

ELECTRICAL AND COMPUTER ENGINEERING ACADEMIC OUTCOMES ASSESSMENT PROGRAM

1. Department Mission and Academic Assessment Goals

The mission of the Department of Electrical and Computer Engineering is *to provide quality educational programs in electrical and computer engineering*. In accordance with this mission, specific achievement goals are delineated, and a program is described for the assessment of academic outcomes.

The assessment program is designed to monitor and improve the academic program, and it is prepared in accord with guidelines as provided by the North-Central Association (NCA) and the Accrediting Board for Engineering and Technology (ABET). The program is designed to assess the strengths and weaknesses of the curriculum, not to assess each student. Great care is taken to insure that the assessment tools neither threaten or intimidate individual students, nor infringe upon or restrict the Academic Freedom of individual faculty.

2. The Undergraduate Program

a. Department Goals

The faculty believes that each electrical engineering and computer engineering student must acquire:

A strong knowledge base in mathematics, basic science and engineering science as the foundation for lifelong learning.

The ability to use this knowledge base, and to apply engineering skills to the creative solution of problems.

The ability to communicate effectively.

These requirements are consistent with a consolidation of the eleven accrediting criteria found in ABET's proposed Engineering Criteria 2000. The level of knowledge that is accepted as a "strong knowledge base" is determined by the faculty as reflected in the design of the direct measures of assessment.

The ABET EC2000 criteria require that engineering programs demonstrate that their graduates have:

- (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

- (d) an ability to function on multi-disciplinary 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 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.

The criteria above are appropriate for any engineering program. Criteria specific to EE consist of the following:

- (l) knowledge of probability and statistics, including applications appropriate to the program name and objectives;
- (m) knowledge of mathematics through differential and integral calculus, basic sciences, and engineering sciences necessary to analyze and design complex devices and systems containing hardware and software components, as appropriate to program objectives.
- (n) knowledge of advanced mathematics, typically including differential equations, linear algebra, complex variables, and discrete mathematics.

The faculty of the Department of Electrical and Computer Engineering concurs with, supports, and maintains the ABET criteria as a set of department goals pertaining to student learning outcomes. Additionally, the department calls upon the knowledge of its External Advisory Committee (EAC) to maintain contact with that portion of its constituency that employs our graduates. The EAC periodically reviews the department's goals and fully concurs with those listed above.

The rationale for these goals is expressed as follows:

Graduates entering the electrical engineering and computer engineering professions are confronted with the highest rate of *technology turnover* of any engineering discipline. In less than five years after graduation from a baccalaureate program, an electrical engineer or a computer engineer will find it necessary to utilize technology that did not exist when

that engineer was in college. Today's ECE students will need to use every learning technique from self-study to distance-learning courses to stay current with the extraordinarily rapid changes in technology. To take advantage of the wide range of study methods available, all engineers must have *learned* the fundamental concepts of mathematics and science upon which their knowledge of engineering is built.

I. Although some of our students assume challenging and rewarding careers in non-engineering areas of industry, the faculty's purpose, in part, is to educate students in the practice of engineering. This means that our students must be adept at analysis and synthesis; they must be able to make appropriate judgments relating to social and environmental impact, aesthetics, economics, and ethical considerations.

1 The department's EAC has confirmed that engineers are expected to work in multi-disciplinary teams where communication among the members and knowledge of team-management principles are vital. Proper documentation of work done and in progress is necessary. Engineers in all segments of industry must be able to communicate their ideas and to work together effectively. This requires not only effective oral and written communication, but also the use of computer-based graphical and information systems.

b. Assessment Measures

A mixture of *direct* and *indirect* assessment methods have been devised for evaluation of the undergraduate program. These particular methods have been selected to permit the economical evaluation of *all students at well-spaced points* in their careers. The entire program spans a seven-year period, from lower division engineering student, to young practicing engineer.

i) Senior Design Capstone Sequence

A standard list of criteria shall be used to evaluate the student reports and portfolios from our capstone Senior Design projects in May. Specifically, students completing the 10-credit senior-year design project and the 2-credit design methods course will be able to:

1. Function as a member of a design team. Bring their personal technical expertise to bear on a problem requiring multiple technical specialities.
2. Develop a clear engineering design problem from a customer statement of desired product/system performance.
3. Develop experiments and collect and analyze data.
4. Make clear written and oral reports.
5. Develop a project timeline/schedule.

Which of the eleven ABET criteria are satisfied by the Design Sequence? The following criteria should be covered :

- 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.
- d) an ability to function on a multi-disciplinary team
- 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 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.

The following assessment tools will be used to assess outcomes 1 through 5 indicated above:

Written Communications: These will be periodic letters, memos, progress reports, and the final report.

Oral Presentations: These presentations will be made at interim progress points and after writing the final report.

Assessment Surveys: The students and their faculty advisors will complete assessment forms at the end of the design projects. Depending on availability, the External Advisory Committee and the industrial sponsors of the projects will also participate in this assessment.

Student Team Portfolio: Each student team will construct a portfolio containing relevant project work throughout the project. This will include the three items above.

In evaluating the final written and oral reports, the outcomes are assessed using the following questions:

- a) Has the student team developed a clear engineering design problem that meets customer product/system performance?
- b) Has the student team used basic math, science, and engineering skills to explain the significance of its findings?
- c) Has the student team devised a scheme of experiments to test the design or the principles employed in the design?

- d) Has the student team performed the experiment (if needed as part of the project), collected the data, understood the data, analyzed, and interpreted the data?
- e) Has the student team given clear statements of the objectives, design plans, and design implementation?
- f) Has the student team developed a time line/schedule to implement their plan?
- g) Has the student team stated the decisions made considering alternate design plans?
- h) Has the student team given sufficient reasoning to support all conclusions and recommendations made in the report?
- i) Has the student team shown honesty, justice, and fairness in their choice of recommendations?
- j) Has the student team set professional standards and practiced ethical means to achieve their goals?
- k) Has the student team considered the impact of their recommendations on their community and on the society as a whole?

Assessment surveys will have questions on teamwork, multi-disciplinary tasks, contemporary issues, global impact of the project, and life-long learning experience.

ii) *Selective Assessment Using Final Exam Questions:*

Target courses throughout the curriculum are chosen to measure specific ECE outcomes. The ECE outcomes will be measured by the analysis of (a) final exam question(s) in all terminal core courses and in all terminal courses in the advanced elective sequences. Most commonly, each faculty member ("teacher") teaching a terminal course as described above will find a different faculty member ("assessor") who will select one question from the teacher's final examination which the assessor feels will best serve as an assessment for the course outcomes. The Assessment Committee will collect from the "teachers" the names of proposed "assessors" by noon Tuesday of the term's 9th week. The assessor's selection of the final exam question will be made after the last class meeting of the term takes place. After the exam is given the assessor will, in timely fashion, extract the students' responses, analyze the results in a brief written report, and provide the report and the raw data to the Assessment Committee.

Communication between assessors and teachers is encouraged, particularly if the assessor feels that no question is appropriate. If the discussion does not result in an appropriate

question being included in the examination by the teacher, then no question will be selected and this consequence will be reported to the Assessment Committee.

The assessment approach described above is presumed to be the one most commonly used, but is not intended to preclude or inhibit other faculty innovations which serve or enhance the intended purpose. On the contrary, faculty are encouraged to develop such innovations. Examples of innovations include examinations and assessments for select course(s) made by an ad hoc committee of faculty, or the case where multiple faculty teaching the same course choose to administer a common final exam with a single selected assessment question.

Initially, our basic success metric is to determine whether 70% of assessed students for a given outcome receive 60% credit. The assessor's report will include recommendations to all faculty involved in the course sequence, and will be reviewed by the Assessment Committee which may add notes before conveying the report to the appropriate faculty. Further, the Assessment Committee will use the reports to collect appropriate data for aggregation and reporting, and will supply a summary report to all faculty during the subsequent quarter.

It is anticipated that as this assessment measure matures faculty may choose to refine the success metric and/or adjust the list of courses to which this measure is applied.

The target terminal courses and associated ECE-specific technical outcomes are listed in Tables I and II, below. These technical outcomes represent the fundamental analytical, design, and knowledge-based skills that the ECE faculty expect graduates to master. We recognize that these outcomes are a sample of the key elements of the undergraduate program. Clearly, our students explore a much wider variety of topics.

Table I.
Technical Outcomes - Terminal ECE Core Courses

Topical Area	Technical Outcome	Course
Signals and systems	Frequency domain analysis of linear systems.	EE322
Circuits	Laplace transform analysis of linear circuits.	EE233
Electromagnetics	Basic plane wave applications of solutions to Maxwell's equations.	EE242
Electronics	Small signal analysis of amplifier circuits.	EE353
Computers	Model/simulate an engineering problem using a high level programming language.	EE365
Controls	Analysis of a linear system using a state model.	EE371
Power	Understand distribution systems and the use of per-unit representation of power system quantities.	EE380

Table II.
Technical Outcomes - Terminal Courses in Advanced Elective Sequences

Topical Area	Technical Outcome	Course
Signal processing	Design of infinite impulse response filters.	EE423
Electromagnetics	Understand and be able to use the Friis transmission formula for antenna system design.	EE445
Electronics	Design of a variety of bipolar amplifier types.	EE404
Computers	Understand the organization of state-of-practice computers and networks.	EE465
Controls	Analyze and design digital control systems using difference equation models, digital simulation, and z-transform techniques.	EE473
Communications	Apply basic concepts of forward error correction coding, information theory, and spread spectrum.	EE409/ EE419
Power	Apply and understand the limitations of unsymmetrical fault calculations.	EE486

iii) Sampled Retention of Expected Prerequisite Knowledge:

The instructor in each EE course section will evaluate the student's performance on the prerequisite knowledge required for the course **during the first two weeks** of the semester. A report on the assessment of prerequisite knowledge will be **due by the end of the fourth week** of the semester. The topics to be covered are listed on the Course Information Sheet under "Prerequisites by Topics".

The form, format, and style of this evaluation is left to the discretion of the instructor. For example it may be an in-class or take-home exam, open book or closed book, a homework assignment, a quiz, a lab practical exam, or any other form that can be graded. In order for the students to take the evaluation seriously, it must be graded and it must count as part of the course grade.

To minimize penalizing students who took the prerequisite courses in which the expected prerequisite topics were inadequately covered, it is recommended that instructors:

- Limit the evaluation to topics in the 'Prerequisites by Topics' section in the course Information Sheets.
- Provide a study guide to the students covering the major topics to be covered on the prerequisite evaluation.
- Consider grading options for the evaluation that allow students a second chance to improve their grade on the evaluation (a retest, pass/fail option, etc.) (The ORIGINAL grade should be reported to the assessment committee.

Instructors will use the *Report on Evaluation of Prerequisite Knowledge* form, which follows this section. If students attempt the evaluation more than once, the **first** score will be reported to the assessment committee. It is not expected that all instructors will use all the lines on the form. If you do not break the reporting down into specific prerequisites, specify "general" as the prereq topic.

The "Instructors Comments" field on the *Report on Evaluation of Prerequisite Knowledge* form is the very important. The comments can be used to indicate any strengths or weaknesses that the instructor has uncovered, recommendations for changes in prerequisite course, or general recommendations for improving the programs.

Two key principles are addressed by this approach. First, testing for prerequisite knowledge (i.e., in a course subsequent to that in which the material is presented) introduces an element of time that allows a more accurate estimation of students' long-term retention of the prerequisite material. Second, repeated emphasis to the students of the need for long-term retention may help to overcome the difficult task of increasing student cognition of the continuity, need, and importance of lifelong learning.

Initially, our basic success metric is to determine whether 70% of assessed students for a given outcome receive 60% credit.

The report forms will be collected by the staff in the ECE office and the Assessment Committee will collect, consolidate, and convey the recommendations to the appropriate faculty via the Undergraduate Program Committee or other designated responsible faculty, who will return a brief written description of the actions taken to address the recommendations. The Assessment Committee will catalog the actions taken so that their effectiveness may be evaluated in future assessment cycles. Further, the Assessment Committee will use the reports to collect appropriate data for aggregation and reporting, and will supply a summary report to all faculty during the subsequent quarter.

Report on Evaluation of Prerequisite Knowledge
Electrical and Computer Engineering Department
 Due: end of 4th week of semester

Course No: _____ Sem/yr: _____ Instructor: _____

Specific Topics Tested	Mean Score (%)	% with score > 60%
Prereq topic (specify)		
Prereq topic (specify)		
Prereq topic (specify)		
Written Expression (grammar, spelling, clarity of explanation, etc)		
Other (specify)		

Comments of Administration of your Evaluation of Prerequisite Knowledge: Describe how your evaluation was organized and administered (In-class exam vs. homework assignment) and comment on how well this approach worked.

Instructors Comments: Your observations, comments, and recommendations are often much more valuable than numerical scores. Please attach extra sheets if necessary.

iv) Mid-program Communication Skills Assessment:

ECE students will develop communication skills significantly through their freshman general education sequences and will enhance these abilities through teamwork and reporting in the Senior Design sequence. Throughout the ECE core program, additional writing and speaking activities will engage the students. We have chosen to assess at the approximate midpoint of the ECE curriculum, communication skills in the context of several ABET objectives, specifically:

(g) an ability to communicate effectively

(h) the broad education necessary to understand the impact of engineering solutions in a global 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

For example, EE380 students will be required to do a writing project relating power and energy conversion technology to a contemporary issue. Assessment of the project will explore the student's ability to access multiple information sources, analogous to a life-long learning scenario. A committee of faculty will be formed to conduct the assessment and construct a report for feedback into the ECE curriculum and into the MTU General Education curriculum.

vi) Survey of All Departmental Alumni Three Years After Graduation:

These annual surveys use a questionnaire developed by the department. Alumni are questioned about the adequacy of the skills they acquired at Michigan Tech and their recommendations for the department. The results of the survey are returned to the Chair and the Undergraduate Curriculum Committee.

vii) Fundamentals of Engineering Exam:

The results of the Fundamentals of Engineering Examination given nationally by the National Council of Examiners for Engineering and Surveying (NCEES) will be used to assess how well students in Michigan Tech's Electrical Engineering and Computer Engineering Programs compare with students both in the State of Michigan and in the nation. The assessment will use the NCEES Report #6 which gives average student scores for selected subjects (based on several questions for that subject) for MTU students, students in Michigan, and all students taking the exam nationally. The selected subjects and corresponding ABET criteria assessed are given in Table V.

Table V. FE Selected Subjects & ABET Criteria	
Subjects	ABET Criteria
Chemistry	a, k
Computers	a, k
Dynamics	a, k
Electrical Circuits	a, k
Engineering Economics	a, k
Ethics	f
Fluid Mechanics	a, k
Material Science	a, k
Mathematics	a, k
Mechanics of Materials	a, k
Statics	a, k
Thermodynamics	a, k

The MTU Electrical Engineering and Computer Engineering programs will be deemed successful in this element if more than 70% of MTU students taking the exam pass. Further, the program will be deemed successful if the MTU pass rate for each subject is above the pass rate for State and National students.

viii) Assessment by Other Units of the University

The Assessment Council:

The University has established the Assessment Council to promote assessment within the university and to share assessment results between different units of the University. The Assessment Council is composed of a representative from each academic department. The assessment reports from each unit are collected by the council in October of each year and redistributed to its members. The Electrical and Computer Engineering Department's representative takes the appropriate reports and distributes them to the Electrical and Computer Engineering Department's Assessment Committee for review. After reviewing the reports our assessment committee will contact the other departments if we have any concerns.

During the Spring of 1998, the Assessment Council will develop formal methods of sharing assessment data and recommendations between departments. While doing this, they will specifically address the educational outcomes from ABET.

Presently there are several assessment reports which supply significant data for the Electrical and Computer Engineering Assessment Committee to review. They are explained below.

Social Science Department:

The Social Sciences department has set as one of its goals is that students will gain a better understanding of social science concepts and analysis. This goal will strengthen the students ability to understand the impact of their engineering solutions in a global and societal context (h). The assessment measure used are course embedded pre and post tests in the 100 and 200 level social science courses that all students must take. The results are collected by the Social Science's Curriculum Committee which reports the results to the University Assessment Council. This program was piloted in the 1996-97 academic year. It was further refined and is being implemented during the 1997-98 academic year.

Student Attitudes and Development Committee:

The Student Attitudes and Development Committee is assessing Michigan Tech's students attainment of 5 goals. The goals are:

- Goal 1:** Students at Michigan Tech will graduate from the institution as skilled team players. (d)
- Goal 2:** Students at Michigan Tech will graduate from the institution as skilled communicators. (g)
- Goal 3:** Students at Michigan Tech will graduate from the institution as skilled leaders.
- Goal 4:** Students at Michigan Tech will graduate as individuals who have a high value for the continued acquisition of knowledge and lifelong learning. (i)
- Goal 5:** Students at Michigan Tech will graduate as individuals who can participate effectively in a global society and can demonstrate that they value a diversity of opinions and perspectives. (h)

As can be seen, assessment of Goals 1,2,4, and 5 will also assess ABET criteria d, g, i, and h respectively.

The assessment is done by testing a large sample of the University's students, once as freshman and then again as seniors. The two groups are picked so that they are representative of the whole student body. As such we assume that they are representative of Electrical Engineering and Computer Engineering students. (the scores will be reported by individual departments, although the numbers will be lower and the significance of the sample may be questionable) The testing is done during freshman

orientation and then again shortly before the seniors graduate. By performing a pre and post test, the effectiveness of the program as a whole can be evaluated.

Both tests are provided by the Higher Education Research Institute and are part of a national longitudinal study by Dr. A. Astin. The Cooperative Institutional Research Program (CIRP) test is administered to freshman and the College Senior Survey (CSS) test is given to the seniors.

The CIRP test was first administered to the Freshman in 1993 and the CSS test was administered to the seniors in 1997. The results of this pilot study are presently being tabulated and will be available in the summer of 1998. This process will be continued on an annual basis starting in the 1998-1999 academic year. The results will be distributed to the departments through the Assessment Council in March of each year.

General Education:

One of the goals of Michigan Tech's General Education program is to demonstrate that all students demonstrate a foundational communication skill. The assessment of this goal is also an assessment of ABET educational goal (g): an ability to communicate effectively. This goal is assessed by taking a representative sample of student essays written in the upper level (300-400) general education courses. The essays are scored by a panel of faculty on writing skills and the ability of the students to integrate knowledge from several courses. The results of the assessment are reported to the Assessment Council, and from their to the Department.

ix) *Ad Hoc Assessments:*

The faculty recognizes that as any assessment program evolves additional innovations for assessment must be encouraged. While it is impractical to incorporate every new assessment tool or idea into our mainstream assessment program, it is imperative that we give fair examination to viable alternatives. Thus, as part of its annual assessment cycle, the Assessment Committee will evaluate new assessment innovations undertaken by individual faculty. The evaluation will consider the efficacy of the assessment tool, the resources required for its implementation, and the appropriateness of incorporating the ad hoc assessment data into the current assessment metrics.

Examples of current ad hoc assessment opportunities that have been suggested by individual faculty include:

Student presentations in the manner of a five-minute project meeting, to be undertaken in the senior design project courses and/or in upper division courses involving student projects.

Student poster sessions in late sophomore- and/or early junior-level laboratory courses.

Use of existing written feedback from on-campus interviewers and co-op sponsors.

c. Assessment Use

Statistical results compiled from the EE111/EE211 assessment examinations will identify consistent patterns of shortcomings which will guide curricular modification decisions. Individual results can also be used by each student to evaluate his or her own performance in each of the various scored areas, and the student can then seek remedial work in any area. As described previously, the Assessment Committee evaluates these results and forwards them with recommendations to the Undergraduate Program Committee for further action.

Basic knowledge, the ability to creatively apply knowledge to new situations, teamwork, industrial interaction, and communication skills associated with the senior design projects are examined using the portfolios, project reports, oral presentations, and surveys. The materials prepared by the student design teams are evaluated in all of these areas with evaluation to detect strengths and weaknesses. The evaluations are performed by a capstone course committee in the summer and recommendations are forwarded to the Department Chair and the faculty in September.

Selective assessment using final exam questions and sampled retention of expected prerequisite knowledge are the tools that will give us the tightest feedback loops in our Assessment Plan. The reports generated by the faculty and approved by the Assessment Committee will allow rapid feedback for adjustment to the curriculum.

In addition, sampled retention of expected prerequisite knowledge is intended to encourage students to approach their academic program in a more holistic manner than is often demonstrated by focusing on individual courses. As we develop and refine the metric and methods described in the previous section on this tool, we also anticipate increased communication and teamwork among faculty that teach in different course sequences.

The mid-program communication skills assessment will sample verbal and written communication skills. These skills are explored in a variety of ways in a variety of courses. This assessment will allow us to make decisions on increasing or adjusting the objectives of presentations and written assignments in courses throughout the heart of the students' programs.

Summaries of the results of the alumni survey are used to evaluate strengths and weaknesses in the program and to guide decisions concerning course content, curriculum revisions, and modification of departmental goals. The Assessment Committee makes recommendations that are forwarded to the Department Chair and the faculty.

The FE Exam serves primarily as an external tool to judge the overall quality of ECE graduates. It can indicate general areas of concern within the curriculum, but its lack of precision

limits its helpfulness in “closing the loop.” We will have to rely on data from the rest of the “toolbox” to guide detailed improvements.

d. Administration and Implementation Schedule

The Assessment Committee oversees the assessment program, and administers it with the help of the Undergraduate Curriculum Committee, the Graduate Committee and the entire faculty. These committees continually review the effectiveness of the assessment program and recommend modifications to the program as necessary. They also analyze the results of the assessment to determine what changes in the curriculum are desirable. The tentative schedule for assessment activities is shown in Table V.

e. Faculty Participation and Support

Successful implementation of this plan requires the active support and participation of departmental faculty in all aspects of the program. In January 1996, the department adopted as part of its strategic initiatives, the goal to “implement a departmental plan for assessing student academic success.” Faculty are involved in the preparation, revision, and approval of this plan.

Table V. Assessment Implementation Schedule	
September	Assessment Committee and Undergraduate Curriculum Committee complete report on previous year’s assessment activities.
October	Faculty and External Advisory Committee review and discuss report. Faculty approve report. Alumni survey mailed.
November	Second mailing of alumni survey. Assessment reports from other departments are reviewed.
December/January	Alumni survey data processed and report written
May	Senior project assessment implemented.
Summer	Assessment Committee and Undergraduate Curriculum Committee begin report on previous year’s assessment activities.
Throughout the academic year	Selective assessment using final exam questions, sampled retention of expected prerequisite knowledge , and mid-program communication skills assessment activities take place according to the procedures described previously.

3. M.S. in Electrical Engineering

a. Departmental Goals

Outcome #1: M.S. graduate students in Electrical Engineering should have an advanced level understanding of fundamentals of Electrical Engineering plus a graduate level understanding of their major area(s) of thesis research.

Outcome #2: M.S. graduate students should be able to communicate scientific results in writing and oral presentation.

Outcome #3: M.S. graduate students should become proficient in their specialized area of electrical engineering, and successfully execute an advanced research project, or pass a comprehensive written examination.

b. Assessment Measure - Outcome #1

- i) The written and oral defense of the M.S. thesis is evaluated in terms of these knowledge areas through an evaluation form prepared by the departmental graduate committee.
- ii) Upon graduation an exit interview is conducted by the department chair.

c. Assessment Measure - Outcome #2

- i) M.S. students are required to present a departmental seminar on their research topic prior to defense.
- ii) The final thesis defense is preceded by a public presentation which is evaluated by the thesis committee using a form prepared for this purpose.
- iii) The written thesis is evaluated by the thesis examination committee using a form provided by the graduate committee.

d. Assessment Measure - Outcome #3

- i) The final M.S. thesis defense is evaluated by an examining committee, including a member from outside the department, using a form developed by the graduate committee.

Upon graduation an exit interview is conducted by the Department Chair. The graduate is asked to provide comments about the strengths and weaknesses of course work and the research experience. Additionally, comments are sought regarding possible improvements that could be made in the department infrastructure and processes that affect graduate student performance. The student is also asked to send suggestions back to the Department Chair by email within a few months after departure when some additional perspective may have been gained. The Department Chair records interview comments and evaluates whether to bring comments or suggestions to the rest of the faculty for discussion.

4. Ph.D. in Electrical Engineering

a. Departmental Goals

Outcome #1: Ph.D. graduate students should demonstrate mastery of their major area of specialization.

Outcome #2: Ph.D. graduate students should be able to communicate the results of their scientific research in writing and in oral presentation.

Outcome #3: Ph.D. graduate students should demonstrate competence in the conduct of individual research investigations that represent a significant contribution to the cumulative knowledge in the field.

b. Assessment Measures - Outcome #1

- i) Ph.D. students are required to pass three examinations covering basic electrical engineering and advanced knowledge within their specialized area(s).
- ii) The written thesis is evaluated by the dissertation examination committee using a form provided by the graduate assessment committee.

Upon graduation an exit interview is conducted by the Department Chair. The graduate is asked to provide comments about the strengths and weaknesses of course work and the research experience. Additionally, comments are sought regarding possible improvements that could be made in the department infrastructure and processes that affect graduate student performance. The student is also asked to send suggestions back to the Department Chair by email within a few months after departure when some additional perspective may have been gained. The Department Chair records interview comments and evaluates whether to bring comments or suggestions to the rest of the faculty for discussion.

c. Assessment Measure - Outcome #2

- i) The final dissertation defense is preceded by a public presentation which is observed and evaluated by the graduate assessment committee using a form provided for this purpose.
- ii) The written dissertation is evaluated by the dissertation examination committee using a form provided by the graduate committee.