
</tr>
<tr>
<td>Robert Schultz</td>
<td>Microprocessors</td>
<td>Signal processing, biometrics, ios &amp; android application development</td>
</tr>
<tr>
<td></td>
<td></td>
<td>National Security Agency</td>
</tr>
<tr>
<td>Louisa Sellami</td>
<td>Semiconductors</td>
<td>Integrated sensors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Univ of Maryland, Univ of Madrid, Univ of California, Irvine, George Washington Univ.</td>
</tr>
<tr>
<td>Pat Vincent</td>
<td>Operating systems, Data structures, networks</td>
<td>Algorithms, data structures, computer programming, networks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New faculty, none established yet</td>
</tr>
<tr>
<td>Owens Walker</td>
<td>Microprocessor interfacing, networks</td>
<td>Networks, wireless networks, cyber security</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Naval Postgraduate School, National Security Agency</td>
</tr>
</tbody>
</table>

Table 6-7. Faculty topical coverage and research area.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Conference Proceedings</td>
<td>17</td>
<td>18</td>
<td>37</td>
<td>11</td>
<td>17</td>
<td>8</td>
<td>108</td>
</tr>
<tr>
<td>Journals</td>
<td>10</td>
<td>11</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>31</td>
</tr>
<tr>
<td>Pedagogical</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>Books/Chapters</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>Patents</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Total per year</td>
<td>36</td>
<td>37</td>
<td>42</td>
<td>16</td>
<td>23</td>
<td>23</td>
<td>177</td>
</tr>
</tbody>
</table>

Table 6-8. Faculty publications.
B. Faculty Workload

Complete Table 6-2, Faculty Workload Summary, and describe this information in terms of workload expectations or requirements.

With a widely recognized reputation as a strong undergraduate-only educational institution, the Naval Academy has the distinct mission to prepare the future officers for the Naval and Marine Corps Services. Our faculty is actively engaged in all aspects of student instruction – individually preparing, teaching, and grading all course and laboratory work without the aid of teaching assistants or dedicated graders. A full teaching load is required of all faculty and normally consists of two course sections each semester. In addition, our students have scheduling priority for additional faculty time to receive extra instruction (office hours) as requested.

As an institution, the Naval Academy uses a workload measure called the Total Midshipmen Contact (TMC) hours to determine optimal department sizing. For a given section of a course this corresponds to the product of the number of midshipmen in the section and the number of contact hours for the course. All courses are given a designation that indicates the lecture hours, lab hours, and credits as (Lecture hours – lab hours – credit hours). Lecture classes without a lab are typically designated (3-0-3) and have three contact hours. Most courses with labs are designated either (2-2-3) or (3-2-4) and have four and five contact hours, respectively. A nominal teaching load for a professor consists of either three sections of a lecture course or two sections of a lecture with lab course. For a section size of 20, the TMC for three sections of a (3-0-3) course would be 180. Using the same section size, the TMC for two sections of a (2-2-3) is 160, and two sections of a (3-2-4) is 200. The desired average TMC for the department when “fully staffed” is in the neighborhood of 160. Average TMC within the Electrical and Computer Engineering Department is shown in Table 6-9, calculated based on loading during spring semester of each academic year. It can be seen that, based on this workload measure, the size of our department is adequate but the workload is rising and, for the last two years, has been above the desired target.

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>2011-12</th>
<th>2010-11</th>
<th>2009-10</th>
<th>2008-09</th>
<th>2007-08</th>
<th>2006-07</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE faculty members</td>
<td>40</td>
<td>40</td>
<td>41</td>
<td>39</td>
<td>40</td>
<td>41</td>
</tr>
<tr>
<td>Total Midshipmen Contact (TMC) hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recitation</td>
<td>4020</td>
<td>3850</td>
<td>3709</td>
<td>3534</td>
<td>3602</td>
<td>3551</td>
</tr>
<tr>
<td>Laboratory</td>
<td>2750</td>
<td>2694</td>
<td>2554</td>
<td>2508</td>
<td>2484</td>
<td>2432</td>
</tr>
<tr>
<td>ECE Dept. TMC hours</td>
<td>6770</td>
<td>6544</td>
<td>6263</td>
<td>6042</td>
<td>6086</td>
<td>5983</td>
</tr>
<tr>
<td>Average TMC hours per faculty member</td>
<td>169.25</td>
<td>163.60</td>
<td>152.76</td>
<td>154.92</td>
<td>152.15</td>
<td>145.93</td>
</tr>
</tbody>
</table>

Table 6-9. Total Midshipmen Contact (TMC) hours for the ECE Department.
As a department, the Electrical and Computer Engineering Department outlines workload expectations in ECEDeptNote 12550:

“i) Teaching is the most important performance criteria; no amount of research, scholarly, or extracurricular accomplishment can outweigh mediocre performance in the classroom. Some examples (not an exhaustive list) of broad measures of effective teaching include the establishment of an environment that fosters student learning, demonstrated student learning and motivation to learn, contributions of individual faculty members to assessment of student learning, application of assessment results to improve student learning, tangible course and laboratory development, regular peer and student evaluation of the course and instruction received, mentoring midshipmen in directed study and research courses, and serving as a Trident Scholar or Bowman advisor (which also represents research and scholarly activity in most cases).

(ii) Research/scholarship appropriate to the discipline, like excellence in classroom teaching, is a continuing expectation for all faculty members throughout a career at the Naval Academy. Tangible evidence of research/scholarly excellence, especially evidence that is peer-validated, provides the strongest single indicator of a person’s currency in his or her academic discipline, as well as exemplifying that person’s ability to foster a thirst for life-long learning among the midshipmen. Some examples or indicators of research/scholarship performance (again, not an exhaustive list) are peer-evaluated publications and presentations, patents and patent applications, authorship of books or book chapters, invitations to participate in or lead conference panels and workshops, and the acquisition of external research grant support.

(iii) Service is a faculty responsibility at the Naval Academy, and it provides important evidence of the candidate’s comprehensive understanding of and commitment to the Naval Academy mission. In fact, demonstrated contributions in service to the Naval Academy are a primary means for determining a person’s ability to work effectively with others in advancing the Academy mission beyond the contributions normally associated with classroom teaching. Some examples of service contributions (again, not an exhaustive list) include participating in significant curriculum development activities, serving on the Faculty Senate, contributing to department, division, or institutional assessment activities, participating as a faculty representative for a major extracurricular activity or club or varsity sport, and substantive committee service at every level of the Naval Academy. It may also include professional service such as conference planning, work on behalf of professional organizations, or reviewing books and journal articles.

(iv) The level of scholarship and service will be evaluated with consideration of the academic rank of the faculty member. The service element of a tenure-track faculty member is not expected to be as significant as that of a tenured faculty member in order to receive an excellent ranking. Similarly, senior faculty are expected to demonstrate leadership in their service endeavors or other significant contributions to the institution in order to receive an excellent ranking.”
C. Faculty Size

Discuss the adequacy of the size of the faculty and describe the extent and quality of faculty involvement in interactions with students, student advising and counseling, university service activities, professional development, and interactions with industrial and professional practitioners including employers of students.

The adequacy of the size of the faculty is discussed in Sections A and B of this criterion. Accordingly, the following focuses primarily on the extent and quality of faculty involvement.

Faculty involvement with students

The nature of the Naval Academy, undergraduate only with all students living “on campus,” leads to extensive interaction between the faculty and the students. All class sections are normally sized at less than 22 students to maximize the student-faculty interaction. In each course, students are also routinely encouraged to seek one-on-one time with faculty members for either extra instruction on the course material or to engage in professional discussions leveraging the military experience of the instructor.

As discussed earlier, we have found the size of the faculty in our Electrical Engineering program to be adequate. We have on the order of one faculty for a little more than two students allowing for an intimate experience between student and faculty. Almost every major course has an associated lab that is taught by the course instructor where the student is given the opportunity for one-on-one instruction. Additionally, most senior design projects are mentored by at least two faculty members, generally one long term faculty member plus one military officer. In addition to bringing subject matter expertise and military experience, the military officer brings added leadership and discipline into the project activities. The ratio of students to long-term faculty members is provided in Table 6-10.

Students are also assigned an individual faculty advisor for guiding their academic progress through their course of study at the Academy. The advisor-to-advisee ratio is also presented in Table 6-10. All long-term faculty are expected to serve as academic advisors which is a central role for all faculty at the Naval Academy. Academic advisors typically meet with their advisees multiple times per semester as discussed in detail in Criterion 1, Section D.

<table>
<thead>
<tr>
<th></th>
<th>AY2011-12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Electrical</td>
</tr>
<tr>
<td>Number of students (Major)</td>
<td>90</td>
</tr>
<tr>
<td>Number of Long Term Faculty</td>
<td>13</td>
</tr>
<tr>
<td>Number of Advisors</td>
<td>11</td>
</tr>
<tr>
<td>Advisor to Advisee ratio</td>
<td>8.18</td>
</tr>
</tbody>
</table>

Table 6-10. Student to advisor ratios for both Electrical and Computer Engineering

Another opportunity for faculty to teach students about the Electrical Engineering profession is through involvement in student chapters of professional societies and by involving students in
conferences sponsored by professional societies. IEEE has recently endorsed the establishment of a Chapter of IEEE-Eta Kappa Nu at the United States Naval Academy. The Chapter is the "Lambda Kappa" Chapter of IEEE-Eta Kappa Nu and the installation ceremony (including induction of the charter members) was held on April 26th, 2012.

There are also opportunities for faculty to interact with students that are not necessarily in their department or division by serving as a faculty representative for an athletic team or club. Monitoring the academic progress or each member of the team and counseling when necessary is a routine and essential duty of the Faculty Representative. Faculty Representatives counsel midshipmen on selection and change of majors, assist midshipmen to pre-register for appropriate courses, advise midshipmen about summer school, monitor extra-instruction for midshipmen who need it, and advise the Coaches and Officer Representatives on the academic status of the team members. They are also encouraged to attend practices and games when they can, including traveling with the team for away events.

Faculty involvement with industry, research institutions, and employers of our graduates

Many of the long term faculty members have ties with industry as well as research institutions. These faculty members not only bring their experience into their classroom lectures, but they also involve the students by proposing related senior design projects and serving as their faculty mentors for those projects. Sometimes these interactions result in students being assigned to summer research or internship opportunities. As an example, for the summer of 2012, the list of places for internships and research sponsorship include the National Security Agency, U.S. Naval Research Laboratory, Navy Cyber Warfare Development Group, Crossmatch Technologies, Scientific and Biomedical Microsystems, the Scitor Corporation, Naval Air Systems Command, U.S. Pacific Command, Naval Sea Systems Commands, Woods Hole Oceanographic Institution, U.S. Army Research Laboratory, Southern Methodist University and The Johns Hopkins University.

Uniquely, all of our graduates are ultimately assigned to military service. Therefore, the opportunity for both our students and our civilian faculty members to interact with our military officers, who represent the future employers of our graduates, is of particular value and importance. These military faculty officers provide insight into future assignments, duties, demands, responsibilities, and requirements for our students. In addition, as indicated in Table 6-7, a number of our faculty members have research ties to Department of Defense research institutions and sponsors. These DoD-specific research connections serve to not only ensure that the research at the Naval Academy supports military priorities, but they also help to keep our faculty informed on the “needs of the Navy and Marine Corps warfighter.”

Faculty involvement in university service activities

The department has the requirement to support various university-level committees, demands, and responsibilities. These include representatives on the Faculty Senate, as well as additional membership on Senate sub-committees, institutional boards, and provisional advisory committees. Specific ECE Department faculty service includes (but is not limited to):
• Plebe Advisor
• Graduate Education Program Advisor
• IEEE faculty Rep
• Sexual Assault/Victim Intervention (SAVI) Liaison
• Library Liaison
• Varsity Football Tutor
• Independent Studies
• Department Internship Coordinator
• Division I Curriculum Committee Member
• Senate Core Curriculum Subcommittee Member
• Raouf Award Committee Member
• Academic Affairs Committee Member
• Faculty Senate Finance Committee Member
• Department Stem Coordinator
• Trident Scholarship Committee Member (Div & Dept)
• Naval Academy Research Council (NARC) Committee Member
• Midshipmen Research Liaison
• Director, USNA Center for Biometric Signal Processing
• Chair, Research Committee
• Research Committee Member
• Research Award Committee Member

It should be noted that the rank composition of our faculty continues to be a challenge as these institutional burdens are unduly placed on faculty who are still trying to achieve academic promotion. This shortcoming was highlighted in the report from our most recent external visiting committee which stated:

There is only one faculty member at the rank of Professor in the department. This number is very low for a department of this size. In a comparable department at other academic institutions there would be at least 5 Professors for a healthy and well balanced faculty. This lack of Professors places an increased workload on the Associate and Assistant Professors with respect to service activities, decreasing available time for research and publication activities that are required for promotion and tenure.  

We continue to seek opportunities to grow our number of full professors through both academic promotion and hiring actions. With a recent academic promotion that is effective August 2012, we will have two full professors in our program for the upcoming fall term.

D. Professional Development

Describe the professional development activities that are available to faculty members.

The department and the institution provide faculty members with a multitude of opportunities designed to enhance their professional skills. These can be seen as both research-related and teaching-related.

The department seeks to provide assistant professors travel funding for up to three conferences per year, with the expectation that they will present papers at 2 of the three. The department also strives to make travel funding available for associate professors to attend up to 2 conferences or

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workshops, and for full professors to attend up to 1 conference/workshop per year. It also ensures that each civilian and PMP faculty member is normally given one day off each week during both the fall and spring semesters in order to dedicate time for their research. Tenured and tenure-track faculty are also expected to conduct research work in their field during the summer months. Similarly, long-term military faculty are typically provided the opportunity for research during the summer. The academy provides summer funding for new assistant professors to support research for up to the first 3 years through the Naval Academy Research Council (NARC) program. There is also limited senior-NARC funding for associate and full professors to reinvigorate their research. Research collaboration, not competition, is encouraged amongst the faculty at the Naval Academy.

To support teaching development in our faculty, the Electrical and Computer Engineering Department has an active peer-to-peer teaching mentorship program that is governed by our department notice 1531.20. Through this program, peer teaching pairs are assigned on a rotating semester-by-semester basis. These pairs observe one another in the classroom and provide both written and oral feedback. The department also has a Rotational Faculty Mentoring Program (Department Notice 1754) to develop the teaching skills of new rotational military faculty members upon their arrival at the Naval Academy. Through this program, new military faculty members are assigned a mentor that will regularly meet with and observe them during their first three months of teaching. Among other guidance, the mentor will help the new faculty member to develop his/her own teaching style, teaching strategies and lecture notes, provide coaching on time management and course management as well as assist in specific tasks such as preparing for their first day of lecture and developing their course website.

Across the institution, support for teaching development is also provided by the Naval Academy's Center for Teaching and Learning, which was created in January 1996 as a part of the Faculty Enhancement Center. The Center's mission is to support faculty in providing the best possible academic instruction to the Brigade and to cultivate an institutional climate which promotes high quality student learning. The Center, which is directed by Dr. Rae Jean Goodman, provides programs to assist faculty in their scholarship of teaching and learning. Table 6-11 is a listing of workshops and seminars offered in a typical year. Most programs are offered in the summer when faculty have more time to devote to developing their teaching abilities. The Effective College Teaching course is extremely popular and many of our instructors, both military and civilians alike, participate in this course. The department and the TLC also provide funding to attend workshops/seminars outside the academy. The Faculty Development Committee administers the Faculty Development Fund (ACDEANINST 4001.2) for this purpose when departmental funds are not available or appropriate.

The academy also provides faculty funding to support development of new courses or significant improvement of existing courses through the Curriculum Development Project (CDP) program (ACDEANINST 1553.1H). The primary objectives of the program are to provide an enhanced means for faculty to maintain the currency of course content and the effectiveness of course pedagogy, to ensure that courses, particularly core, division, and larger enrollment courses, are well connected to one another and well integrated within the curriculum as a whole, to foster creativity and innovations in curricular development and thereby enhance the intellectual growth of midshipmen, and to enhance curriculum and course assessment practices.
Further details on the professional development of our faculty can be found in the individual vitaes of Appendix B.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Dates</th>
<th>Presenters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective College Teaching</td>
<td>16-17 May (0830-1630)</td>
<td>Richard Felder and Rebecca Brent</td>
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Table 6-11. Teaching and learning workshops offered during summer 2011.

E. Authority and Responsibility of Faculty

Describe the role played by the faculty with respect to their guidance of the program, and in the development and implementation of the processes for the evaluation, assessment, and continuing improvement of the program, including its program educational objectives and student outcomes.

All members of the Electrical and Computer Engineering Department are actively involved in both the guidance and continuous improvement of the Electrical Engineering Program. Specifically, we have a number of faculty committees as well as several assigned areas of individual responsibility as shown in Figure B-5 and discussed in the accompanying write-up in Background Section D. Organizational Structure.
As shown in Figure 6-1, the department’s assessment and evaluation (program improvement) organizational structure is unique and fosters ownership of the assessment process among all department faculty members and effectively distributes workload across the entire department. Student outcomes (a) through (k) are “championed” by individually assigned long-term (civilian and permanent military) faculty members and champions of similar outcomes are clustered together in groups. The groups are organized in a manner designed to leverage similarities in the educational strategies and assessment methods of the outcomes. Additionally, a Core Outcome Group has been established that adopts a similar structure for program improvement activities related to courses that we teach for students outside of the Electrical and Computer Engineering programs.

Some faculty members not assigned as Outcome Champions form a senior leadership team consisting of Outcome Group leaders, Electrical or Computer Engineering program leads, and the Department Assessment Chair. The Assessment Chair and program leads work together to ensure outcome champion recommendations are forwarded for approval, as necessary, to the Curriculum Committee and incorporated into the respective programs. This senior assessment leadership team also works together to assess and evaluate our graduates’ attainment of our program educational objectives utilizing the process discussed in Criterion 4, Section A. Program Educational Objectives. Remaining faculty members assume supporting roles designed to help outcome groups (Group Wingman) and/or the assessment team leadership (Tiger Team).

All faculty assignments are nominally based on a three-year rotation cycle. In this manner, all faculty members are actively engaged in and provide leadership for our assessment process. A sample assignment timeline for the Assessment Chair is shown in Figure 6-2. This timeline provides a one year turnover and added leadership to share workload during preparations for ABET Accreditation visits. As needed or desired, the advisor to the Assessment Chair may have dual hats (e.g., as one of the program leads). A nominal progression through assessment roles is shown in Figure 6-3. The turnover schedule of outcome champions and group leaders is designed to ensure that it aligns with the assessment schedule of the particular outcome(s). Faculty members are also rotated throughout outcomes and groups to broaden their exposure to our program improvement process.

The assessment process is also supported by the department’s Curriculum Committee and the various course coordinators. The curriculum committee, which consists of select faculty members, meets monthly during the academic year to review all proposed curriculum changes. Decisions are made available to course coordinators and outcome champions both electronically and hardcopy (the latter in the form of committee minutes which are posted in the department conference room). Each course has a course coordinator assigned whose responsibility is to ensure quality and continuity of the course. The course coordinator works with the curriculum committee, outcome champions and other faculty teaching the course to ensure that the program objectives are met and are consistent from year to year. More details on the role of the course coordinator are provided in Criterion 4, Section B.
The organization structure of our program improvement process was recently selected for presentation at the 2012 ABET Symposium in St. Louis, Missouri.\textsuperscript{52}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure6-1.png}
\caption{ECE Department Program Assessment Structure}
\end{figure}

Overall faculty guidance of the Electrical Engineering program is also achieved through participation on a number of committees within the department. Each committee is led by a faculty member, who acts as chairman of that committee. The committees make recommendations to the department chairman, or in some cases, to other committees. Some committees interact directly with either divisional or yard-wide committees. For example, curriculum change requests are initiated by the Outcome Champions and Curriculum Committee as described above, approved by the department chairman, and submitted through the Division I Curriculum Committee to the Faculty Senate Curriculum Committee. An organizational chart of the department is provided in Section D of the Background Information chapter. The ultimate responsibility for running the program rests with the department chairman. The department chairman has the authority to create new committees as needed to address issues when they arise. A set of departmental notices that govern the program are listed in Table 6-12 and included in Appendix F.
Describe the roles of others on campus, e.g., dean or provost, with respect to these areas.

The Academic Dean and Provost has ultimate authority over all academic affairs. He is assisted in the development and implementation of the processes for the evaluation, assessment, and continuing improvement of academic programs by the Academy Effectiveness Board (USNAINST 5420.36), the Director of Special Academic Programs, Dr. Peter Gray, the Faculty Senate Assessment Committee, and Faculty Senate Curriculum Committee.

The purpose of the Academy Effectiveness Board (AEB) is to coordinate the development, maintenance, and execution of the Naval Academy’s Effectiveness Plan and its associated assessment process. The focus of the Board and the Plan is the mission of the Naval Academy and its obligation to provide combat leaders of character. This institution-wide plan provides an assessment-based framework for implementing the Academy’s Strategic Plan, and covers all three mission areas (mental, moral, and physical) as well as all mission-support functions related to our four-year leadership immersion program. The AEB reports directly to the Superintendent and the Senior Leadership Team. It works closely with the respective leaders of the Academy’s mission areas (Commandant, Academic Dean, and Athletic Director) and mission-support functions (including Admissions, Deputy Superintendent/Chief of Staff, Deputy for Finance and Chief Financial Officer, and Deputy for Information Technology Services) to; (1) collaborate in planning and implementing effectiveness assessment within and among the Academy’s three mission areas; (2) provide models and support for the development and implementation of effectiveness assessment within the USNA mission support functions; and (3) monitor the global, Academy-wide effectiveness assessment processes. The Directors of Academic Assessment, Ethical Leadership Assessment, and Institutional Research ensure that the work of the AEB is supported with valid, reliable, and timely data and the best professional practices of institutional effectiveness assessment appropriate to the Naval Academy’s mission. The Director of Academic Assessment also provides institutional oversight of the academic assessment
process and facilitates communication between departments and divisions to enhance the improvement of the overall student experience.

The Faculty Senate Assessment Committee serves as the primary agency of the Senate dealing with Academic Assessment and is charged with monitoring academic assessment at the Naval Academy. The committee has two members from each of the four Divisions and one from the Physical Education Department. The Director of Academic Assessment serves as an ex officio member of the committee. The Committee plans and monitors the implementation of frameworks and timetables for academic assessment, in coordination with the Academic Dean, reviews departmental and divisional assessment reports, and meets with departmental and divisional assessment committees to discuss departmental assessment activities and facilitate the communication of best practices. The Committee reports annually to the Senate on the state of academic assessment at the Naval Academy. The Senate forwards the report and recommendations, along with its own comments, analysis and/or proposals, to the Academic Dean and Provost.

The Faculty Senate Curriculum Committee serves as the primary agency of the Senate dealing with the curriculum. It investigates and holds hearings regarding all proposed changes in the curriculum. It reports all recommendations through the Academic Dean and Provost to the Superintendent’s Executive Board. The committee has two members from each of Divisions 1, 2, and 3 and one from each of the Department of Physical Education, the Department of Leadership, Ethics, and Law, and the Department of Seamanship and Navigation.
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Professional Organizations
Professional Development
Consulting/summer work in industry

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Instructions: Complete table for each member of the faculty in the program. Add additional rows or use additional sheets if necessary. Updated information is to be provided at the time of the visit.

1. Code: P = Professor  ASC = Associate Professor  AST = Assistant Professor  I = Instructor  A = Adjunct  O = Other
2. Code: TT = Tenure Track  T = Tenured  NTT = Non Tenure Track
3. The level of activity, high, medium or low, should reflect an average over the year prior to the visit plus the two previous years.
4. At the institution
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<td>EE 334 (3-2-4) – 1 section</td>
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<td>% of Time Devoted to the Program</td>
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<td>LT John Lankford</td>
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<td>Capt. Tracy Martin</td>
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<td>Fall 2011: EE 301 (3-2-4) — 2 sections Spr 2012: EE 302 (3-2-4) – 2 sections EE 303 (2-2-3) – 1 section</td>
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<td>Major Chris Mayer</td>
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<td>30 20 50</td>
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<td>LT Juan Moreno</td>
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<td>FT</td>
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<td>Assistant Professor Hau Ngo</td>
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<td>CDR Hartley Postlethwaite</td>
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<td>Spr 2012: EE 332 (3-2-4) – 2 sections</td>
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<td>PT or FT</td>
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<td>Capt. Ryan Whitty</td>
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<td>FT</td>
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<td>LCDR Jennie Wood</td>
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<td>Dr. Currie Wooten, PEO/IWS Chair</td>
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1. FT = Full Time Faculty or PT = Part Time Faculty, at the institution
2. For the academic year for which the self-study is being prepared.
3. Program activity distribution should be in percent of effort in the program and should total 100%.
4. Indicate sabbatical leave, etc., under “Other.”
5. Out of the total time employed at the institution.
CRITERION 7. FACILITIES

A. Offices, Classrooms and Laboratories
   Summarize each of the program’s facilities in terms of their ability to support the attainment of the program educational objectives and student outcomes and to provide an atmosphere conducive to learning.

1. Offices (such as administrative, faculty, clerical, and teaching assistants) and any associated equipment that is typically available there.

The Electrical and Computer Engineering Department main office and all individual faculty offices are located in the recently repainted and re-carpeted Maury Hall, which is shared with the Weapons and Systems Engineering (WSE) Department. The layout of our faculty offices is shown in Figure 7-1: approximately half the offices belong to our department, the other half to the WSE department. The ECE Department main office located on the third floor includes dedicated office space for the Department Chair, the Associate Department Chair, and the Department Executive Assistant. These leadership office spaces feature all of the accoutrements found in a typical faculty office detailed below, but are physically larger and include a small meeting table. Additionally, this main office includes a reception area, space for the Department Administrative Assistant, a small Department Conference Room, and a supply storage area. A larger conference room located on the second floor is shared with the Systems Engineering Department and is routinely used for Department-wide meetings. Both conference rooms are equipped with chalkboards, clocks, doors, windows, chairs, computers, projection systems, and teleconferencing equipment.

A typical faculty office, shown in Figure 7-2, is provided for use in course preparation, extra student instruction, student advising, and faculty research/publication. These offices range in size from 129 to 157 square feet and include a stylish matching set of desk, chairs (for both faculty and visiting students), credenza, wardrobe, a set of three bookshelves, and a file case. Additionally, the nominal office has a telephone, computer, printer, scanner, and a chalkboard. The computer equipment is on a four-year replacement cycle pending government funding. The most recent cycle of technology replacement occurred during the summer of 2011, in which 26 faculty computers, scanners, and printers were replaced.

2. Classrooms and associated equipment that is typically available where the program courses are taught.

The 22 dedicated classrooms of the Electrical and Computer Engineering Department are located in the basements of Rickover and Mahan Hall (as shown in Figure 7-3). These rooms support teaching in either a traditional lecture or studio format. Most rooms are configured as shown in Figure 7-4 with dedicated student desk space and a full set of workbenches that feature laboratory equipment sufficient for twenty-two individual students. To support instructional activities, rooms include multiple fixed and sliding blackboards and feature lecture stations equipped with desktop computer, audio system, display projector, document camera, and DVD player. To support student experimental activities, each laboratory bench features various AC and DC power supplies, multipurpose programmable function generator, oscilloscope,
multimeters, motor/generator sets, and all necessary electrical and electronic components and connectors.

Figure 7-1. Faculty Office Spaces in Maury Hall
To support courses that rely more heavily upon computers for instructional activities, 5 classrooms feature individual student computer workstations instead of experimental laboratory workbenches. For large lecture events, auditorium spaces are available in Rickover Hall. Several auditorium rooms are open to the Department to schedule on an as-needed basis throughout the academic year.

3. Laboratory facilities including those containing computers (describe available hardware and software) and the associated tools and equipment that support instruction. Include those facilities used by students in the program even if they are not dedicated to the program, and state the times they are available to students. Complete Appendix C containing a listing the major pieces of equipment used by the program in support of instruction.

The Electrical and Computer Engineering Department maintains six dedicated laboratory spaces. These spaces are primarily used for student instruction but are also used by faculty members to conduct research activities. Details for each laboratory are presented below. We close this section with a brief discussion of the Project Support Branch, which supports manufacture and fabrication requirements across the entire Engineering and Weapons Division.
Figure 7-3. ECE Classrooms and Laboratory Spaces

Figure 7-4. Typical Studio Classroom Layout
Senior Design Laboratory

The Senior Design Laboratory contains 40 lab stations, each equipped with an oscilloscope, power supply, two multimeters, and a desktop computer. It is intended to be a flexible lab space in order to accommodate a wide variety of capstone design projects. Depending on the capstone projects, students may also use other spaces (e.g., a student group involved in a microfabrication-related project may make extensive use of the microfabrication lab) but the design laboratory provides a work space where they can build circuits and small systems, store their equipment, and conduct the “desk tasks” (e.g., programming, writing, literature searching) associated with their project. Seniors are each assigned a lab station at the beginning of the year for their use throughout the year and students in group projects are assigned neighboring stations.

The laboratory also includes bins of common electronic components, wire spools, and machining tools—including a drill press, band saw and sheet metal folder. The machining tools are kept in a separate room with more restricted access to ensure that the midshipmen are properly trained for use of these tools. The classroom and workbenches are also used for several senior electives.

Classes supported: EE411, EE414, EC415, EE426, EE451, EC404

Microfabrication Laboratory

The USNA Microfabrication Laboratory is a Class 10,000 facility that contains an electron beam evaporation system, mask aligner, spinner, probe station and ventilated benches for wet chemical processing. The lab also includes a Dektak surface profilometer for characterizing the thickness and roughness of thin films. Deionized water is available through a small filter unit that attaches to the regular water line. Dust levels are controlled in the room by a laminar flow system that incorporates HEPA filters to reduce particulates, and the lab has an anteroom which is also dust-controlled and which serves as the “gowning area.” Users are required to don lab coats, shoe covers, hair covers, gloves and eye protection in order to enter the laboratory. The lab contains an eye wash station and safety shower, and storage cabinets for flammable materials. Chemical waste is stored according to waste type and periodically collected and sent for special treatment. MSDS sheets are collected for the materials in use in the lab and stored in a binder in the gowning area. All users are required to undergo training with the lab supervisor, and a buddy system is in effect which requires students to always have a partner with them in the laboratory when working outside of class hours. The lab is physically small (about 345 ft²) and much of the floor space is taken up with equipment, so it can only comfortably handle about 5 people at a time. The gowning area is about 25 ft².

Classes supported: EE372, EE414, EC415, EE49X

Power Laboratory

Founded in the fall of 2002, the Power Laboratory is the result of nearly ten years of dedicated service of Dr. John G. Ciezki (a former faculty member) and was developed to meet the needs of the Navy for a competently trained officer corps in the area of Electric Power as the Navy has embarked on an all-electric ship platform. The laboratory received a capital investment of over $750K through the initial years of set-up. These monies were used to purchase equipment and
instrumentation to outfit six laboratory teaching stations. Each station is equipped with a modern Oscilloscope, DC power supply, function generator, computer and multiple handheld multimeters. A complete inventory of laboratory equipment is included in Appendix C.

Classes supported: EE320, EC244

Biometrics/Digital Signal Processing Lab

The Biometrics/Digital Signal Processing lab serves several functions within the Electrical and Computer Engineering Department (ECE) and the Naval Academy. It is a studio lab, so it supports both lecturing as well as lab work, having 15 dual-monitor computer workstations. Within the department, it supports the Digital Signal Processing course and the Biometric Signal Processing course, as well as a few computer engineering courses, capstone projects and independent student research. The high tech systems within the lab also help promote STEM. The lab serves as the location of the ECE academic workshop for the Naval Academy Summer Seminar, and also is an integral part of many USNA STEM initiatives such as tech camps, and various high school and middle school visits.

Classes in the Biometrics/Digital Signal Processing Lab typically involve a great deal of coding, in MATLAB, C/C++ and Assembly language. The computers in the lab are high performance to allow graphics-intensive routines, and having dual-monitors facilitates the efficiency of code/compile/run. Computers are loaded with MSOffice, Visual Studio, MATLAB, Adobe Audition, and several biometric system-related programs. Special hardware used for research or demonstrations include: the A4Vision 3-D Face Recognition System, the LG IrisAccess 4000 iris recognition system for lab access, the Schlage HandKey hand geometry recognition system, a custom multi-spectral iris image collection system, SecuGen Hamster fingerprint scanners, and the EyeGaze eye tracking system.

Courses served: EE432, EE435, EE414, EC415, EC361.

Fiber Optics Laboratory

The Fiber Optics Lab serves several functions within the Electrical and Computer Engineering Department (ECE) and the Naval Academy. It supports a variety of courses as well as independent student research. As a teaching laboratory it is used extensively in the Fiber Optical Communications course, as well as for several labs in Engineering Electromagnetics. It has been used occasionally in support of Fundamentals of Electronic Instrumentation. The lab has also been used extensively for student research and faculty research. Examples include multiple Trident Scholar and Bowman Scholar projects, independent study projects, and capstone design projects. In the teaching room of the lab, up to eight students can work comfortably. A smaller secondary room focuses on independent student and faculty research.

A wide range of concepts can be explored in the teaching labs that use this laboratory. Basic free space optics is discussed in the electromagnetics course (e.g., using beam splitters and mirrors) and in fiber optics (e.g., coupling of light from free space to fiber using HeNe lasers, observation of optical modes and speckle patterns). Additional labs in fiber optics focus on communications. For this purpose, the lab has a wide assortment of optical components and lasers, including: optical modulators, bias controllers, optical amplifiers, optical attenuators (and pads), optical
power sensors and multimeters, couplers, various wavelength division multiplexing (WDM) devices, semiconductor and DFB lasers (from free space to near IR) and tunable lasers, and long spools (25km) of fiber. High bandwidth test equipment is available, including: Agilent Digital Communications Analyzers and laser mainframes, optical transmitters and receivers, optical spectrum analyzer, bit error rates testers (3GHz and 12GHz), RF spectrum analyzers and signal generators in GHz ranges. Current student and faculty research using this lab is focused on optical sensing using fiber Bragg gratings or other devices. Much research has also focused on high speed WDM optical networking.

Courses served: EE472, EE372, EE426, EE414, EE49X.

**USNA Wireless Measurements Group Facilities, Equipment, and Other Resources**

The Wireless Measurements Group (WMG) at the United States Naval Academy is a focused research group that aims to be a premier center for performing and analyzing a wide variety of wireless measurements, providing a high caliber educational experience for undergraduate engineering students, and emphasizing the role of wireless in operationally Navy relevant scenarios. Under the direction of Dr. Chris Anderson, the WMG has amassed more than a decade of experience performing a variety of radiofrequency measurements in environments as diverse as: in-building, outdoor forests, agricultural fields, dense urban areas, and underground mines. The WMG’s state-of-the-art laboratory facilities can be utilized to perform measurements at center frequencies ranging from 100 MHz up to 20 GHz, and at bandwidths of up to 1.0 GHz.

The Wireless Measurements Group utilizes variety of integrated classroom/laboratory facilities for both classroom instruction as well as lab/research activities. In particular, the following facilities are regularly utilized to teach wireless and communications related undergraduate electrical and computer engineering courses:

- Communications & Digital Design Lab
- Dedicated Senior Design Lab
- Wireless Measurements Lab

All of these spaces strive to maintain a 1:1 ratio between students and lab benches/workstations.

In the Communications & Digital Design Lab, each lab bench is equipped with the following:

- Dual Linear Power Supply: 0-24V / 1A
- Two Digital Multimeters: Voltage, Current, and Resistance
- Spectrum Analyzer: 100 kHz – 3.0 GHz Input Frequency Range
- Digitizing Oscilloscope: 4 Channels / 5 GS/s per Channel / 1.0 GHz Bandwidth per Channel
- Three Function/Arbitrary Waveform Generators: 1 Hz – 20 MHz Output Frequency Range
- Selection of low-cost, portable, RF signal generators: Frequency ranges that cover 700 MHz — 2.4 GHz
- Standard Desktop Computer Workstation
Additionally, the following equipment is available in the Wireless Measurements Lab:

- Selection of four high-performance signal generators: 3 kHz – 3.0 GHz Output Frequency Range
- Spectrum Analyzer: 9 kHz – 13 GHz Input Frequency Range
- Handheld spectrum analyzer: 9 kHz — 20 GHz Input Frequency Range
- Handheld real-time spectrum analyzer: 10 kHz – 6.2 GHz Input Frequency Range
- Vector Network Analyzer: 300 kHz – 8.5 GHz Input Frequency Range / 1601 Points
- Vector Network Analyzer: 10 MHz – 20 GHz Input Frequency Range / 25,001 Points
- Vector Signal Analyzer: 3 kHz – 6 GHz Input Frequency Range / 36 MHz Bandwidth
- Two high-power (28W and 70W) amplifiers covering the range of 100 MHz – 4.7 GHz.
- Two medium-power (10W) amplifiers covering the range of 800 MHz – 4 GHz.
- Selection of various narrowband and broadband antennas.
- Small (8’ x 8’ x 14’) antenna test chamber.

Project Support Branch (E&W Division Asset)

The Project Support Branch (PSB) is an Engineering and Weapons Division asset that supports all of the departments in the Engineering and Weapons Division. The skilled staff manufactures and fabricates equipment and apparatus to support laboratories, midshipman and faculty research, classroom instruction and student capstone design projects. The staff routinely provides instruction and demonstrations of manufacturing processes and techniques to midshipmen in engineering classes such as materials science and manufacturing. The PSB staff also assists design project teams by offering advice and guidance on design for manufacturing (DFM) issues related to their design projects. The PSB shops have extensive capabilities for working with a wide variety of materials including wood, plastic, composites and metals. The available equipment ranges from traditional manual tools such as presses, brakes, table and band saws to modern computer numerical controlled (CNC) mills, lathes, routers, water jet and wire electric discharge machining centers. Material joining capabilities include adhesive bonding and GMA, GTA and SMA welding, soldering and riveting. The staff includes up to sixteen full-time employees with expert skills in the trades of wood working, composites manufacturing, model making, boat building, machining, fabricating, sheet metal work, welding and CAD/CAM.

Project-based Learning

Project-based Learning is one of the Strategic Initiatives in the Strategic Plan of the US Naval Academy. The engineering programs at USNA have been increasingly expanding the amount of project based learning in both courses covering engineering fundamentals and in capstone design courses. Also, more and more of the capstone design projects are larger scale engineering projects that are participating in national and international competition. The programs have insufficient space to facilitate this growth and the use of hallways, closets, and any other
available space is common, especially in the spring semester when projects are being constructed, tested, modified, etc. The Engineering and Weapons Division is exploring the possibility of utilizing space in a remote building located at Hospital Point. It is not ideal given its location but it is within walking distance of Rickover/Maury Halls. The Division is also encouraging more efficient use of spaces to create additional space for project-based learning and capstone projects.

As will be mentioned in Criterion 7 Part D, many of the classroom and laboratory spaces of the Division are poorly climate controlled to the extent that the quality of education is negatively impacted.

B. Computing Resources

Describe any computing resources (workstations, servers, storage, networks including software) in addition to those described in the laboratories in Part A, which are used by the students in the program. Include a discussion of the accessibility of university-wide computing resources available to all students via various locations such as student housing, library, student union, off-campus, etc. State the hours the various computing facilities are open to students. Assess the adequacy of these facilities to support the scholarly and professional activities of the students and faculty in the program.

Each Midshipman is provided either a desktop or laptop conforming to the requirements listed in Table 7-1. These requirements are updated annually to ensure the latest technology is being utilized and that the computing resources meet the demands of the course curriculum. In addition to these personal computers which each midshipmen is required to maintain and the computing resources described in Part A, each midshipmen is assigned a Naval Academy account which allows access to any computer connected to the ACADEMY domain.

The Nimitz Library provides more than eighty networked desktop computers with access to the Library Catalog and other electronic resources, including abstracting/indexing databases, electronic journals and electronic books. Over seventy of these computers also have Microsoft Office Software available. There are two stand-up workstations connected to a printer in the Reference area; currently there is no charge for printing at this time. Additionally, the Library has thirty-six laptops that may be borrowed from the Circulation Desk for in-house use only. The laptops have Microsoft Office software, DVD/CD-RW drives, and can connect to the wireless network available throughout most of the Library.

At USNA there are two groups responsible for providing and managing computing resources that affect the Division of Engineering and Weapons, the Computing Support Branch (CSB) within the Division of Engineering and Weapons, and the Information Technology Services Division (ITSD), a USNA asset.

Computing Support Branch (CSB)

The Computer Support Branch (CSB) is part of the Division of Engineering and Weapons and is responsible for providing computing support for engineering education and research. It is responsible for supporting a wide variety of computer lab classrooms, design studios, instructional computing and central systems for midshipmen engineering courses and academic
projects. CSB also supports general purpose faculty computing, research labs and administrative efforts as well as special purpose computational systems.

CSB support for computer lab classrooms and central systems includes: general and special purpose hardware and application software; specialized devices and engineering applications; integrated parallel computer systems and visualized computing. CSB provides expertise in: various operating systems and appliances such as Windows, Linux, Solaris, Irix, MacOS, etc.; workstations; server services such as directory, application, file, web and print; specialized controllers and network attached, iSCSI, fiber channel and direct attached storage and backup systems. CSB also provides software patching and for all lab and classroom computer workstations and servers.

Because CSB is part of the Engineering and Weapons Division, it responds quickly and efficiently to emergent needs in the classroom for student projects and for research needs. Although currently the ECE Department depends on its own technicians to support our courses, the expertise within CSB has led to the decision to have CSB provide the brunt of computing support for the ECE Department’s core cyber security course as it develops, and when it “goes live” in the fall of 2013.

Information Technology Services Division (ITSD)

ITSD is a Division under the Superintendent that is responsible for providing services to over 7000 computer users yard-wide. It facilitates all telecommunications, data communications, television and other video systems, storage area networks, backup systems, learning management systems, data warehouse, intranet and extranet web resources. The network has a star-mesh topology with a gigabit/quad gigabit Ethernet core. The network has over 10,000 switch data ports and supports voice, video, and data through wall and floor outlets located in every building. The network also supports wireless access ports in some locations.

The following discussion presents one of the problem areas that impact the Division of Engineering and Weapons and all of the engineering programs offered by it.

In terms of academic computing, resources and support, the engineering programs are currently operating in a disadvantaged and unacceptable position. This is due to the programmatic support (or lack thereof) of from the Information Technology Services Division (ITSD), the organization responsible for these services throughout the Naval Academy. ITSD’s mission is to develop, manage and integrate information technology systems at the Naval Academy; however, its policies and procedures have had a significant negative impact on the academic departments’ abilities to conduct their academic programs. Some of the “problem” areas and some specific examples follow.

1. **Investment purchases.** ITSD oversees the process for making large purchases such as computers and laboratory equipment that support the academic mission, referred to as “investment purchases.” The academic departments and the various lab groups annually submit to ITSD their prioritized plan for obtaining new instrumentation and replacing old. The problem arises in the implementation. ITSD answers predominantly to externally driven requirements and is dedicated to institutional priorities. ITSD is not
always responsive to priorities established by CSB. However, as part of Engineering and Weapons Division, CSB is dedicated to academic priorities. ITSD should facilitate the requirements established by CSB whenever possible. For example, the Division of Engineering and Weapons prioritized all such investment requests for this past Fiscal Year (Oct 1 to Sep 30) and submitted that prioritization. Little, if any, attention was paid to this list in executing the investment purchases for the Division this past year. When money becomes available and investment purchases are to be made, ITSD makes the decisions about which items are to be purchased for all academic departments/lab groups often without regard for division-wide priorities.

A specific example follows. The Engineering and Weapons Department’s Computing Support Branch (CSB) ordered servers to support the instructional computing infrastructure. The request for these servers was ultimately denied with little explanation or feedback. Moreover, although CSB supports Rickover Hall classrooms, design studios, instructional computing for courses, research labs and special purpose computational systems, ITSD does not request CSB input concerning equipment needs, requirements or priorities beyond publishing current computer builds with little regard to suggestions for improvements.

ITSD’s control extends well beyond traditional computer hardware and software. They make purchase decisions on all electronic devices used for data collection and acquisition in the labs. Such equipment is usually highly specialized and discipline specific, requiring highly trained technical staff to operate. In other cases, the equipment is to be used in an advanced research setting by faculty and technical staff. In most cases, ITSD does not have staff members who have the requisite knowledge to make decisions regarding the purchase of such equipment. ITSD’s review and purchasing function should be limited to desktop and laptop computers, computer peripherals (disk drives, printers, etc), and computer software of a general nature (operating systems, standard office software, etc) – it should not extend to specialized laboratory equipment and software used within the context of laboratory data collection or faculty research. Prioritization and development of purchasing specifications for such equipment and software should be made with the E&W Division where the technical expertise and end-users reside.

The current process for executing the investment budget is problematic for the engineering programs. This process has been conducted in this manner for many years. The engineering division tried to improve the situation by generating the division wide priority list this past year but has received little if any cooperation from ITSD in this regard.

2. *Wireless classrooms.* Only a small percentage of classrooms and labs in the Division of Engineering and Weapons are wireless. The current situation does not allow our students to exercise the full functionality of the tools available for learning. It slows the speed of learning and inhibits collaborative learning in a hands-on discipline. For an institution that claims to be state of the art in this regard, we are clearly behind. Engineering and Weapons has been pushing for wireless support for at least the past few years. ITSD has been reluctant to facilitate this progress. CSB has the requisite expertise to specify, install
and maintain wireless networks. However, they are inhibited from doing so due to poor cooperation from ITSD. ITSD is reluctantly and slowly conceding on the issue of the wireless classroom but obstacles still remain regarding the pace at which these are being implemented and the proper type of equipment necessary to support the educational activities planned. Constraining CSB’s ability to support engineering academic priorities is bad for the institution; it is affecting midshipmen engineering majors across all engineering departments as well as non-engineering majors enrolled in engineering core courses.

3. **Patches and updates and licensing issues.** ITSD has on occasion installed patches and updates and remotely rebooted instructor workstations during in-progress class/lab sessions, which have resulted in instructor demonstrations to the students and labs no longer working properly even though they had worked the previous day when the instructor checked them. Communications between ITSD and the academic side of the house have frequently been VERY POOR. The academic side of the house does not always feel “served” by ITSD as should be the case but rather feels dictated to, controlled by ITSD with little or no regard for the impact on our educational activities and with little or no regard for the substantial technical expertise of our faculty and staff members in the areas of networking, computing, etc.

Note that the Division’s Computer Support Branch (CSB) provides software patching and updates in Rickover Hall (EWLAB Domain) for all lab and classroom computer workstations and servers except the professor’s office computers on the third deck (ITSD).

The academic departments use software tools that in some cases must be licensed annually, e.g., MATLAB, used extensively by the Engineering and Weapons Division and the Math and Science Division. Even though the new licenses must be purchased each year and available at the beginning of the fall semester, the new software is not always available; it does not seem to be a priority for ITSD.

For example, the Engineering and Weapons Department’s Computing Support Branch had to receive temporary licenses for the Mathematica software suite on multiple occasions, well into the fall academic semester. These burdensome workarounds were necessitated by the software purchase not being completed in a timely fashion.

4. **Domain issues.** ITSD switched from the usna.edu domain to the academy.usna.edu domain beginning in the middle of the fall semester of 2010-11, resulting in numerous name resolution and authentication issues for the remainder of that semester. In conjunction with this domain change, the use of child domains is no longer allowed by ITSD. This decision was made after an ITSD consultation with Microsoft regarding the USNA network architecture, but without consideration of academic needs. The E&W Division for many years kept its own EWLAB child domain under usna.edu in order to facilitate the Computer Support Branch’s ability to manage technology resources to support the pedagogical goals of the E&W division. In this, CSB maintained administrative/super user control over the EWLAB domain and was able to rapidly make
adjustments within EWLAB in real-time as the need arose. Since child domains are no longer allowed, the E&W Division has lost the ability to manage the network resources that directly affect E&W classes. This will have a HUGE impact on our ability to properly carry out the Mission and the associated education of midshipmen across all engineering departments as well as for our engineering core courses that support the non-engineering majors as well.

As a practical matter, Engineering and Weapons has lost control of its resources—even if ITSD grants the CSB administrative and technical controls that are needed to support the educational mission, ITSD can revoke those permissions at any time and for any reason (or for no reason). In the former arrangement, equipment problems were quickly remedied by CSB and emergent student needs were rapidly addressed. Going forward, we see such matters handled by ITSD trouble tickets with multi-day turnaround times. This particular issue is one that will have an immediate and negative on the quality of the education provided to midshipmen (students) in engineering programs.

The Division is currently seeking to hold more meetings between ITSD personnel and division personnel to facilitate better communication and hopefully better cooperation. Improvement in these four areas is critical in order to maintain the high quality of our education programs and to continue to improve upon them.

C. Guidance

Describe how students in the program are provided appropriate guidance regarding the use of the tools, equipment, computing resources, and laboratories.

Students receive instruction on the safe and effective use of laboratory equipment in each course that requires an experimental educational component. Prior to laboratory experiments that expose students to potential hazards, a safety briefing on those hazards is provided. A limited amount of laboratory technician support is also available to assist the proctoring of experiments. In addition to focusing on the importance of safety, students are typically given an introduction to the use of the equipment either by demonstration or a step-by-step procedure illustrating the correct use of the equipment.

The Engineering and Weapons Division has instructions governing laser safety, battery-charging safety, radiation safety including our neutron generator, midshipmen use of labs and shops, and risk management procedures for capstone project activity safety. This is in addition to all the USNA safety requirements that apply. Copies of these instructions will be provided to ABET if needed and will be available for review during the accreditation visit.

In terms of appropriate use of computers, midshipmen are given guidance on the regulations concerning the use of government-owned computer facilities and must attest to this understanding when they log on to the USNA network. In addition, midshipmen are required to take Department of Defense annual Information Assurance training. This guidance/training will be made available for viewing during the site visit.
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Table 7-1. Student Personal Computing Resources
D. Maintenance and Upgrading of Facilities

Describe the policies and procedures for maintaining and upgrading the tools, equipment, computing resources, and laboratories used by students and faculty in the program.

The department has a team of laboratory technicians that are assigned to maintain each lab. As problems are identified, the equipment is either repaired in house or replaced using standard government purchasing procedures. Computing resources are maintained and upgraded on a 4-year cycle in accordance with USNAINST 7320.1 U.S. Naval Academy Information Technology Asset Management Policies and Procedures.

In terms of facilities, all of our labs/classrooms (except for the power lab) are contained in Rickover Hall. Rickover Hall officially opened in 1975 and since that time the Division of Engineering and Weapons has been housed predominantly in Rickover Hall and Maury Hall. Rickover Hall houses all of the offices, classrooms, and laboratories for Aerospace Engineering, Naval Architecture, Ocean Engineering, Mechanical Engineering, and General Engineering plus all of the teaching and laboratory spaces for Electrical Engineering and Computer Engineering and some of the teaching and laboratory spaces for Systems Engineering. It is the primary engineering building at USNA.

Just prior to Tropical Storm Isabel, September 2003, Maury Hall had received a complete renovation. In the year following Tropical Storm Isabel, minor damage to Maury Hall caused by the storm was quickly rectified. Complete renovation of Michelson and Chauvenet Halls, homes to the Division of Math and Science, were completed in the two years following the storm. Rickover Hall had approximately three feet of floodwater throughout the basement (laboratory) level. In the approximately two years following the storm, approximately one half of the Rickover Hall basement was renovated to accommodate the Electrical Engineering laboratories. Also, approximately 25% of the first floor of Rickover Hall and approximately 20% of the second floor were renovated subsequent to the storm to relocate laboratory functions that were destroyed on the basement level.

However, as will be described below, Rickover Hall has never had a major renovation since it opened in 1975 and is therefore still utilizing the vast majority of its original infrastructure and is consequently continually negatively impacted by problems arising from this aged infrastructure. The quality of our teaching and research is TRULY impacted in a negative manner.

Through the years there have been various plans to renovate Rickover Hall. There was a committee formed in the early to mid 1990s, which planned a Rickover renovation, but no renovation followed. By 1997, the USNA Academic Facilities Master Plan laid out a plan to renovate all of the academic buildings, including a sequencing plan and a swing space plan to accomplish the renovation. Funding was obtained for this ambitious renovation plan. A complete renovation of Rickover Hall was planned for Phase 3 (of 4). However, once the program was completed (and it should be noted that the renovation process was complicated by Tropical Storm Isabel), all but two of the 11 academic buildings had been fully renovated; the two not renovated were Rickover Hall and Nimitz Library.

The July 2006 USNA Academic Facilities Basic Facilities Requirement (BFR) states in the Background Section; “an increasing emphasis is being placed upon the need for faculty research
labs. Mathematics, science, engineering, and technology-related lab research spaces are particularly necessary but often underprovided and inadequate”. This “need” remains unsolved to date. (Report prepared for USNA and NAVFAC by independent contractor hired by USNA).

In August 2006, USNA reported to the US Navy’s Inspector General on the general status of USNA. On page 63 of that report in a section entitled “Academic Facilities” the following sentence appears; “To date, six of the academic buildings, including the oldest facilities, have been fully renovated and reconfigured to meet current requirements. The recently completed renovation of Michelson and Chauvenet Halls has provided state of the art classroom and laboratory facilities to the Department (should be Division) of Math and Science. Required in the near term is renovation of the Library, the Rickover Engineering Building and provision for of additional space for Languages and Regional Studies”.

Also from page 62 of that report “The Naval Academy has been developing and updating a draft Master Plan for the entire Annapolis complex, to ensure that ongoing renovations and proposed new construction continue in a well considered and orchestrated manner.” No renovation followed; the issues remain today. During this past Academic Year (2011-2012), Clark Nexsen, an engineering and architecture firm, was contracted to study the existing conditions of Rickover Hall as a whole in order to make recommendations for the continued longevity of the facility. On May 11 a draft report was submitted Clark Nexsen. The following paragraphs highlight the major problems existing in Rickover Hall today, in the opinion of the Division of Engineering and Weapons, with confirming opinions as reported by Clark Nexsen in the May 11 report.

The #1 issue with the building is the HVAC system, which does not adequately control the indoor air environment. This has produced a classroom and office environment regularly exceeding 80°F and with relative humidity ranges which seriously affect the learning environment. Classroom temperatures as high as 90°F have been frequently experienced in the fall and spring transition periods when the chill water supply has been turned off (fall) or has yet to be turned on (spring). Even when the chill water is turned on there are still considerable difficulties in balancing the temperature and humidity throughout the Rickover spaces. Many offices, classrooms, and laboratories are frequently at conditions of temperature and/or humidity, which negatively impact the functions ongoing in those spaces. The cause of much of this is a 40 year-old HVAC system plus the ductwork and active terminal systems supplying the individual spaces are inaccessible due to the ceiling tile configuration and active components, which will not modulate to thermostat control signals. Further, the design of the HVAC system does not permit a simultaneous air conditioning and heating mode for most of the spaces – a condition which routinely happens due to the large glass surfaces and solar heat gain on the south faces while the spaces along the shadowed north building faces require heat.

Clark Nexsen, in their recent study, concluded that “The majority of the mechanical equipment and systems in Rickover Hall is at the end of its useful life and should be replaced”. They also stated that all controls, piping, ductwork, and appurtenances should be replaced as part of a coordinated design to serve the current occupancies of the building. A new, modern direct digital controls system is recommended for the future mechanical systems. This control system should be fully integrated with the Academy’s central monitoring system to allow for remote monitoring and control. A new chilled water bridge arrangement is recommended to decouple the building’s chilled water loop from the campus chilled water loop.
In at least some locations in Rickover, the 40 year-old supply air ductwork is internally insulated with fiberglass. This makes it impossible to clean, distributes fiberglass particles in the air stream, and is a haven for wetness and mold. Some parts of the supply air system have been inspected and cleaned over time but no systematic inspection, cleaning, or renovation of the entire system has been conducted.

The #2 issue is water via utility leaks, storm water intrusion, and chill water sweating, all of which have caused significant and costly structural and equipment damage, in addition to stained and sagging ceiling tiles in numerous locations. The staff has implemented a common workaround of installing gutters under known leaks in multiple locations within the building. Rickover Hall has a variety of different piping systems including domestic hot and cold water, high temperature hot water, chill water for HVAC, condenser water, air handler hot water, and compressed air. The majority of these systems are 40 years old and, not surprisingly, frequently experience failure. Leaks in Rickover Hall have been commonplace for nearly 20 years. They are disruptive, potentially hazardous, and they result in damage to equipment, computers, and furniture. They have a negative impact on the quality of the education we provide. We have also had frequent mold problems and associated health issues due to all of these leaks.

Based on its age and frequent leaks, Clark Nexsen recommends that the green roofing system on the first floor be removed down to the structural concrete deck, and replaced in its entirety. They also recommend: 1. Repair or replace main line gate valves. 2. Repair or replace sump pumps and piping. 3. Install air gap auto shut off assembly. 4. Install tunnel flooding alarm system. 5. Repair or replace water piping and gate valves with new piping and ball valves as renovations occur. 6. Domestic Hot Water: Replace water piping and gate valves with new materials as renovations occur. 7. Sanitary Sewer: Replace DWV pipe and fittings with new materials as renovations occur. 8. Roof, Terrace and Planter Drains: Replace roof drains and connection piping as roof repairs or renovations occur.

Additional issues beyond HVAC and frequent leaks follow. Rickover Hall has experienced two major traumas during its service history, both of which continue to be evidenced in the building: Tropical Storm Isabel in September 2003 flooded the lab deck and completely filled the sub-basement and pits that extend below the elevation of the lab deck; the August 2011 earthquake shook the building and caused widespread minor damage.

The clean-up and restoration following the 2003 flooding caused by Tropical Storm Isabel left some areas and systems un-remediated. Various utilities in G49 were abandoned in place. The sub-basement was not cleaned and some of the systems contained therein were abandoned in place. The reliability of the sub-basement ventilation system has contributed to mold issues in the occupied space.

The steel frame structure is speculated to be undamaged by the seismic event, but numerous locations are covered in a manner that makes them inaccessible. The seismic event caused cracks and wracked finished walls in multiple locations that have yet to be repaired. More significantly, in some locations, fire blocking located above the ceiling tile elevation of the lab deck have been damaged and are being prevented from falling by electrical conduits and ceiling tile grid wires.
High-pressure hot water exists in Rickover in nearly 40 year-old piping. This water comes into the building at about 375°F and under sufficient pressure to keep it from boiling. This is dangerous if the plumbing system is degraded. We are not aware of any systematic inspection of the hot water supply system. If this ruptures, the steam expansion will be destructive and a health hazard.

Rickover Hall has serious problems with HVAC, continual leaks, and a variety of other issues all of which have a significant negative impact on the quality of teaching and learning. Every semester during weather transitions between seasons, the HVAC system detracts from learning as it results in many classrooms with temperatures exceeding 90 degrees F where students routinely fall asleep and struggle to concentrate. The climate control problems are not unique to transition periods as discussed elsewhere. There are also safety concerns regarding the aged infrastructure as noted above. There is at present no plan to address these problems.

The cost to renovate or properly repair Rickover Hall is huge, estimated to be somewhere between 150 and 250 million dollars. What is needed is a genuine commitment and a detailed and logical plan of action on the part of the Naval Academy for truly resolving this long-standing problem.

E. Library Services

Describe and evaluate the capability of the library (or libraries) to serve the program including the adequacy of the library’s technical collection relative to the needs of the program and the faculty, the adequacy of the process by which faculty may request the library to order books or subscriptions, the library’s systems for locating and obtaining electronic information, and any other library services relevant to the needs of the program.

The Nimitz Library has access to major engineering indices and databases including Engineering Village, INSPEC, and IEEEXplore. When accessed through the Nimitz Library website, links allow the researcher to access the electronic documents if available, or request the document through inter-library loan.

A dedicated engineering librarian monitors the book collection and subscriptions and is available to assist any faculty member. Faculty members are consulted on subscriptions and are included in the process when budget cuts require subscription cancellations.

Rising subscription costs are reducing the amount of library funds available for the purchasing of books. However, the Systems Engineering department has found the both the print and digital collections to be adequate for both student and faculty research.

F. Overall Comments on Facilities

Describe how the program ensures the facilities, tools, and equipment used in the program are safe for their intended purposes (See the 2012-2013 APPM Section II.G.6.b.(I)).

The safety of the physical facilities used by the Electrical and Computer Engineering Department is the responsibility of the assigned U.S. Navy First Lieutenant in conjunction with the Public Works Division of the U.S. Naval Support Activity Annapolis. Their combined efforts include
scheduling and overseeing routine and emergent maintenance, building inspections, and capital investment project implementation.

Daily oversight of laboratory spaces and the safety of tools and equipment used by the Electrical and Computer Engineering Department are assured through the oversight of the Technical Support Division and the associated departmental laboratory technicians. Further safety-related information about the program is included in Section C. Guidance above.
CRITERION 8. INSTITUTIONAL SUPPORT

A. Leadership

Describe the leadership of the program and discuss its adequacy to ensure the quality and continuity of the program and how the leadership is involved in decisions that affect the program.

The Division of Engineering and Weapons at the Naval Academy is headed by the Division Director, a Navy Captain who typically serves a three to four year term and is assigned from the Navy’s Engineering Duty community. At the Division level, the Director is assisted by an Executive Director, typically a Navy Commander, and a Senior Professor, typically a former department chair. These positions normally carry a three-year appointment, which may be renewable. A Department Chair who is appointed by the Academic Dean heads each academic department at the Academy. The Dean requests and takes into account recommendations of the respective department faculty and the division leadership when appointing department chairs. Department chair terms are normally for two years and are renewed depending on the recommendation of the department faculty and the division leadership. In the Division of Engineering and Weapons the normal term of office for a department chair is four years although longer terms are possible. The Senior Professor meets with each department chair at least three times per year to review the performance of the chair and to discuss the state of affairs in the respective department.

The Division Director and the division staff meet with the department chairs weekly to discuss ongoing activities, upcoming events, budget issues, and other pertinent issues. Department chairs have the opportunity to discuss problems, challenges, and other ideas in these meetings. Annual assessment reports are required from each department and are submitted to the Dean through the division. The Division generates a summary assessment report each year as well.

As discussed earlier, at the department level, the chair is assisted by an associate chair who is often a military officer. The department chair is responsible for the curriculum of the department and for assessment processes related to the curriculum. Department chairs hold periodic department meetings, typically monthly, to discuss department business and also meet at least twice per year with each civilian faculty member to review his/her performance and progress. Military faculty members undergo a military review process at least once per year through their military chain of command.

The committee structure and leadership of the Electrical and Computer Engineering Department is presented in the Section D of the Background chapter.

B. Program Budget and Financial Support

1. Describe the process used to establish the program’s budget and provide evidence of continuity of institutional support for the program. Include the sources of financial support including both permanent (recurring) and temporary (one-time) funds.

2. Describe how teaching is supported by the institution in terms of graders, teaching assistants, teaching workshops, etc.
3. To the extent not described above, describe how resources are provided to acquire, maintain and upgrade the infrastructures, facilities and equipment used in the program.

4. Assess the adequacy of the resources described in this section with respect to the students in the program being able to attain the student outcomes.

Funds for faculty and staff salaries are not transferred to budgets controlled by the Division of Engineering and Weapons. Rather, starting salaries for faculty and staff and annual merit pay increase as well as annual bonuses are negotiated with the Dean’s office. Funds for adjunct faculty members are likewise not transferred to division budgets but are negotiated with the Dean. The Division leadership works closely with the departments to determine the need for faculty and adjunct faculty based primarily on their teaching loads and on the needs for specific technical expertise. Rotational military faculty can also be shifted from one department to another to meet teaching requirements. The Division also works with the departments in determining specific technical areas where Permanent Military Professors (PMPs) can be of assistance to the department and works to assure these areas are included in the annual US Navy advertisement for this program.

Funds are provided to the Division in two main classifications; Expense and Investment. Each department and each interdisciplinary laboratory group has an Expense and an Investment Budget each year. Expense budgets are mainly used to pay for supplies, faculty travel, office furniture, staff training, minor repairs, and other miscellaneous items. Investment budgets are for major equipment purchases or upgrades.

Expense budgets have been adequate but not increased to match rising market prices in recent years; they typically remain at the prior year’s level. Departments have been able to obtain necessary supplies and to support faculty and staff development through conference travel and external short courses. However, this has often been done through other funding sources. If the expense budget continues on its current trend, departments will have a difficult time maintaining an appropriate level of faculty development.

Investment budgets have been sufficiently well funded to allow continual renewal of laboratory equipment for many years. Sufficient investment budget purchases have been supported in FY2012 to insure continual renewal of the Division’s teaching and research “equipment” provided that ITSD cooperates in making purchasing decisions in line with division priorities. Although the Division has funds available and has prioritized its requirements, it is not always able to procure the equipment due to the current administrative structure. ITSD has no accountability to the Division in regards to their purchases for the Division, frequently ITSD executes equipment procurement in an ad hoc fashion and the affected departments are not able to predict if or when their teaching and research needs will be met. Predictions of investing funding beyond this year are not possible at this time given the current state of affairs of debt and deficit with the U.S. Government.

Capstone Design projects in the Division are typically funded from external sources. Sufficient funds have been obtained each year to support a robust and aggressive capstone design project program. A record amount of external funding (approx 400K) was obtained in Academic Year 2011-2012 to support capstone design projects. The Division will continue to seek external funds.
for the capstone design projects. However, if the external funding obtained for this purpose were to decline, then the quality of the design projects would be impacted. Support and progression of project-based learning and STEM is an institutional priority and for many years the Division has encouraged the Academy to solicit private funds working with the Naval Academy Foundation to create an endowment or grant for capstone projects. In spite of enthusiasm for project-based learning, the Division has yet to receive any substantial funding. The Naval Academy Foundation could do more to help the Division in this regard and some progress has been made in this past academic year. The Division is pushing for better communication with the Naval Academy Foundation so as to better articulate needs. The Division will continue to seek external funds for the capstone design projects. However, if the external funding obtained for this purpose were to decline, the quality of the design projects would be dramatically and negatively impacted.

The Naval Academy does not utilize graders or teaching assistants at all. The Academy does provide onsite teaching workshops on a regular basis through the Office of Faculty Development. These are typically during the summer session and during the winter break.

The amount of funding provided to date has had no negative impact on any programs ability to attain the desired student outcomes.

However, one MAJOR problem with respect to Financial Support is that the funding necessary to renovate Rickover Hall have not been provided nor have funds been provided since immediately following Tropical Storm Isabel to substantially address the major problems of HVAC and leaks (with the exception of the currently underway repair/replacement of the “roofing system” over the part of the Rickover Hall lab deck that is underneath the plaza area in between Rickover and Maury Halls. Please refer back to Criterion 7 for a complete discussion regarding the need to renovate Rickover Hall.

C. Staffing

Describe the adequacy of the staff (administrative, instructional, and technical) and institutional services provided to the program. Discuss methods used to retain and train staff.

Each academic department in the Division of Engineering and Weapons has an educational technician who provides the department with administrative support in timekeeping, travel arrangements, ordering and maintaining supplies, scheduling of courses, and administrative record keeping. In recent year some departments have had a difficult time retaining their administrative support due to the relatively low pay grade and have also had to function for extended periods without such support. In the past year the pay grade has been increased for these positions and all positions have been filled. The Division is optimistic that retention will improve due to the increased pay level.

Short courses in word processing, spreadsheets, etc. are offered at no cost through the Human Resources Department at the Naval Academy. Specific training in use of the travel system is periodically offered. Administrative support personnel participate in these courses and training opportunities as appropriate. The educational technicians are competent and although the workload can be high at times are able to manage the administrative demands of the departments.
There is a relatively large technical support staff in the Division of Engineering and Weapons. The Division is currently authorized 70 technical staff members; 21 of these are currently empty. From this, the ECE department is assigned 8 civilian educational support personnel (including their supervisor), of which 2 billets are vacant, and 3 enlisted Navy electronics technicians, of which one is vacant. A wide range of technical skills is present in the staff and they are organized into functions that support the teaching laboratories and research functions in the division. In order to accommodate the empty technical staff billets, we frequently postponed development of new labs and are at times forced to compromise the quality of our project based learning, capstone design projects, and research. Our current technical support department does an adequate job in fulfilling the scaled down demands of the faculty and the midshipmen, but we need more support to avoid continuing our current compromise. Overtime is sometimes requested and generally authorized in the spring semester in keeping up with the demands created by the capstone design projects, particularly in the project support branch (the shops). The Division of Engineering and Weapons has recently identified six staff positions where a “fill” is critical. The Division will soon meet with the Dean’s Office discuss these needs and hopefully develop a plan to address them.

The Division hosts/supports a large amount of teaching laboratories, project based learning activities, capstone design activities, USNA STEM outreach activities, faculty and midshipmen research activities (including independent research, Trident and Bowman Scholar research), summer internship activities for midshipmen and for visiting students, and various other worthwhile and Mission related activities. The demand/work load on our technical staff is ever increasing and the training required to keep up with instrumentation and teaching methods that are rapidly evolving is continually increasing. The Division technical staff is struggling to keep up with it all. The near term addition of a Cyber 2 course for ALL midshipmen (which includes a laboratory component) will further add to this situation. The Dean’s office is aware of this situation and is working to obtain resources to allow the Division to fill some, hopefully many, of the currently empty technical staff billets.

Funds are available through the Expense Budgets to send technical staff to technical training courses. Some training is accomplished through funded research budgets when the specific training is sufficiently relevant to the funded research and only with consent of the funding source.

As alluded to earlier, the Division is also fortunate to have approximately 10 Navy enlisted personnel assigned to it including generally at least one Chief Petty Officer to lead them. The enlisted personnel are utilized by the Academy for many different functions that are not directly supportive of the Division and they have a variety of training requirements to complete while they are assigned here. However, they are utilized as additional technical staff members and are distributed amongst our various technical branches. They are an asset to the teaching activities of the Division. Careful planning/coordination between the branch supervisors and the enlisted leadership is necessary to assure enlisted staff availability for activities where their help is most needed. Some branch supervisors do this well; others are frustrated by not fully “owning” the enlisted personnel. The Division does NOT view this as a major problem but rather one that requires more internal communication and efforts to promote this are continually being discussed and attempted. The Division is fortunate to have these men and women amongst us and the midshipmen learn a great deal from their interactions with them.
D. Faculty Hiring and Retention

1. Describe the process for hiring of new faculty.
2. Describe strategies used to retain current qualified faculty.

Once authorized by the Academic Dean to hire a new faculty member, the respective department oversees the process. Departments advertise nationally in the appropriate journals and other publications and also typically utilize e-mail distribution lists as well to advertise available positions. The Division provides some financial assistance to departments to help offset the costs of advertising and interviewing. Departments utilize hiring committees to screen applicants and invite an appropriate number of applicants to visit USNA for a full day interview. Typically between 3 and 5 applicants are interviewed. Departments determine the most appropriate candidates based on these interviews and request permission to hire after determining their most desirable candidate. The Academy strives to make highly competitive offers to new assistant professors in order to attract high quality candidates. Further, the Academy promises new faculty full coverage for at least two of their first three summers to assist them with the establishment of a productive research program. Demands on assistant professor for administrative and service roles are kept to a minimum to allow the assistant professor to develop the high quality teaching record and research scholarship record necessary for promotion to associate professor with tenure. Very few faculty members depart from USNA due to job dissatisfaction.

E. Support of Faculty Professional Development

Describe the adequacy of support for faculty professional development and how such activities such as sabbaticals, travel, workshops, seminars, etc., are planned and supported.

Faculty professional development is accomplished via several activities. The Academy has a sabbatical program. Sabbaticals can be requested once every seven years and can be requested for one semester or for one full academic year. It is rare that a sabbatical is denied. On rare occasions when the number of requests in one year is high, some faculty may be encouraged to delay the request to subsequent years. Full salary and benefits are covered for one-semester sabbaticals while 70% of salary and benefits are covered for a 10-month period for full academic year sabbaticals.

Departments have sufficient funds provided through their annual Expense Budget to support faculty travel to conferences and training courses. Junior faculty receive priority treatment with respect to conference travel. Faculty with robust research programs usually support their conference travel from their own research funds and often involve younger faculty in their research programs and support their conference travel from research funds. During the past two academic years the Superintendent of the Naval Academy provided additional funding specifically for faculty conference travel. The Research Office has special funds to assist faculty with publication costs when research funding cannot cover them. It is rare that a faculty request for this assistance is rejected. The Academy provides funding when not otherwise available to junior faculty to cover their summer salary for at least two of their first three years at USNA. The Academy also has funds to match one summer month’s worth of salary and benefits when the other month’s worth is obtained from a US Navy laboratory. It should be noted that faculty at USNA are paid for 10 months each academic year rather than the more typical 9 months of
support at other institutions. As discussed in Section D of Criterion 6, the Office of Teaching and Learning at USNA hosts several teaching workshops at USNA each summer and often during the winter break. There is no cost to faculty or departments for attending these workshops and faculty are encouraged to attend. In scheduling of classes department’s strive to provide one day each week free of classes so that faculty have the opportunity to develop and participate in a research collaboration with nearby research facilities such as the Naval Research Laboratory, Naval Surface Warfare Center – Carderock, and the Johns Hopkins University Applied Physics Laboratory among others.
PROGRAM CRITERIA

Describe how the program satisfies any applicable program criteria. If already covered elsewhere in the self-study report, provide appropriate references.

A discussion of how the Electrical Engineering program satisfies both general and program curricular requirements is provided in Section A.5 of Criterion 5. We provide the details of where program criteria is specific covered in the following. The syllabi for each of the courses identified can be found in Appendix A.

The program criteria for Electrical Engineering identifies the following curricular requirements. We address each individually.

The structure of the curriculum must provide both breadth and depth across the range of engineering topics implied by the title of the program.

The following required courses in the Electrical Engineering program provide breadth and depth across the range of electrical engineering topics:

- EE221 Introduction to Electrical Engineering I (3-2-4)
- EE241 Electronics I (3-2-4)
- EE320 Introduction to Electrical Engineering II (2-2-3)
- EE322 Signals and Systems (3-2-4)
- EE354 Modern Communication Systems (3-2-4)
- EE372 Engineering Electromagnetics (3-2-4)
- EE411 Electrical and Computer Engineering Design I (2-2-3)
- EE414 Electrical Engineering Design II (0-4-2)
- Major Elective 1* (3-2-4), (3-0-3), (2-4-4), (2-2-3), or (4-0-4)
- Major Elective 2* (3-2-4), (3-0-3), (2-4-4), (2-2-3), or (4-0-4)
- Major Elective 3* (3-2-4), (3-0-3), (2-4-4), (2-2-3), or (4-0-4)
- EE242 Digital Systems (3-2-4) (now EC262)
- EE361 Microcomputer-Based Design (3-2-4) (now EC361)
- SI204 Introduction to Computer Science (3-2-4)

The specific courses that meet the major elective requirements are listed in Criterion 5.

The curriculum must include probability and statistics, including applications appropriate to the program name; mathematics through differential and integral calculus; sciences (defined as biological, chemical, or physical science); and engineering topics (including computing science) necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components.

Probability and statistics with electrical engineering applications is provided by:

- SM313 Probability with Applications to EE (3-0-3)
Mathematics through differential and integral calculus is provided by the following calculus sequence required in the first two years:

- SM121 Calculus I (4-0-4)
- SM122 Calculus II (4-0-4)
- SM221 Calculus III With Vector Fields (4-0-4)
- SM212 Differential Equations (4-0-4)

The required science sequence taken in the first and second years is:

- SC111 Foundations of Chemistry I (3-2-4)
- SC112 Foundations of Chemistry II (3-2-4)
- SP211 General Physics I (3-2-4)
- SP212 General Physics II (3-2-4)

The engineering topics (including computing science) necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components are covered in the following courses:

- EE221 Introduction to Electrical Engineering I (3-2-4)
- EE241 Electronics I (3-2-4)
- EE320 Introduction to Electrical Engineering II (2-2-3)
- EE322 Signals and Systems (3-2-4)
- EE354 Modern Communication Systems (3-2-4)
- EE372 Engineering Electromagnetics (3-2-4)
- EE411 Electrical and Computer Engineering Design I (2-2-3)
- EE414 Electrical Engineering Design II (0-4-2)
- Major Elective 1* (3-2-4), (3-0-3), (2-4-4), (2-2-3), or (4-0-4)
- Major Elective 2* (3-2-4), (3-0-3), (2-4-4), (2-2-3), or (4-0-4)
- Major Elective 3* (3-2-4), (3-0-3), (2-4-4), (2-2-3), or (4-0-4)
- EE242 Digital Systems (3-2-4) (now EC262)
- EE361 Microcomputer-Based Design (3-2-4) (now EC361)
- ES300 Naval Weapons Systems (3-0-3)
- ES410 Control Systems and their Application to Weapons (3-2-4)
- EM316 Thermo-Fluid Sciences I (3-0-3)
- EM317 Thermo-Fluid Sciences II (2-2-3)
- SI204 Introduction to Computer Science (3-2-4)

*The curriculum for programs containing the modifier “electrical” in the title must include advanced mathematics, such as differential equations, linear algebra, complex variables, and discrete mathematics.

Advanced mathematics is covered in the following course:

- SM212 Differential Equations (4-0-4)
Signature Attesting to Compliance

By signing below, I attest to the following:

That Electrical and Computer Engineering Department (**Electrical Engineering Program**) has conducted an honest assessment of compliance and has provided a complete and accurate disclosure of timely information regarding compliance with ABET’s *Criteria for Accrediting Engineering Programs* to include the General Criteria and any applicable Program Criteria, and the ABET Accreditation Policy and Procedure Manual.

**Dr. Andrew T. Phillips**
Academic Dean and Provost

[Signature]

_______________________________                      July 6, 2012
Signature      Date