College of Engineering

New Mexico State University Klipsch School of Electrical & Computer Engineering

Report Title: 2007-2008 ECE ABET Activities Report

Authors(s): Undergraduate Studies Committee

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Overview

This report documents the ABET activities undertaken by the faculty members of the Klipsch School of Electrical & Computer Engineering since the previous ABET visit. The faculty have concentrated on two main tasks:

1. Improving the organization of the capstone course
2. Revising the ECE core curriculum and associates outcomes measurement.

This report documents the activities to date. These activities will continue through the current academic year with roll-out of the new curriculum starting in the Fall 2009 semester.

2006-2007 Changes

Motivation

At the end of the 2006-2007 academic year, a combination of data from the senior exit interviews and the faculty acting as mentors of the senior capstone design classes noticed that the students were not (1) having the same level of design required in each project and (2) the students did not seem to understand some of the key concepts associated with systems engineering and design. Faculty members, in consultation with the Undergraduate Studies Committee decided to concentrate on making improvements to address these deficiencies in the following capstone cohort.

Activities

Activities taken to improve the design content and level the expectations for each project included:

1. Changing the methodology for assigning the students to the capstone classes from an ad hoc methodology to one where the students are presented with the choices for the capstone projects and then the students would apply to the projects via a written application with a list of skills that they could bring to the project. The project faculty mentors would select the teams from the applicants, trying to accommodate as many students as possible.
2. All members of the academic year cohort would have common meeting times to review administrative details and have presentations. The project teams would also meet individually outside of this common meeting time.
3. A common set of instructions, lasting approximately 4 weeks, would be given to the entire capstone cohort. This instruction would cover basic design process and review expectations.
4. Each capstone group would be required to present

    a. A project System Concept Review
    b. A project Preliminary Design Review
    c. A project Critical Design Review
    d. A project Final Review

   These reviews would be held in common among the capstone cohort students so the all teams could see the activities of the other teams.
5. The students were given a common template for the design reviews to work with.
6. Each design project to be reviewed by at least one member of the Undergraduate Studies Committee and this member reports back to the committee as a whole.
7. Common evaluation templates for oral and written presentations were developed.
8. A common Table of Contents for the project Final Report was developed.

Assessment

The assessment of these changes is still underway. The instructions for the students were re-worked after the first year's use because they were too detailed. The evaluation rubrics are also under further review by the Undergraduate Studies Committee.

Curriculum Review

During the 2007-2008 academic year, a review of the undergraduate curriculum was started. This review was started to address several concerns:

1. The need to meet the mandated articulation agreements among the EE programs in New Mexico. This agreement indicated a problem with the EE 111/EE 211 sequence.
2. The state and NMSU increased the number of general education credits required to graduate.
3. The mathematics department increased the number of credits on certain required courses.
4. The faculty were questioning the mathematics and physics preparation in certain classes and looking to see if the prerequisites should be changed in certain classes.
5. It had been approximately 10 years since the last major look at the curriculum which raises concerns about having a program that is competitive with that of our peers.

Items 2 and 3 lead to asking the question if there would be a way of making the curriculum more efficient to keep the required credits to graduate close to the previous 128 hours.

To start this process, a review of the NMSU curriculum as compared with the NMSU peers was conducted to see if we were maintaining currency. From this review, we determined that

1. We needed to revise our thinking about the existing math and physics prerequisite sequence

2. We needed to insert mathematical applications at the sophomore level to help better prepare students for upper-division classes
3. We needed to have an entry class that would be engaging and keep students who are not calculus-ready interested in the program.

From these observations, we developed the proposed curriculum changes that are outlined in the next section.

Draft Changes to Core Curriculum

The results of the Undergraduate Studies' Committee's study of the curriculum are given in the following graphic. Curriculum changes include:

1. Move mathematics and physics class to prerequisites for starting circuit analysis so that the students have a better understanding of the physics of components before using them in analysis and design.
2. Combining EE 111 and EE 211 into a single course EE 280. This course occurs later in the sequence to allow the students to have the proper mathematics and physics preparation so that the basic circuit analysis for RLC components can be covered in a single semester. This will allow for articulation with the other programs in the state.
3. A new introductory class, EE 101, will be introduced to permit those students who are able to program in the *C* language to have a class that they can also take. The class will have projects and include instruction in digital logic and introduce VHDL.
4. There will be two mathematical analysis classes introduced: EE 210 and EE 310. The first class will cover basic mathematics and probability and have a strong Matlab programming component. The second class will introduce multi-variable calculus and vector calculus and review complex numbers.
5. EE 260 is a new class for digital electronics. The class is being designed to introduce microcontrollers with a view towards studying embedded systems. This class will also utilize the C programming from EE 161.
6. EE 312 is basically the existing EE 311 covering transforms and mathematical description of systems.
7. EE 314 is a follow-on class to EE 312. This class will introduce applications of signals and systems in communications, signal processing, and controls.
8. EE 391 is a revised power electronics class while EE 380 is the basic semiconductor electronics class.

The other required classes for each student remain but with new numbers: EE 410 -- Systems Engineering, EE 418 -- Capstone I and EE 419 -- Capstone II.

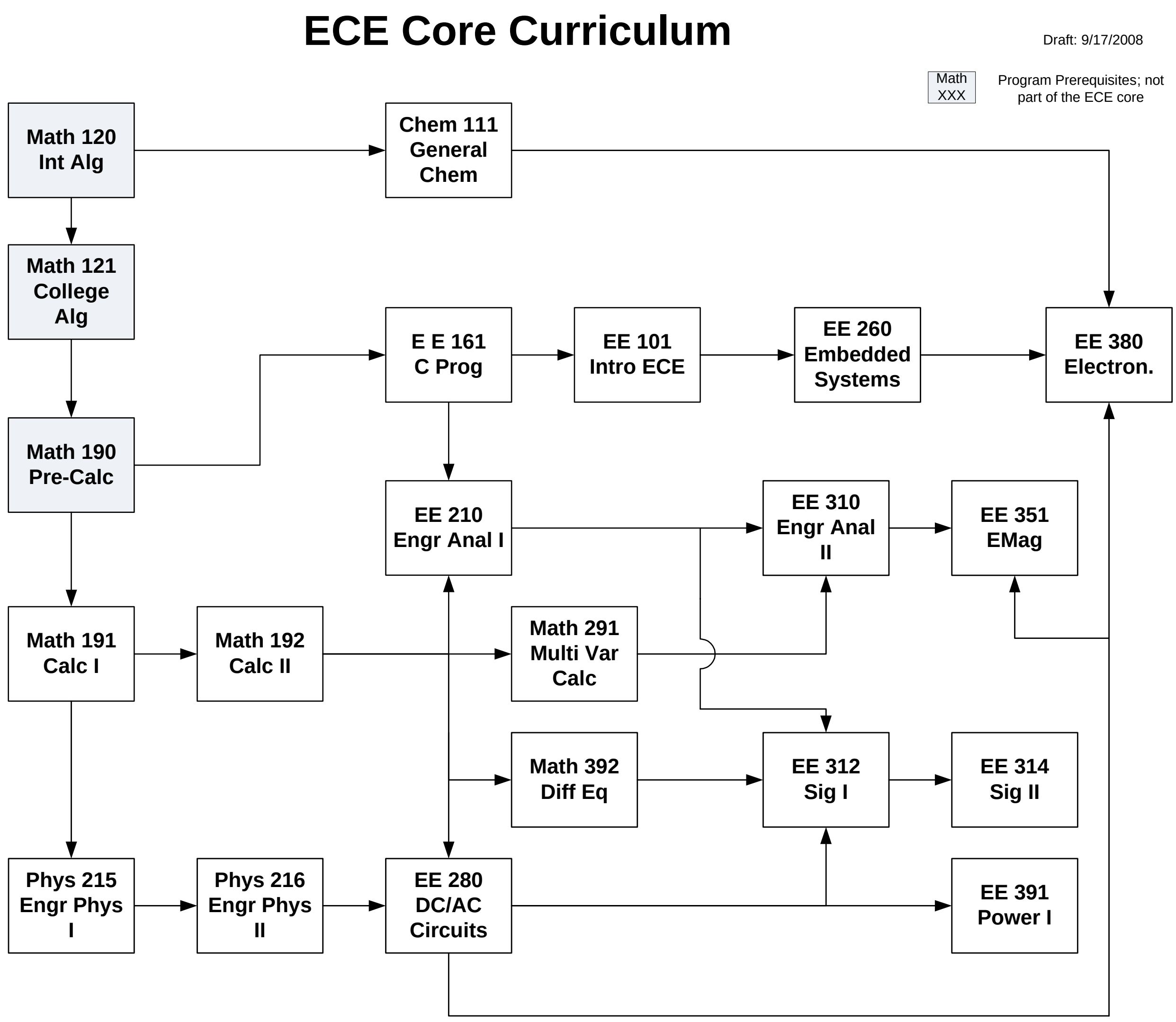

Figure 1 – Draft Revised ECE Core Curriculum

The elective classes will be revised to mesh with the revised core contents. The intent of the core class content design is to have at least two technical groups in the department become responsible for the content so that some of the current content stove-piping can be removed.

Draft Changes to Outcomes Measurements

During the 2006 ABET visit, the program reviewer had concerns about the methodology used by the EE program to assess the outcomes. Basically, the PEV advised the NMSU faculty that (1) the assessments were too detailed and too frequent and (2) the assessment rubrics should more directly measure the outcomes. Further insights given by Gloria Rogers at ECEDHA meetings also indicated better ways to configure the assessment. In particular, her suggestions were to (1) decide on the key indicators for each criterion, (2) decide on the objective measures for the outcomes that are tied to these key indicators, and (3) decide on an assessment schedule that covers all criteria at least twice over a six-year period.

The revised assessment methodology for the program outcomes is being developed in conjunction with the revised curriculum. All of the outcomes will be assessed in at least one required class in the program. The assessment methodology for determining the specific outcomes to be measured is developed in these stages

1. The ABET, IEEE, and NMSU outcomes are grouped into similar categories so that there is only one assessment group for these common concepts,
2. Each category is given a "NMSU Interpretation" to demonstrate the common emphasis we will give to the group and how we believe those concepts are best realized within our program,
3. The key indicators are developed to give a finite collection of statements to realize the NMSU meaning
4. The key indicators are mapped into required classes that will be used in the assessment process.

The current working draft for the new assessment methodology is given in the table below.

Proposed Activities for 2008-2009

Because this overall activity is still in progress, there are planned steps to be accomplished this year. These steps will permit the faculty to roll-out the assessment methodology along with the new class content. The steps for this year are:

1 – Have the department faculty members come to a consensus that the outcome interpretations, key indicators, and activities are the ones we wish to measure
2 – Have each class develop official learning outcomes (most important outcomes that will be in the published syllabus and every instructor for the class should meet; probably between 10 and 20 measurable outcomes) and key indicators for those outcomes
3 – Develop the methodology for measuring each of the outcomes and the success metric (e.g., 70% of the class will exhibit or exceed behavior X)
4 – Mapping the class outcomes to the ABET-measurable outcomes for departmental data collection
5 – Determine the order of reviewing the data and “turning the crank”; I would suggest that for the ABET outcomes, we collect the data yearly but only look at the trends in detail every three years so that we can low-pass filter the results.

While these steps are being developed, the faculty members have continued to use the existing assessment methodology.

Table 1 -- Draft Revised Assessment Methodology

Topic	Source	NMSU Interpretation	Key Indicators	Where Measured
Mathematical Science	**IEEE (b):** Knowledge of Prob. and Stats. and EE applications **IEEE (c):** Knowledge of Math through differential and integral calculus **IEEE (e):** Knowledge of advance Math, Diff. Eq. and vector calculus **ABET (a):** Apply Knowledge of math, science and engineering	Students will demonstrate Mathematical Science knowledge from differential and integral calculus, vector calculus, differential equations, complex numbers, linear algebra, and probability and statistics.	1. Ability to integrate and differentiate functions 2. Ability to perform multi-dimensional integrals 3. Ability to solve first and second order ODE 4. Ability to determine magnitude and phase of complex numbers 5. Ability to solve systems of equations using matrix techniques 6. Ability to compute probabilities using PDF's and Bay's theorem 7. Ability to compute means and standard deviations for engineering data	1. EE 210, EE 312, EE 310 2. EE 310, EE 351 3. EE 280, EE 314 4. EE 280, EE 210, EE 314 5. EE 210, EE 314 6. EE 210, EE 314 7. EE 210, EE 419

Topic	Source	NMSU Interpretation	Key Indicators	Where Measured
Basic Electrical Science	**IEEE (d):** Knowledge of basic science **ABET (a):** Apply Knowledge of math, science and engineering	Students will demonstrate knowledge of the physical principles underlying electrical and electronic components, electrical and electromagnetic energy transmission, and the basic physical laws governing electricity, electronics, and electromagnetics.	1. Ability to mathematically describe RLC components 2. Ability to describe the physics of semiconductor materials 3. Ability to analyze circuits using KVL and KCL 4. Ability to determine Thevenin and Norton equivalents 5. Ability to utilize Maxwell's Equations 6. Ability to compute energy transmission over a line 7. Ability to compute reactance, impedance, susceptance, and admittance for series and parallel groups of components	1. EE 280 2. EE 380 3. EE 280 4. EE 280 5. EE 351 6. EE 391 7. EE 280

Topic	Source	NMSU Interpretation	Key Indicators	Where Measured
Electrical Engineering Content	**IEEE (a):** Breadth and Depth across the range of EE topics **IEEE (f):** Knowledge of engineering science	Students will demonstrate Engineering Science knowledge across a range of electrical engineering topics as sampled from the FE syllabus contents.	1. Demonstrate the ability to use Boolean logic 2. Demonstrate the ability to program in VHDL 3. Demonstrate the ability to utilize a microcontroller 4. Demonstrate the ability to utilize a FET 5. Demonstrate the ability to compute Power Factor 6. Demonstrate the basic understanding of AM and FM 7. Determine the stability characteristics of a system 8. Demonstrate the ability to sample a signal 9. Demonstrate the ability to convolve two signals 10. Demonstrate the ability to design op-amp based circuits 11. Demonstrate the ability to compute FFT, Laplace, and Z transforms	1. EE 101 2. EE 101, EE 260 3. EE 260 4. EE 380 5. EE 280, EE 391 6. EE 314 7. EE 314 8. EE 314 9. EE 312 10. EE 280, EE 380 11. EE 312

Topic	Source	NMSU Interpretation	Key Indicators	Where Measured
Critical Thinking	**NMSU (a):** Apply critical thinking skills to solve problems in EE **IEEE (g):** Ability to analyze and design complex electrical and electronic devices and systems that contain hardware and software components. **ABET (b):** Ability to design and conduct experiments as well as to analyze and interpret data **ABET (c):** Ability to design a system, component or process to meet desired needs **ABET (e):** Ability to identify, formulate and solve engineering problems	Students will demonstrate the ability to realize an Engineering Design by formulating engineering problems to meet a desired need, analyzing the problem, devising a solution to the problem involving a system of hardware and/or software entities, and testing and validating the correct solution via measurements and analysis.	1. Demonstrate the ability to develop the requirements and acceptance criteria for a design problem 2. Demonstrate the ability to develop a hardware/software system to realize design requirements 3. Demonstrate the ability to devise measurements to validate design implementation against the design's acceptance criteria	1. EE 410, EE 418 2. EE 410, EE 418 3. EE 419
Tools	**NMSU (b):** Apply computers to assist in solving EE problems **ABET (k):** Ability to use the techniques, skills and modern engineering tools necessary to engineering practice.	Students will demonstrate the ability to use Engineering Tools including test and measurement equipment, computer-based analysis, design and/or simulation tools, and a computer programming language.	1. Ability to measure current, voltage, and resistance 2. Ability to make RF measurements 3. Ability to program in C and Matlab 4. Ability to use a computer for engineering analysis 5. Ability to use a CAD package 6. Ability to use a simulation package	1. EE 280 2. EE 351 3. EE 161, EE 210, EE 312 4. EE 161, EE 210 5. EE 380 6. EE 280, EE 380
Professional Communications	**ABET (g):** Ability to communicate effectively	Students will demonstrate the ability to produce both oral and written engineering reports.	1. Solo reports 2. Interdisciplinary team reports	1. EE 101 2. EE 498, EE 499

Topic	Source	NMSU Interpretation	Key Indicators	Where Measured
Professional Ethics	**ABET (f):** Understand professional and ethical responsibilities	Students will demonstrate the ability to apply professional ethics.	1. Demonstrate ethical thinking related to an engineering case study	1. PHIL 323
Professional Impact	**ABET (h):** Broad education necessary to understand the impact of engineering solutions in a global and societal context. **ABET (j):** Knowledge of contemporary issues	Students will demonstrate the ability to discuss the societal or regulatory implications of an electrical engineering topic.	1.	
Lifelong Learning	**ABET (i):** Recognition of the need for and the ability to engage in life-long learning	Students will demonstrate the ability to learn a topic using self-study abilities.	1. Demonstrated mastery of an engineering topic not taught in class	1. EE 101, EE 260
Professional Development	**NMSU (c):** Experience the profession first-hand through co-op and internships **NMSU (d):** Obtain meaningful employment or continue with graduate education	Students will have experience in exploring electrical engineering specializations and career options.	1. % of students taking internships and co-ops 2. % students taking jobs in industry 3. % students attending graduate school	1. Senior exit survey, EE 311 Record Check 2. Senior exit survey 3. Senior exit survey