Undergraduate Academic Assessment Plan- 2012-13

Electrical Engineering

College of Engineering

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Electrical Engineering
College of Engineering
Undergraduate Academic Assessment Plan

1. Introduction

The EE program is an upper division program for which not all students qualify to study. We examine eight (8) pre-professional courses to determine admission to upper division coursework. The eight pre-professional courses for electrical engineering are:

- Calculus I, II, and III,
- Differential Equations,
- Physics I (with Calculus) I and II,
- Chemistry I, and either
- Chemistry II or a Biological science.

All students in the BSEE program are expected to have, within their first 60 semester hours, a grade point average of 2.5/4.0 or higher based on all attempts in the eight pre-professional courses. This requirement is more rigorous than the College of Engineering (CoE) requirements, which base the minimum GPA on best attempts. In addition, EE program students are expected to have a grade of C+ or higher in each course of Calculus I, II, and III, Differential Equations, and Physics (with Calculus) I and II based on the first two attempts. Lower division students who do not meet this requirement are reassigned to the Undecided Engineering major with the College of Engineering Student Services Office.

Transfer students are expected to have completed all eight pre-professional courses listed above. Conditional admission may be granted if the transfer student has completed six of the eight pre-professional courses with the required grade point average. The six courses must include Calculus I, II, III, Physics with Calculus I and II.

We encourage lower division students to initiate and participate in study groups. This is done by collecting and distributing contact information for Electrical Engineering students. These groups often develop into lasting relationships through their career. We encourage some of our upper division student organizations to help us achieve this outreach, for example, by conducting exam review sessions coordinated by an honor society for some of the basic ECE courses. This provides the students leading the review session with better-developed presentation and communication skills as well as providing for better review sessions and thus aiding in student retention and their overall understanding of the material.

Students' academic progress is monitored automatically by the Student Academic Support System (SASS) or Tracking Audit mentioned earlier. The ECE Student Services Office checks the audit to determine if the students have satisfied the requirements before degree certification.

2. Mission Statement

The mission of the Department of Electrical and Computer Engineering is to "Offer under-graduate and graduate degree programs in electrical and computer engineering and to conduct research which serves the needs of Florida and the nation." The objectives of the EE program at UF are to prepare students upon graduation for:

Program Objective 1: Successful careers in a dynamic industry that is global, multi-disciplinary, and evolving; and/or for admission to, and excelling in, the top graduate programs in the world;

Program Objective 2: Good citizenship by engaging in ethical engineering for the betterment of society and the world.

The Department of Electrical and Computer Engineering serves the university and college mission with its offering of the undergraduate program in electrical engineering. The Program Mission Statement articulates a pair of educational objectives that are consistent with the mission of the department, the college, and the university.

The first aspect of the first objective focuses on students having successful careers. This statement was carefully developed to encompass many of the career paths that graduates may follow. We recognize that many engineers change career paths and move into management, sales, manufacturing, as well as a wide variety of other careers so we do not specify the industry or type of career. In electrical engineering, whole new product segments are created frequently. Graduates need to be prepared to evolve their careers for a dynamic industry. We instill within our students the idea that that continued learning is critical to success. We also recognize that industry is increasingly global and multi-disciplinary. Our graduates will also need to learn to interact with engineers and customers that may have different educational and cultural backgrounds. While at UF, students need to prepare here for that world by learning how to learn and getting exposure to other disciplines. Breadth is a value in our program.

The second aspect of the first objective focuses on graduate school. We want our graduates to pursue advanced degrees. We encourage our own graduates to obtain a **Master's** degree in EE and have incentive programs to encourage that. Our industrial stakeholders strongly support this objective. Increasingly, hiring is focused around advanced degree holders. We also have joint programs with management and law to encourage students to obtain degrees outside Electrical Engineering, since we recognize that this type of cross training can be very valuable.

The second objective focuses on good citizenship and ethics. The ultimate objective for any educational program is for its alumni to use their skills to better society, and this is particularly true of engineering. Furthermore, we want alumni to be good citizens and go on to be a credit to the university. Consequently, we encourage our graduates to be community active, in all senses of community. Alumni should be active in their company, in volunteering in local civic and humanitarian organizations, as well as being active in their professional community.

Our mission and objectives meet the needs of the constituents identified below. Alumni are most interested in successful careers and admission to graduate school. This is directly addressed in the first objective. Employers want graduates that can contribute to their businesses and understand ethics. Both objectives address these issues. Faculty want to see our alumni do well in the outside world and see them make a mark on the world, and our objectives express this desire.

2.1 Constituents

The Department of Electrical Engineering has identified a number of stakeholders in its program. The stakeholders are those constituents having the most to gain or lose in terms of how well the department carries out its mission. Key stakeholders are:

- future alumni
- current alumni
- employers of our graduates
- faculty

All of these were involved in defining the objectives of the program. There are many others with interest in our program, these include the Legislature, graduate schools, industry, and government, and last but by no means least, the citizens of the State of Florida.

Student groups were consulted when drafting the departmental objectives. Focus groups of the officers of HKN (the EE Honor society), WECE (Women in ECE), and the Institute of Electrical and Electronic Engineers (IEEE), the EE professional society student branch were consulted. Draft objectives were presented to general meetings of these student groups for feedback. The students have been very supportive of these objectives.

2.2 Process for Revision of the EE Mission

The department has established an assessment and revision process that is used for continuous improvement of the undergraduate EE program with regard to how they serve the department's mission statement and program objectives. We use both direct and indirect assessment methods of how well our graduates have achieved the program educational objectives via an external advisory board and alumni surveys, respectively. These assessment methods directly inform the department chair, associate chair, and undergraduate coordinator on how well the objectives are achieved. When minor modifications or adjustments are needed, the details of the modification are directed to the departmental curriculum committee, which in turn informs the faculty members serving on the appropriate course committees who implement the change and assess the success of the change. Modifications of a systemic level are brought before the program faculty. Figure 2.1 diagrammatically shows our assessment and feedback procedure.

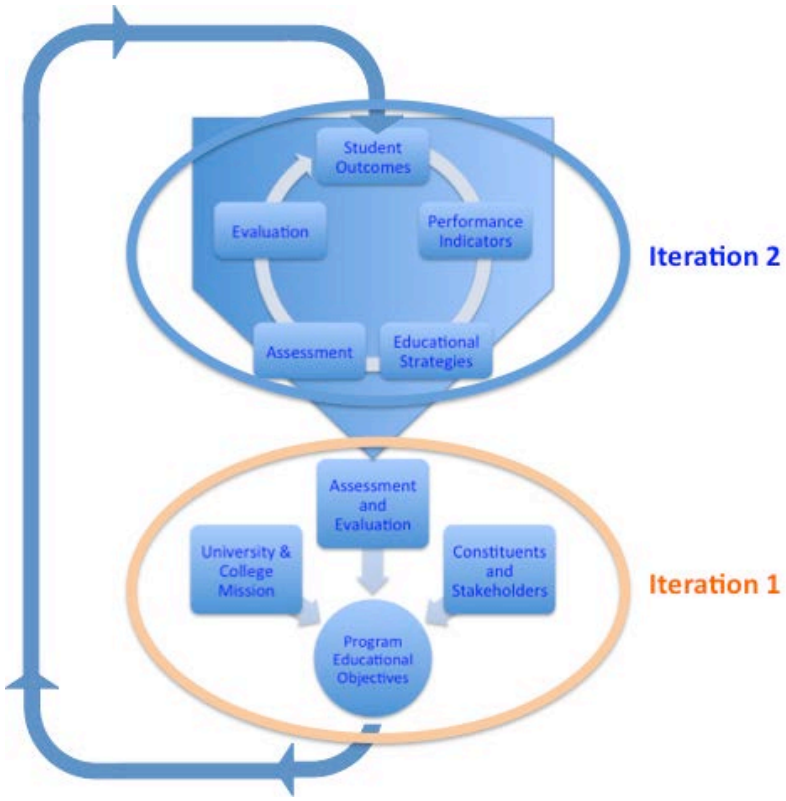

Figure 2.3 Objective Assessment Feedback Loop

a. External Advisory Board – The EE program hosts an active External Advisory Board (EAB). The EAB consists of people that span a diverse spectrum of electrical engineering-related activities. Many of those who serve on the EAB are both alumni of our program and employers of our graduates. They offer insight, advice, and guidance on both the strengths and weaknesses of our programs. Their inputs are heard at both the department and college (dean's) level. Though the EAB meets as a body only once a year, they are called upon on other occasions to serve in an advisory capacity, for example, for service on a department chair search committee.

b. Alumni Survey Alumni are sent a survey to assess how our curriculum satisfies the needs of industry. Results of the surveys indicated that our alumni were well prepared to enter industry. A detailed analysis of these results appears later in this report.

Every year we survey those alumni three, five, and eight years after graduation, hence all alumni are surveyed three times. This survey is coordinated through the college to help provide a consistent and sustainable process. This eight-year span includes sufficient time for a graduate to obtain a Master's degree and in many cases a Ph.D. degree as well.

c. Curriculum Committee – The Curriculum Committee meets monthly during the academic year and frequently appoints subcommittees to investigate issues and make recommendations. The committee is responsible for all aspects of the program including approving and reviewing all courses in the undergraduate program ensuring the courses prepare future alumni to one day meet the stated program objectives. They are responsible for reviewing options and making recommendations to the full faculty for major changes in the curriculum. The curriculum has two

ex-officio student members, the IEEE and HKN presidents, to help give these stakeholders a voice in the proceedings. The students do not have voting rights, but they frequently will talk to their membership and report back opinions on curriculum committee issues.

The curriculum committee reports any changes back to the full faculty for discussion and vote. Curriculum issues are usually taken up at a faculty meeting at least once per semester. Changes in the catalog require additional approval from the college curriculum committee and faculty.

Though the Alumni Surveys and External Advisory Board the EE program administration is informed on how well the program objectives are being met along with how well it serves the needs of the stakeholders. A process is in place that communicates the findings with the program faculty members, the Curriculum Committee, and finally Course Committees with the feedback necessary to measurably improve our program in a manner consistent with college and university mission. At present, there is no indication that our Mission Statement or its articulated Educational Objectives need revision.

3. Student Learning Outcomes (SLOs)

The focus of the EE program with regard to its mission has a curriculum of study and Student Learning Outcomes (SLO) that prepares its graduates for successful careers in a dynamic industry that is global, multi-disciplinary, and evolving and/or for admission to, and excelling in, the top graduate programs in the world. It also prepares them to be good citizens by engaging them in ethical engineering for the betterment of society and the world. The program thus prepares the whole person. It further prepares the student to become a trained engineer who will be successful in his or her profession regardless of what that profession may actually be. The objectives also recognize that the trained engineer is a human person who must be prepared to make ethical decisions and work in a diverse, multinational environment.

Student Learning Outcomes are identified as follows:

Existing SLOs in the 2012-13 undergraduate catalog:

1. Apply knowledge of mathematics, science and engineering principles to electrical engineering problems.

2. Design and conduct electrical engineering experiments, analyzing and interpreting the data.

3. Design an electrical engineering system, component or process to meet desired needs within realistic economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability constraints.

4. Communicate technical data and design information effectively in writing and in speech to other electrical engineers.

Revised SLOs for the 2013-14 undergraduate catalog:

Content Knowledge

- CK1 - knowledge of probability and statistics, including applications
- CK2 - knowledge of mathematics, basic and engineering sciences necessary to analyze and design complex systems
- CK3 - knowledge of advanced mathematics including linear algebra, complex variables and discrete mathematics

Critical Thinking

- CT1 – apply knowledge of mathematics, science, and engineering
- CT2 – design and conduct experiments, as well as to analyze and interpret data
- CT3 – design a system, component, or process to meet desired needs
- CT4 – function on multi-disciplinary teams
- CT5 – identify, formulate, and solve engineering problems

Communication

- C1 – an understanding of professional and ethical responsibility
- C2 – communicate effectively
- C3 – the broad education necessary to understand the impact of engineering solutions in a global and societal context
- C4 – assess the need for, and an ability to engage in life-long learning
- C5 – a knowledge of contemporary issues that impact the field of electrical engineering
- C6 – use the techniques, skills, and modern engineering tools necessary for engineering practice

Revised SLOs for 2013-14 Undergraduate Catalog:

Revised SLOs as of AY 2013-14	Link to 2011-12*, 2012-13* SLOs
Content	
Knowledge of probability and statistics, including applications	Apply knowledge of mathematics, science and engineering principles to electrical engineering problems.
Knowledge of mathematics, basic and engineering sciences necessary to analyze and design complex systems	Design and conduct electrical engineering experiments, analyzing and interpreting the data.
Knowledge of advanced mathematics including linear algebra, complex variables and discrete mathematics	
Critical thinking	
Apply knowledge of mathematics, science, and engineering	Design an electrical engineering system, component or process to meet desired needs within realistic economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability constraints.
Design and conduct experiments, as well as to analyze and interpret data	
Design a system, component, or process to meet desired needs	
Function on multi-disciplinary teams	
Identify, formulate, and solve engineering problems	
Communication	
An understanding of professional and ethical responsibility	Communicate technical data and design information effectively in writing and in speech to other electrical engineers.
Communicate effectively	
The broad education necessary to understand the impact of engineering solutions in a global and societal context	
Assess the need for, and an ability to engage in life-long learning	
A knowledge of contemporary issues that impact the field of electrical engineering	
Use the techniques, skills, and modern engineering tools necessary for engineering practice	

*Undergraduate catalog dates

4. Curriculum Map

Table 4.1 indicates which of the Program Objectives are addressed by the SLO, while Table 4.2 provides the link between individual program courses and SLOs.

Table 4.1: Program Objectives Addressed by SLOs

	CK1	CK2	CK3	CT1	CT2	CT3	CT4	CT5	C1	C2	C3	C4	C5	C6
PO1	X	X	X	X	X	X	X	X	X	X	X	X		X
PO2					X	X	X		X	X	X	X	X	

Table 4.2 Curriculum Map

Electrical Engineering **College of Engineering** Key: **I**ntroduced **R**einforced **A**ssessed

Courses / SLOs	EGN1935	EEL2000	EEL3105	EEL3111C	EEL3112	EEL3135	EEL3211	EEE3308	EEE3396	EEL3472	EEL3473	EEL3701C	EEL3923	EEL2401L	EEL4242C	EEE4306	EEE4310	EEE4329	EEE4331	EEL4351	EEE4373	EEE4420	EEL4440	EEL4445	EEL4461	EEL4514	EEL4514L	EEL4516	EEL4595	EEL4610	EEL4657	EEL4657L	EEL4712C	EEL4703C	EEL4744C	EEL4750C	EEL4834	EEL4912	EEE4924
Content																																							
CK1								I	I																	A	R	R											
CK2			I, A	A	I	R	R	A	R	R	R	R	A	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	A	A
CK3			I, A	I	I	A					R															R	R	R		R	R	R							
Critical Thinking																																							
CT1			I, A	A	I	A	I	R	R	A	R				R	R	R	R	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
CT2				I				A				A	R	R	R	R										R	R	R				R					R	A
CT3								I, A	R			A	R			R	R	R								R	R	R		R	R		R	R	R			A	A
CT4	I																																				A	A
CT5	I		I	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R		R	R	R	R	R	R	R	A	A
Communication																																							
C1	I	I											R																								A	A
C2		I						R				R	R														R								R		A	A
C3		I																								R	R	R									A	A
C4		I						R									R	R				R				R	R	R									A	A
C5		I																								R		R									A	A
C6				I, A	I	A	I	I	R	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	A	A

Table 4.3: Actual Assessment Methods Indicated in Table 4.2

	EEL 3105	EEL 3111C	EEL 3135	EEE 3308	EEL 3472	EEL 3701C	EEL 3923	EEL 4514	EEL 4912	EEE 4924
CK1								Design Project		
CK2	Exam Question	Exam Question		Design Project			Formal Presentation		Design Proposal	Design Proposal
CK3	Exam Question		Exam Question							
CT1	Exam Question	Lab Quiz	Programming Project		Exam Question					
CT2				Design Project		Design Project				Design of Experiment
CT3				Data Analysis		Design Project			Design Presentation	Design Presentation
CT4									Work in Teams	Work in Teams
CT5									Preliminary Report	Preliminary Report
C1									Lab Exam	Lab Exam
C2									Class Presentations	Class Presentations
C3									Lab Exam	Lab Exam
C4									Lab Exam	Lab Exam
C5									Lab Exam	Lab Exam
C6		Programming Project	Programming Project						Formal Report	Formal Report

For all classroom-format classes, assessment is performed by mean of a focused question on either a homework assignment or an exam question. For all laboratory-format classes, assessment is performed by evaluation of a lab report.

5. Assessment Cycle

The heart of the assessment process for the student outcomes is the course committee. Every course in the EE Program has a course committee and this committee is required to meet after every semester that the course is taught. Each course committee consists of three to four faculty members. These faculty members are those who either teach the course, teach one of its prerequisites, or teach courses that have this course as a prerequisite. The faculty members represented, therefore, are some of the strongest stakeholders of student success in the course. Every faculty member who teaches in the program is on at least one course committee.

We use direct assessment of student performance on the educational outcomes via the course committees. This is supplemented with indirect assessment methods such as course/instructor evaluations. We do not measure outcomes in every class, but instead sample the outcomes across the curriculum in a subset of classes. Because these classes are mostly required, all students are measured at least twice on each outcome. The departmental web pages hold all course reports and outcomes of performance. Individual student performance is also collected as part of the student Academic Learning Compact mandated by the State of Florida. The individual student data are kept with the rest of the student records and are considered private under State and Federal laws, so are not generally available.

The department makes use of several specific activities to measure the degree to which we are achieving the student outcomes and that these outcomes serve the program educational objectives. These are,

- The Curriculum Committee, which meets every month during the academic year and frequently appoints subcommittees to investigate issues and make recommendations.
- Course committees meet after every semester that the course it taught.
- Alumni are surveyed annually; three, five, and eight years after graduation.
- The External Advisory Board meets at the end of every Spring semester.

The Curriculum Committee is responsible for all aspects of the undergraduate program including the review and approval or denial of all courses in the undergraduate program, ensuring the courses prepare students to meet, as alumni, the program educational objectives. The Curriculum Committee is responsible for reviewing options and making recommendations to the full faculty for major changes in the curriculum. The curriculum committee has two ex-officio student members, the IEEE (the international EE professional society) and HKN (the EE honor society) presidents, to help give these stakeholders a voice in the proceedings. The students do not have voting rights, but they frequently communicate with their membership and report back opinions on curriculum committee issues. At least one member of the Curriculum Committee is present at the External Advisory Board meetings and recommendations made by the External Advisory Board are communicated to the Curriculum Committee.
The Curriculum Committee reports back to the all EE program faculty members for discussion and vote on any curricular issues. Any changes to the degree, which appear in the undergraduate catalog, must also be approved by the college curriculum committee and by a majority of faculty members.

The **Alumni Survey** assesses how well the curriculum prepared our graduates for the needs of their industry, and results indicate that the EE program alumni are indeed well prepared for their chosen careers.

Complete Alumni Survey are available online on the departmental web site. The results from the 2011 survey are summarized here. These included graduates from the 2001-2008 (those three, five, and eight-years out) With 59 replies received, and with 31% coming from alumni from 2008, results indicate that graduates are satisfied with their education. When asked, *"Compared with co-workers with EE degrees from other institutions, do you believe that you were adequately prepared for your career?"* 95% responded that they were as prepared, better prepared, or much better prepared. Only around 2% (one respondent) said that their preparation compared poorly to other institutions.

Also, specifically asked was the suitability of the first Program Educational Objectives (Successful careers in a dynamic industry that is global, multi-disciplinary, and evolving; and/or for admission to, and excelling in, the top graduate programs in the world) using a scale of 1 = unnecessary or undesirable, 3 = acceptable, 5 = highly necessary and desirable. The average response a 3.86, indicating that over 88% felt that they mostly achieved the first PEO. Over 75% of the respondents said they were attending graduate school. Regarding the second PEO, *"Good citizenship by engaging in ethical engineering for the betterment of society and the world,"* over 91% felt that they mostly achieved the objective. Four graduates said that they had not achieved the first objective while one graduate said that they did not meet the second.

Successful achievement of the second part of the first objective, *"Admission to, and excelling in, the best graduate programs in the world,"* was attained with 63% of the graduates obtaining an advanced degree. This exceeds our expectation that roughly 30% of our alumni pursue an advanced degree.

The first objective focuses on graduates having successful careers, and this aspect was targeted with several specific questions. Nearly 80% of those responding have indicated that they attended short courses or technical conferences. A clear majority, 64% of respondents, said they are employed in electrical engineering while 36% are not. Roughly 71% claim to have made significant technical contributions to their employer or research group and 61% have already been promoted. Roughly three-quarters (75%) have participated on multi-disciplinary teams and 3% have led them, while 58% have worked with customers or vendors located outside the US.

The first objective also focuses on graduate school, and 75% of our respondents have gone on to graduate school while 48% have received M.S. or M.E. degrees in engineering, and 10% have received a law or doctoral degree. It is our desire to have our graduates pursue advanced degrees and they seem to be doing so in good numbers. Of the 59 respondents, 32% said to have authored or co-authored technical papers.

The second objective further concerns itself with good citizenship and ethics. No respondents felt inadequately prepared to handle ethical decisions. Over 71% have encountered situations in which they needed to make an ethical decision, while 48% are members or leaders of civic, charitable, or volunteer groups. About one-third of our graduates are active in their companies outreach programs and 75% have mentored junior employees at their companies.

As previously discussed, the **External Advisory Board (EAB)** serves as a focus group assessing our success in meeting our program objectives. The EAB membership is made of industry and government leaders, technical recruiters, and recent alumni. This board meets annually and serves in an advisory role to the chair, helping him understand how our graduates measure up in industry, how they are doing in graduate school, and if they are becoming good citizens. Based on their feedback, we are successful in meeting these objectives. Minutes of the meetings are made available to all on the ECE Department website.

The EAB allows for a more in-depth, "outside," perspective of our progress than is possible from surveys and thus provides valuable feedback.

Input from employers and the External Advisory Board indicate that our graduates are well prepared in the knowledge of mathematics, science, engineering skills, engineering practice, and understand professional and ethical responsibilities. These surveys also indicate that our graduates function well on multi-disciplinary teams, an area of increasing concern as the profession evolves. The EAB provides an important means of direct assessment which, before their establishment was obtained primarily from the employers of our graduates and the indirect assessment method of exit surveys. The EAB thus serves as a direct performance indicator on whether or not we are meeting our Program Educational Objectives.

5.1 Assessment Cycle Chart

Assessment Cycle for:

Program: Electrical Engineering — College of Engineering

Analysis and Interpretation: Every Semester
Improvement Actions: Every Semester
Dissemination: Every Semester

Year / SLOs	10-11	11-12	12-13	13-14	14-15	15-16
Content Knowledge						
CK1	x	x	x	x	x	x
CK2	x	x	x	x	x	x
CK3	x	x	x	x	x	x
Critical Thinking						
CT1	x	x	x	x		x
CT2	x	x	x	x	x	x
CT3	x	x	x	x	x	x
CT4	x	x	x	x	x	x
CT5	x	x	x	x	x	x
Communication						
C1	x	x	x	x	x	x
C2	x	x	x	x	x	x
C3	x	x	x	x	x	x
C4	x	x	x	x	x	x
C5	x	x	x	x	x	x
C6	x	x	x	x	x	x

6. Methods and Procedures

The core mechanism for the assessment of the success of each particular course is the Course Committee, and such a committee governs every course in the program. The Course Committee consists of a chair and two or three additional members. The faculty members who serve on the committee are selected from those who teach either the course itself, one of its prerequisites, or courses that have the course as a prerequisite. The faculty members that constitute the committee are therefore some of the strongest stakeholders of student success in the course. All faculty members are on at least one course committee.

One of the tools the department uses for assessment is the Course Committee Outcomes Assessment Evaluation Form. This form is divided into three sections. Section I covers the syllabus, the textbook, results from surveys, student feedback, and student performance. Section II covers pre-requisites and whether the course has met the needs for any subsequent courses. Section III covers recommendations made by the committee to improve the course.

Course committees meet every time a course is offered, either at the end of the semester or no later than early the following semester. There are several inputs that guide the course committee's assessment process. First, several indirect data sets are reviewed by the chair and are given to the course committee as appropriate. The indirect data includes student course evaluations, grade distribution data, focus group input, and exit survey results. Second, the instructor of the course brings first-hand knowledge of students' performance to the meeting along with any direct assessment of outcomes that may be required. The committee then reviews any sample work products and assigns scores on outcomes using a carefully chosen rubric to ensure that a longitudinally consistent performance metric is measured against.

Course committee results are posted on the web for all faculty members to review. The departmental ABET Committee and department chair monitors timely filing of the reports. The Departmental ABET Committee includes the Undergraduate Coordinator, Associate Chair, Undergraduate Advisor, and Curriculum Committee Chair. The ABET Committee is a standing subcommittee of the Curriculum Committee and is overseen by the department chair. Some issues can be resolved entirely among the course instructors. Other issues need further faculty member input and these go to the curriculum committee for consideration.

For those courses that measure and assess the outcomes, the course instructor provides data in the form of a Likert Scale at the end of semester every time the course is taught. This data shows how many students met a given performance indicator based on targeted questions on the outcomes for that course on an outcome-by-outcome basis. An example may be found on our website at: http://www.ece.ufl.edu/academics/ABET/outcomes/ee2.html

The Curriculum Committee meets monthly and frequently appoints subcommittees to investigate issues and make recommendations. The committee is responsible for all aspects of the program including approving and reviewing all courses in the undergraduate program ensuring the courses prepare students to meet program outcomes. They are responsible for reviewing options and making recommendations to the full faculty for major changes in the curriculum. The curriculum committee has two ex-officio student members, the IEEE (the international EE professional society) and HKN (the national EE honor society) presidents, which gives these stakeholders a voice in the proceedings. The students do not have voting rights, but they frequently will consult with their membership and report back opinions on curriculum committee issues that concern them. The External Advisory Board recommendations are provided to both the ABET and Curriculum Committees.

The Curriculum Committee reports any changes made back to the all faculty members for discussion and vote if required. Curriculum issues are usually taken up at a departmental meeting at least once per semester. More substantive changes may require additional approval. For example, a major change in the EE program would first be approved by department Curriculum Committee and then brought before the departmental faculty members. At that point the change would be brought before the college Curriculum Committee, then college faculty members. It then either goes to the Faculty Senate, if necessary, or directly to the Registrar. If the proposed change were to result in an increase the hours required for the degree, then it must go to the State Board of Regents for approval.

Direct assessment raw data is available from the instructors. Each course committee meeting culminates in a report that is posted on the department web page and available for all see; faculty members, alumni, employers, and students. The course committee report answers questions for every course taught such as:

- Syllabus: Does the syllabus reflect current content? Does it need to be adjusted for new topics? Does it still reflect the needs of students and follow-on courses?
- Textbook: Is the textbook working well? Should changes be considered for the next academic year? Are there new books available that should be evaluated? Does the book map well onto the syllabus?
- Evaluations: Do other assessments (student performance / exit surveys) indicate issues that need to be addressed?
- Student Performance: Did students master the material? Are there problems regarding knowledge of key concepts? Performance indicators, such as a focused question on a quiz or the results of some assigned project, are used to assess this and the results documented.

Certain courses are used to assess, measure, and evaluate student outcomes using specific performance indicators that allow the determination on whether or not our students are meeting those student outcomes. Specific metrics (assignments / projects / quizzes / targeted test problem results) are used to ascertain this. Instructors for these courses are required to assign a numeric score between one and five for each student. The scale is: 1-not acceptable, 2-minimally acceptable, 3-acceptable, 4-mastered, 5-outstanding.

We sample student performance on the outcomes in select courses rather than in all classes that exercise a particular outcome. For example, outcome a is measured in four courses; EEL 3105, 3111C, 3135, and 3472, even though that outcome is part of all but seven of the courses taught in the program. Such sampling gives us a good indication of a student's accomplishments both across the outcomes and across their progress toward a degree. Assessment generally takes place in required courses (since all students in the program must take them) and each outcome is generally assessed in at least two courses. This means that every student is measured, assessed, and evaluated (an assessment cycle) twice during their academic career for essentially every outcome. The results of this assessment process are then directed to the curriculum committee for action, if action is required. Specific examples of this assessment cycle for each outcome are provided later in this section. Further details can be found on the department web page and are cross-filed by outcome and course.

To ensure adequate levels of achievement, additional constraints are imposed upon certain course requirements. For example, any electrical engineering course that is a prerequisite for another electrical engineering course must be completed with a grade of C or higher. The department Petitions Committee must approve course substitutions or other variations from the normal requirements for the program.

The department also requires students to take an exit survey upon graduation as an indirect measure of outcome achievement. Students are asked for feedback on specific courses as well as on their opinion about mastery of their outcomes. Exit survey data is shared by the department chair with the curriculum and ABET committees as well as being made available to faculty members. Sections of the survey are directed to specific course committees as appropriate.

Based on the information received from the exit interview questionnaires of graduating seniors, the majority of the students are satisfied with the program, faculty and staff members. They are obtaining competitive positions in industry or are being admitted to top-ranked graduate schools.

The Student Learning Outcomes are measured as follows:

CK1 - knowledge of probability and statistics, including applications

A required course in statistics and probability (STA 3032) is a part of the EE program curriculum. We use this course to monitor student's abilities in this area. Students are required to obtain a passing grade (i.e., a grade of D or better) in this course to graduate. This measures at least some ability in statistics.

We also assess directly the student capability in Communications (EEL 4514), though not a required course, the skills addressed by this outcome are heavily exercised in this course. In Spring 2011, 96% of the students in EEL 4514 demonstrated knowledge of probability and statistics at a sufficient level. The mastery average was not high, however, at 3.6. We are currently looking for ways to track this outcome in other courses so as to encompass a broader spectrum of students in our program.

CK2 - knowledge of mathematics, basic sciences, and engineering sciences necessary to analyze and design complex systems

We monitor this in Circuits I (EEL 3111), Electronics (EEE 3308) Design I (EEL 3923) and Senior Design (EEL 4924). Circuits I allows us to monitor student preparation in fundamentals courses as they enter our curriculum. Electronic Circuits captures their skills a little further in the curriculum and Senior Design allows us to monitor their abilities at the end of the process and we see whether they can apply appropriate tools to design problems.

CK3 - knowledge of advanced mathematics including linear algebra, complex variables and discrete mathematics

We assess this outcome in Signals and Systems (EEL 3135) and Analytical Methods (EEL 3105). Introducing EEL 3105 as a program requirement took place in Fall 2008 in response to our assessment of student mastery of these topics at that time.

CT1: an ability to apply knowledge of mathematics, science, and engineering

We use four different courses to assess this outcome. Three are early in the curriculum and give us feedback on student preparation as well as their ability to apply the concepts. In Circuits I (EEL 3111C), we can assess student ability to use linear algebra and their understanding of work and energy. In Signals and Systems (EEL 3135), we can assess student's ability to solve differential equations using engineering techniques as well as their ability to work with complex numbers and

exponentials. In Electromagnetics (EEL 3472), students can be assessed on their ability to work with vector calculus in multiple dimensions. In Analytical Methods (EEL 3105) we assess the students' mastery of linear algebra and complex function theory. In all cases, the course committees are asked to provide sample work and prepare a numerical assessment of the student performance on this outcome based on a well-defined rubric.

CT2: an ability to design and conduct experiments, as well as to analyze and interpret data

We sample the performance on this metric in Electronic Circuits I (EEL 3308), Digital Logic (EEL 3701C) and Senior Design (EEL 4912-13 or IPPD, EEL4924). Electronics requires students to set up experiments to measure and verify circuit design, including variability from components. Digital Logic evaluates the same concepts but for digital circuits. Senior Design extensively tests their ability to prototype circuit and systems subject to multiple design constraints and conformity to industry standards.

CT3: 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

We sample student performance on this metric in Electronic Circuits I (EEL 3308), Digital Logic (EEL 3701), and Senior Design (EEL 4912-13 or IPPD, EEL4924). This allows us to examine student proficiency in both analog and digital designs as well as at the time of graduation. In both classes, design is a key component of both the lecture and lab components. Electronic Circuits I focuses on basic amplifiers and Digital Logic looks at design of digital subsystems and state machines. Senior Design is, of course, the best place to measure this outcome as the students must complete a design to specification.

To help encourage students to do more ambitious designs, the department has a senior design contest. Each year, approximately ten students groups are awarded prizes of roughly $500 over the course of an academic year. The specific number of awards as well as the amount is variable depending on the quality of the senior designs. Those teaching the design course determine how many designs are eligible for an award.

In its early years the designs were judged by a team of volunteers from the faculty as well as an engineer from a local industry. For the past several years, however, the External Advisory Board has judged this contest during their annual meeting. This allows the Advisory Board to see first-hand the results of the capstone design and offer them the opportunity to provide feedback to both the student teams, the senior design faculty, and the department chair regarding the quality of the capstone design course.

CT4: an ability to function on multi-disciplinary teams

We address this in several ways. The design experience is integrated through the curriculum culminating in EEL 4924C (Electrical Engineering Design II). In this design course, each student is usually a member of design group consisting of two or three students. This group completes a design project to specifications provided by a faculty member, much as in industry. The student does have the freedom to choose his/her own design project.

As an alternative to EEL 4924, students may apply for the Integrated Product and Process Design Program (IPPD). For this highly successful program began in Fall 1996 Semester. Engineering students of all disciplines seeking to enhance their qualifications through a practice-oriented

program may apply for this program. Students that are selected for the Integrated Product and Process Design (IPPD) course (roughly 20% of the ECE students elect this option) are assigned to interdisciplinary teams. We can then monitor how these students do as a sample of the student body at large. Generally, students are successful at these projects and that indicates their ability to function on interdisciplinary teams. Some of these teams have attracted national attention and have been featured in the popular press. Spring of 2011 saw a team build an unmanned ATV for firefighters and others working in high threat environments that will help them orient to their team members in hazardous conditions using GPS. Several IPPD designs have developed into commercial products.

The goal of The IPPD program is to have students in their senior year practice engineering on real, industry-sponsored design projects to improve their engineering education and to enhance their opportunity for employment. The program provides both classroom and laboratory experience. Through this program, the student learns how fundamental engineering science is relevant to effective product and process design; that design involves not just project function but also producibility, cost, schedule, reliability, customer preference and life cycle issues; how to complete projects on time and within budget, that engineering is a multi-disciplinary effort. Working in small multi-disciplinary project teams, students get important practical experience in teamwork and communication as well as in developing their leadership, management and people skills. Each team is coached by a faculty member and interfaces with liaison engineers of the companies that sponsor design projects. Several design reviews are required throughout the two semesters and held at the companies. The IPPD program requires six hours of course work and is offered as a sequence of two three-credit courses (EEL 4912 and EEL 4913) during fall and spring terms of the senior year. These two courses are pre-approved substitutes for a technical elective and for the capstone course. Usually at least four or five faculty members are involved as a coach to the IPPD students each semester during the academic year. The department considers IPPD to be extremely important and therefore assigns 25% FTE to the faculty members involved as coaches. Extensive documentation of IPPD self-assessment is available. http://www.ippd.ufl.edu/

We also require breadth courses across engineering disciplines or business to help give students the background to function with students of other disciplines. These basic courses help students learn the language of other disciplines and provide them with a basis for working together. This is reflected in the curriculum by requiring greater breadth across other engineering disciplines than is required by the college. Students are required to pass ten credits of work in this category to graduate, and this allows us to monitor directly training for interdisciplinary work. We also require Technical Writing to help improve their ability to communicate technical specifications and performance.

CT5: an ability to identify, formulate, and solve engineering problems

We use Design I and our capstone Design II to assess student performance of this outcome. This is the key concept we want students to experience in both Design I and II, and a major focus of both courses. Our current assessment has indicated that students are not challenging themselves – they have tended to choose safe, easy to complete projects to insure success. We have instituted a Senior Design prize to encourage students to strive for more complex designs and challenge themselves.

C1: an understanding of professional and ethical responsibility

Previously, a Civil Engineering required course was used to help us educate students about professional and ethical responsibility. Exit surveys indicate that students have been unhappy with the course, as they feel it is irrelevant to their chosen profession, electrical engineering.

Consequently, we introduced a required seminar course in our department (EEL 2000, Introduction to ECE) that will help improve the student experience and relevance of the instruction. This was offered for the first time in Fall 2006, and this course contains a significant ethics component. Feedback from the assessment process indicates that students now find the material covered relevant to their professional careers and are satisfied with the course.

Regarding ethics, students are also guided in Senior Design about professional issues of patents, documentation, and intellectual property. We do directly assess these issues in Senior Design as well as in the IPPD version of the capstone design.

We have created an essay contest to help raise the visibility of these topics. The submitted essays are evaluated to help assess student performance. Different ethical questions are used. Winning essays receive $1500 scholarships sponsored by an endowment from the Sias family in memory of Ralph Sias, an alumni of our department. Due to staffing changes, this contest was not advertised to the students in recent years due to an oversight. Measures have been taken to correct his and once again advertise this contest.

C2: an ability to communicate effectively

The University of Florida has always emphasized the need for effective communications for all students. All UF students must satisfy the "Gordon Rule" that requires a significant writing experience. Before graduation, students must have written 24,000 words across a minimum of four different courses. No course counts for more than 6000 words. No electrical engineering courses count for this writing requirement. For the EE program, we also require all students to take a technical writing course entitled Professional Communication for Engineers (ENC 3245). This is a sophomore-level course that counts 6000 words against the UF writing requirement. The remaining writing comes from the student's selection of courses that fulfill the general education requirement of the university.

We assess the success of these curriculum elements in Senior Design. Students are required to produce a written project description as well as an oral presentation and demo. We can then monitor directly student's abilities at communication. In Fall 2010 in Senior Design, all students had achieved this outcome and the average performance score was 4.4. In Spring 2011, all students achieved the outcome with an average of 4.0.

Previously, we felt that students underestimated the importance of communication in their studies. This no longer seems to be the case. In the Fall 2010 Semester, the WECE chapter, on their own initiative, hosted a forum on effective communication and interpersonal skills and open to all students. The forum was attended by about 75 students and several faculty members. Among other issues, the students asked attending faculty to relay to their colleagues the need for effective written and oral communications skills. This request was indeed shared with the entire ECE faculty and some faculty members have added written and oral communications components to their classes. For example, in EEL 4458 (Fundamentals of Photonics), at the end of the semester students are required to select a short paper from current literature and make a 10-minute presentation on the topic. Students are also required to select one presentation and write an executive summary on the topic at a level that a non-technical person can understand. Other courses now include exam questions that require a written explanation without the use of equations or figures. Senior Design (both departmental and IPPD) measure, in part, student's ability to make a formal presentation and

orally describe their work to faculty, lab instructors, and, for IPPD, to the industrial sponsor and their peers.

C3: the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

This is one of the most difficult outcomes to assess. The electrical engineering curriculum has a general education requirement that should expose students to a global and societal context. Students are required to take a mix of both social sciences and humanities courses to fulfill general education requirements. Some of these must have an international focus as well.

C4: a recognition of the need for, and an ability to engage in life-long learning

In two different courses, we stress the need for life-long learning and assess the student understanding of it in both courses. In Electronic Circuits I (EEE 3308) and Digital Integrated Circuits (EEE 4310) we discuss device scaling and changes in parameters and performance. In electronics, they are pointed at web press releases on new parts and developments to help them learn how to stay on top of these developments.

We encourage students to use the web in Senior Design to research other products and components for their design. They learn to use the web to stay current on developments in the field. They use the web to provide estimated market potential and to find other products that might compete with theirs. They also use it to specify parts and to understand operation and specifications of these components. In Fall 2010, 96% of the students achieved this outcome with an average of 4.2. In Spring 2011, all students achieved this outcome with an average score of 4.5.

C5: a knowledge of contemporary issues

We have a General Education requirement that should expose students to a global and societal context. Students are required to take a mix of both social sciences and humanities courses to fulfill general education requirements. Some of these must have an international focus as well. We hope these courses help students understand our global marketplace and competitive world. This is an area we are developing more activity around – our new seminar course (EEL 2000 – Introduction to ECE) focuses specifically on outsourcing issues. This has been an area of focus for our essay contest as well.

C6: an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

We assess this outcome in three courses, Circuits I (EEL 3111C), Digital Logic (EEL 3701C), and Signals and Systems (EEL 3135). Each course is responsible for introducing students to major tools, both software, hardware, and instrumentation for success as engineers. We monitor student performance in labs and with software packages required in these and subsequent courses.

In addition to our direct assessment in our own required courses, we rely on several other techniques to help achieve success in meeting the outcomes and improving the program. These are:

- The department provides a rich offering of academic and research opportunities spanning the diverse technical specialties within electrical and computer engineering which keeps both faculty and students on the cutting edge of current topics.

- The department provides opportunities for student interaction with faculty and practicing engineers through professional and honor societies. We have excellent chapters of IEEE and HKN, Women in ECE and a student branch of the Audio Engineering Society.
- The department supports and encourages student participation in multi-disciplinary academic endeavors. Through the college breadth requirement of the program, we help prepare students for multi-disciplinary work. For example, several of our students participated with mechanical and aerospace students and won national robotic vehicle competitions.

- We have an essay contest to encourage awareness of ethical issues and good writing skills. $1500 scholarships are awarded to the winners.
- We have a senior design competition to encourage and reward students for challenging projects. Each winning team receives $500 and we give prizes to approximately ten teams each academic year.
- Faculty members are active in research, consulting, and/or other professional activities, both to advance their own professional competence and to integrate new knowledge into the Department's educational programs.
- The Department actively seeks to improve its educational programs through professional development activities, use of enhanced educational technologies, and externally-funded program development.
- Student organizations encourage professional speakers to discuss career options and professional development.
- The Career Resource Center helps prepare students for work with interview training, resume workshop, and career guidance activities.
- An Undergraduate Scholars Program, administered by the College of Engineering, encourages undergraduate students to become involved in research and offers financial incentives to the student as well as the participating faculty members to do so.

We have significantly overhauled our assessment methodology to make use of more direct metrics. This culminates in the course committees where small groups of involved faculty are asked to directly examine student performance metrics. Several classes are used to specifically evaluate student performance on key outcomes.

The Curriculum Committee serves a vital role in continuous improvement by constantly reviewing the curriculum and proposing changes to the entire faculty. Copies of the full minutes of the Curriculum Committee are available upon request.

Some of the changes have resulted in a significant improvement to the ECE Program. For example, assessments indicated that those students who took Design I (Junior Design) performed head-and-shoulders above their peers in Design II (Senior Design) and IPPD as compared with those students who did not take Design I. As a result, the curriculum committee recommended to the faculty that Design I become a required course. Our assessment also indicated that students did not routinely take advantage of computer tools in courses where tools (such as MATLAB) would be beneficial. As a consequence the curriculum committee recommended the addition of one credit to EEL 3135 (by removing one credit from EEL 3112) and using the time to provide instruction on MATLAB. This change occurred in the Spring 2010 semester and its effect will be assessed and evaluated. Similar comments can be made for changing EEL 4834 (Programming for Electrical and Computer Engineers) to a 3000-level course thus encouraging students to take this course sooner rather than later in their academic career.

7. Assessment Oversight

Several people review data from other assessment processes. This data is then sent to course committee or curriculum committee as appropriate. If action is warranted, the appropriate committee or individual will be assigned responsibility for action. Some specific examples include the following:

- Dr. Harris (harris@ece.ufl.edu) and Dr. Fox (fox@ece.ufl.edu) review the Course-Teacher Evaluations, and GPA Distribution by Course each term.
- Dr. Harris, Dr. Fox, Dr. Zmuda (zmuda@ece.ufl.edu), and the ECE Curriculum Committee review Student Exit Interview responses, Employment Questionnaires, Employer Surveys, and Alumni Surveys.

Since the individual course committee controls individual courses, modification of course content and instructional methods is generally initiated at that level.

The department requires students to complete an exit survey upon graduation. Students are asked for feedback on specific courses as well as on their opinion about mastery of their outcomes. Exit survey data is shared with the Curriculum Committee. Sections are fed to specific course committees as appropriate.

Based on the information received from the exit interview questionnaires of graduating seniors, the majority of the students are satisfied with the program, faculty and staff members. They are obtaining positions in industry or are being admitted to graduate school.

Input from employers and the External Advisory Board indicate that our students are well prepared in the knowledge of mathematics, science, engineering skills, engineering practice, and understand professional and ethical responsibilities. These surveys also indicate that our graduates function well on multi-disciplinary teams. Before implementation of direct assessments, exit surveys were our primary means of assessing outcomes. This did lead to some of the changes in our curriculum as will be subsequently discussed.