

ELECTRICAL ENGINEERING

Student Outcomes Assessment Program (SOAP)

(Last updated May 11)

Department of Electrical and Computer Engineering
Lyles College of Engineering

I. Mission

The mission of the Department of Electrical and Computer Engineering is to fulfill the needs of the region and state by providing an undergraduate technical education in Electrical Engineering and Computer Engineering to a diverse group of students. The department strives to continually update its strong program of study in order to qualify its graduates for positions in industry located in the region and beyond, while providing sufficient breadth and depth in its program to assure its graduates a successful practice in the profession. At the same time, students are grounded in the rigorous scientific and theoretical foundations of the discipline in order to enable graduates to enter and be successful in any advanced level educational program of their choosing, and to allow them to build upon this strong foundation and extend it to new depths.

II. Program Objectives

The program awards degrees to students who within three to five years of graduation, through work experience and/or graduate education in the engineering field will be expected to,

- a) Have grown technically and be productive in their respective workplaces.
- b) Be capable of addressing technical problems of increasing complexity.
- c) Communicate and function effectively in an team environment.
- d) Demonstrate ability for independent learning and continued professional as well as ethical development.

As such, the program has the following specific learning objectives:

1. Offer a broad education in the Electrical Engineering discipline with topical depth, as well as hands-on experience through laboratory courses, and grounded in both the sciences and mathematics;
2. Prepare students to accept responsibilities appropriate to an entry level engineer in a variety of engineering industries or government organizations;
3. Provide its graduates the necessary knowledge base to succeed in subsequent graduate electrical engineering education or other professional schooling;
4. Give the students an understanding of societal issues by exposing them to the humanities through a required program of general education;
5. Develop students' capability of thinking creatively, of synthesizing concepts, and

researching sources of information for the purpose of analyzing and solving engineering problems;

6. Motivate students for a life-long ethical practice in the engineering profession, while recognizing the need for continual updating of skills in order to have a successful, productive, and enjoyable career;
7. Enhance students' ability to communicate and work effectively in a team environment.

III. Student Learning Outcomes

The Electrical Engineering program seeks to produce graduates with

Outcome 1 – Knowledge of statistics and the ability to apply knowledge of mathematics and physics to solving engineering problems.

Outcome 2 – The ability to apply knowledge of engineering sciences and engineering design to solving engineering problems.

Outcome 3 – The ability to design, conduct, and evaluate the results of experiments.

Outcome 4 – The ability to design a system, component, or process, to a set of specifications.

Outcome 5 – The ability to work independently.

Outcome 6 – The ability to function and be productive in a multi-disciplinary team environment.

Outcome 7 – The ability to formulate and solve engineering problems.

Outcome 8 – An understanding of professional and ethical responsibilities.

Outcome 9 – The ability to present ideas orally, in writing, and can communicate effectively in their daily environment.

Outcome 10 – The ability to understand technical instructions, and interpret documents prepared by others.

Outcome 11- Have a broad education and knowledge of contemporary issues necessary to understand the impact of the work of engineers on society.

Outcome 12 – The ability to recognize the need for and have the ability to undertake life-long learning and continual updating of professional skills.

Outcome 13 – The ability to use the techniques, skills, and modern engineering tools needed for the engineering practice.

Outcome 14 – Have breadth and depth in engineering subjects.

IV. Relevance of Outcomes to Program Objectives

The learning outcomes contribute to the program objectives as follows:

Objective 1 - *Offer a broad education in the Electrical Engineering discipline with topical depth, as well as hands-on experience through laboratory courses, and grounded in the both the sciences and mathematics.*

This objective is supported via **Outcomes 1, 3, and 14**, where basic science and mathematics (**Outcome 1**), hands-on experience (**Outcome 3**), and breadth and depth in electrical engineering (**Outcome 14**) are ensured.

Objective 2 - *Prepare students to accept responsibilities appropriate to an entry-level engineer in a variety of engineering industries or government organizations.*

All outcomes contribute to this objective. Breadth and depth of knowledge (**Outcomes 1 and 14**), hands-on experience (**Outcomes 3 and 13**), and design and open-ended problem solving (**Outcomes 2, 4, 7, and 10**) are essential technical attributes needed for engineering practice. **Outcomes 6, 8, and 9** pertain to the soft skills of communication and teamwork, which are important to employers and for successful career. Life-long learning and the ability to work independently (**Outcomes 5, 11, and 12**) are attributes that have a long-term positive impact on one's challenging career. Use of engineering tools (**Outcome 13**) is an important aspect to effective engineering practice.

Objective 3 - *Provide graduates the necessary knowledge base to succeed in subsequent graduate electrical engineering education or other professional schooling.*

Outcomes 1-4, and 7 provide necessary competencies to succeed in technical graduate programs. The ability to apply mathematics and physics concepts (**Outcome 1**), knowledge of engineering design (**Outcomes 2 and 4**), hands-on experience (**Outcome 3**), and the ability to formulate and solve problems (**Outcome 7**) are all relevant attributes.

Outcome 5, 7, 9, and 12 are also of important to engineering graduate programs, as well as other professional programs like medicine and law. The ability to work independently (outcome 5), communication skills (**Outcome 9**), and life-long learning (**Outcome 12**) are universal attributes of direct value in these programs.

Objective 4 - *Give the students an understanding of societal issues by exposing them to the humanities through a required program of general education.*

Outcome 8 is directly relevant to this objective. This outcome addresses students' exposure to societal issues, which help them make informed ethical and social decisions. **Outcome 11** also helps strengthen students' understanding of the contributions that engineering has on the quality of living and technological advances in technology that benefit mankind.

Objective 5 - *Develop students' capability of thinking creatively, of synthesizing concepts, and researching sources of information for the purpose of analyzing and solving engineering problems.*

Outcomes 1, 2, 4, and 12-14 address this objective most directly. Having the necessary knowledge (**Outcomes 1 and 14**) and the ability to apply it (**Outcome 2**) gives rise to creative thinking. Design skills (**Outcome 4**) usually require critical thinking and taking creative approaches to complete a competitive product. Life-long learning (**Outcome 12**) is an indication of the ability to seek information and identify its sources. Familiarity with modern engineering tools (**Outcome 13**) facilitates conducting effective research.

Objective 6 - *Motivate students for a life-long ethical practice in the engineering profession, while recognizing the need for continual updating of skills in order to have a successful, productive, and enjoyable career.*

Outcomes 1 and 2 provide the base for further learning. Independent work (**Outcome 5**) is required for continuing one's own learning. Outcome 8 addresses the ethical component of the objective directly. **Outcome 12** promotes a desire and interest in life-long learning while ethical conduct is partly addressed in the general education component of the program.

Objective 7 - *Enhance students' ability to communicate and work effectively in a team environment.*

Outcome 6 contributes directly to enhancing teamwork skills. Communication skills (**Outcome 9**) are also a key to success in functioning in a team environment.

Table 1. Objectives/Outcomes Summary Matrix

Objectives	Outcomes													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Broad education in EE	•		•								•			•
2. Prepare students for practice	•	•	•	•	•	•	•	•	•	•	•	•	•	•
3. Prepare students for advanced education	•	•	•	•	•		•		•			•		
4. Understanding of societal issues								•			•			
5. Critical thinking and solving engr. prob.	•	•		•								•	•	•
6. Life-long learning and ethical conduct	•	•			•			•				•		
7. Communication and team work						•			•					

Outcome 1 – Apply Math and Physics
 Outcome 2 – Apply Engineering Science
 Outcome 3 – Hands-on Experience
 Outcome 4 – Design
 Outcome 5 – Independent Work
 Outcome 6 – Teamwork
 Outcome 7 – Formulate and solve engineering Problems

Outcome 8 – Ethics
 Outcome 9 – Communication Skills
 Outcome 10 – Understand Technical Instructions
 Outcome 11 – Contemporary Issues
 Outcome 12 – Life-long Learning

Outcome 13 – Modern Engineering Tools
 Outcome 14 – Breadth and Depth in Engineering

V. Constituencies

Faculty, students, alumni, and industrial employers are the program's primary constituencies who provide both informal and formal input to the educational process. Students' parents and individuals from the community and state provide informal input to the process on matters affecting the program.

VI. Assessment Tools

The department ensures that graduates achieve learning outcomes in two ways: first, by offering a coherent program of study that provides an opportunity for learning, and second, by developing and applying *direct* and *indirect* assessment techniques to determine the success of students in fulfilling learning outcomes. Table 2 maps the developed assessment tools to each of the learning outcomes. Furthermore, scoring rubrics for **Outcomes 1-4, 7, 9, and 13** are developed by faculty members to facilitate in the assessment process.

Direct Student Assessment Tools:

1. *Culminating Experience* is assessed through *Capstone Design Reports*. *Capstone Design Reports* provide a strong indicator for many of the outcomes indicated in Table 2. Applying engineering science, open-ended problem solving, use of modern engineering tools, computation competence, problem solving, written communication, and team skills for group projects are elements that can be assessed through oral progress reports and written final reports. Sample reports will be made available during the site visit. (*Scoring rubrics applied.*)
2. *Embedded Questions* provide a moderate indicator for breadth and depth in electrical engineering subjects. Table 3 ties the learning outcomes to the current curriculum. The learning outcomes are *introduced* in lower division courses and continue to be *reinforced* throughout the sequence of courses toward the culminating experience. (*Scoring rubrics applied.*)
3. *Lab Reports* are strong monitoring instruments for hands-on experiences, use of modern engineering tools, following technical instructions, written communication, and teamwork skills. (*Scoring rubrics applied.*)
4. *Poster Sessions/Oral Presentations* strongly demonstrate the student's written and oral communication skills. These sessions also show examples of hands-on experiences, engineering design, use of modern engineering tools, and teamwork skills (for group projects). Sample posters will be available to the visiting team during the site visit. (*Scoring rubric applied.*)
5. *Employer Survey* helps assess program objectives and learning outcomes for practicing engineers and VIP students.

Indirect Student Assessment Tools:

1. *Student Transcripts* demonstrate the breadth and depth of topics attempted by individual students.
2. *Course Assessment* demonstrates the accomplishment of course objectives as related to learning outcomes in individual courses. The level of student satisfaction is an indicator of relevant knowledge gained. Survey forms are administered in individual courses in which students appraise the contribution of the course to each educational outcome.
3. *Student/Faculty Forum* is administered in an open forum where students from all levels are present. Most of the outcomes can be monitored by such student input. In these meetings students typically tend to discuss issues like laboratory facilities, curriculum, internships and job opportunities, hands-on experience, available modern tools, lab upgrades, communication skills, ethics, and teamwork.
4. *Exit Interviews/Surveys* address most of the outcomes and document students' level of satisfaction with the learning attributes at the time of graduation. Graduating seniors typically spend between 2-4 years in the department. Therefore, their experiences, usually in the form of oral comments expressed during exit interviews are much more telling and useful than numeric scores on survey sheets. Electrical and Computer Engineering faculty members spend time discussing these comments while placing them in context of other assessment data before considering any changes or adjustments.
6. *Alumni Survey* helps assess program objectives and learning outcomes.

Table 2. Assessment Summary Table										
		Culminating Experience*	Embedded Questions*	Lab Reports*	Poster sessions/ Oral presentations*	Course Assessment	Student/ Faculty Forum	Exit survey/ interview	Alumni Survey †	Employer Survey*†
Out. 1**			•	•		•		•	•	
Out. 2**		•	•		•	•	•	•	•	•
Out. 3**		•		•		•	•	•	•	•
Out. 4**		•	•	•	•	•	•	•	•	•
Out. 5		•	•			•	•	•	•	•
Out. 6		•		•	•	•	•	•	•	•
Out. 7**		•	•			•	•	•	•	•
Out. 8		•					•	•	•	•
Out. 9**		•	•	•	•	•	•	•	•	•
Out. 10		•	•	•		•	•	•		•
Out. 11		•			•		•	•	•	•
Out. 12		•		•	•		•	•	•	•
Out. 13**		•	•	•	•	•	•	•	•	•
Out. 14		•	•		•	•	•	•	•	•

* *Direct assessment tools*

** *Scoring rubrics applied*

† *Provides feedback relative to program objectives*

Outcome 1 – Apply Math and Physics
 Outcome 2 – Apply Engineering Science
 Outcome 3 – Hands-on Experience
 Outcome 4 – Design
 Outcome 5 – Independent Work
 Outcome 6 – Teamwork
 Outcome 7 – Formulate and solve engineering Problems

Outcome 8 – Ethics
 Outcome 9 – Communication Skills
 Outcome 10 – Understand Technical Instructions
 Outcome 11 – Contemporary Issues
 Outcome 12 – Life-long Learning

Outcome 13 – Modern Engineering Tools
 Outcome 14 – Breadth and Depth in Engineering

Table 3. Curriculum map showing the target courses for each learning outcome.

	ECE 1	ECE 2	ECE 71	ECE 85	ECE 85L	ECE 90	ECE 90L	ECE 102	ECE 118	ECE 120L	ECE 121	ECE 124	ECE 125	ECE 126	ECE 128	ECE 128L	ECE 134	ECE 138	ECE 138L	ECE 155	ECE 186	
Out.1				•		•		•			•	•		•	•							
Out.2								•			•	•						•		•	•	
Out.3					•		•			•						•			•			
Out.4			•	•						•								•		•	•	
Out.5				•					•			•					•			•		
Out.6	•				•					•						•			•			
Out.7								•					•	•			•					•
Out.8	•																					
Out.9	•						•			•						•						•
Out.10					•					•						•			•			•
Out.11	•																					•
Out.12	•									•												•
Out.13		•	•						•	•		•			•			•				
Out.14												•	•				•					•

Outcome 1 – Apply Math and Physics
 Outcome 2 – Apply Engineering Science
 Outcome 3 – Hands-on Experience
 Outcome 4 – Design
 Outcome 5 – Independent Work
 Outcome 6 – Teamwork
 Outcome 7 – Formulate and solve engineering Problems

Outcome 8 – Ethics
 Outcome 9 – Communication Skills
 Outcome 10 – Understand Technical Instructions
 Outcome 11 – Contemporary Issues
 Outcome 12 – Life-long Learning

Outcome 13 – Modern Engineering Tools
 Outcome 14 – Breadth and Depth in Engineering

VIII. Assessment Process

The department established the following comprehensive process to assess students' learning according to the aforementioned 14 program outcomes. The current assessment process has been in place since the year 2000.

1. Reevaluation of the mission statement, program objectives, and learning outcomes. (This is done with the input from the advisory council, faculty, and survey response from the alumni and the employers.)
2. Reevaluation of surveys and scoring rubrics will be done by faculty during the scheduled faculty retreat sessions.
3. Data is collected using the assessment tools and according to the established time schedule.
4. Data is analyzed according to the established time schedule. (This is done by faculty and advisory council members.)
5. The action items are determined to close the loop of the assessment.
6. Progress is monitored based on the action items.

On a scale of 1 (poor) to 5 (excellent), the faculty members consider a rating of 3.5 or higher to be satisfactory. An overall rating below 2.0 for any of the outcomes requires immediate attention, and a rating between 2.0 and 3.5 requires further observation as a "carry over item" in the next evaluation cycle.

Rubrics for assessing learning outcomes have been developed and utilized since 2009.

IX. Assessment Activities Timeline

The department collects and analyzes data according to the following schedule:

1. Every semester (starting Spring 09)

- (a) Exit Surveys (Spring and Fall Graduates)
- (b) Embedded questions
- (c) Alumni/Advisory Meeting
- (d) Faculty retreat

2. Annually (starting Spring 09)

- (a) Culminating Experience
- (b) Poster Sessions/Oral Presentations
- (c) Student/Faculty Forums
- (d) Course Evaluations

3. Every third year (starting 2009)

- (a) Alumni Survey/Alumni Focus Group Meeting
- (b) Employer Survey (Currently using Co-op Employer Surveys)
- (c) Review of a mission statement, program objectives, and learning outcomes.

5. Every sixth years (starting 2000)

- (a) Assembly of course binders and assessment of the overall success.