ABET
SELF-STUDY REPORT

For the

Bachelor of Science in Electrical Engineering (BSEE)

at

Alabama Agricultural and Mechanical University

4900 Meridian Street
Normal, Alabama 35762

June 29, 2018

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

BACKGROUND INFORMATION

A. Contact Information

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B. Program History

The Bachelor of Science in Electrical Engineering (BSEE) degree program at Alabama Agricultural and Mechanical University (AAMU) was initiated in Fall 1997. It graduated its first BSEE class of four in May 1999. It was accredited by the Engineering Accreditation Commission (EAC) of Accreditation Board for Engineering and Technology (ABET) in 2000, retroactive to the class of 1999.

In 2011, the Department of Electrical Engineering was combined with the Department of Computer Science to form the Department of Electrical Engineering and Computer Science (EECS), under the direction of a single department chairperson, Dr. Kaveh Heidary (formerly EE chairperson). This action was the result of the university wide realignment in which four new colleges were formed by combining various elements of five existing schools. The School of Engineering and Technology (SET) was transformed into the College of Engineering, Technology and Physical Sciences (CETPS) by absorbing the Department of Physics, Chemistry and Mathematics.

The date of the last general review by EAC of ABET was October 2012. There have been some changes in the BSEE curriculum and faculty since the last general review in 2012.

In 2015 a new Concentration in Nuclear Power was added to the Bachelor of Science in Electrical Engineering degree program. This resulted in bringing the number of concentrations available to the students in the BSEE degree program to four. Students in the BSEE degree program can choose one of four BSEE concentrations, namely, General, Computer Engineering, Microelectronics-VLSI, and Nuclear Power. In preparation for the Nuclear Power Concentration, the following courses were added in 2014: EE 306, Survey of Energy Systems, EE 307, Fundamentals of Nuclear Engineering, EE 460, Nuclear Reactor Engineering I, and EE 461, Nuclear Reactor Engineering II. Also, in 2015, the new course EE 308, Thermal Systems Engineering, was added in order to better align the Nuclear Power concentration with the other three BSEE concentrations. Adding EE 308 allowed dropping ME 310, Thermodynamics, and ME 312, Heat and Mass Transfer, from the Nuclear Power concentration requirements and reinstating EE 303, Electromagnetic Field Theory, as a required course for this concentration. These changes are described below in Criterion 4, Continuous Improvement section, and in Criterion 5, Curriculum.

There have been significant changes in the EE faculty makeup since the last general review. Specifically, Dr. Zhigang Xiao was promoted to the professor rank with tenure in 2013. Dr. Andrew Scott and Dr. Satilmis Budak were both promoted to the professor rank with tenure in 2014. Dr. Stephen Egarievwe, who has expertise in material science and nuclear detection and was Chair of Department of Technology until it was phased out in 2015, joined the EE faculty in 2015, and was promoted to the professor rank in 2017. Dr. Raziq Yaqub, who has expertise in communications, cellular and wireless systems, and system integration joined the EE faculty as tenure-track associate professor in 2016. Additionally, since 2012 two EE faculty, Dr. Sadiq Kucuksari and Dr. Insu Kim, both with expertise in power systems, have joined and subsequently left the university. The latter had joined the EE program in 2014 as tenure-track assistant professor and left AAMU for a faculty position in Korea at the end of 2017 fall semester. Currently, the EE program has one open tenure-track faculty position, and the search is ongoing to identify and hire a new faculty with expertise in electric power systems. The faculty is discussed in detail in Criterion 6.

C. Options

The BSEE curriculum is offered in four concentration areas: General, Computer Engineering, Microelectronics-VLSI, and Nuclear Power. The General EE Concentration is a broad based program that contains required and elective advanced courses from several areas of electrical engineering including microwave engineering, power systems and digital signal processing. The Computer Engineering Concentration focuses on both computer hardware and software systems. Students in this concentration take advanced courses in computer science as well as electrical engineering. Topics including real-time systems, advanced digital systems, high performance computer systems, and machine learning offer depth to this concentration. The Microelectronics-VLSI Concentration contains courses and laboratories emphasizing integrated circuit electronics. Students in this concentration take advanced courses that cover design, simulation, fabrication of integrated circuit chips, and instrumentation and measurement techniques for characterization of microelectronic materials and devices. Students utilize the class-1000 cleanroom laboratory for fabrication of IC chips. The Nuclear Power Concentration focuses on electric power generation and distribution with particular emphasis on nuclear power. Students in this concentration are exposed to the fundamentals of nuclear power generation concepts and systems including principles of nuclear reactor engineering and radiation safety.

D. Program Delivery Modes

The BSEE Program is delivered as a traditional lecture/laboratory day program. Some courses are optionally offered on weekday evenings.

E. Program Locations

The program is offered at the main campus of Alabama Agricultural and Mechanical University in Normal Alabama. The University address is:

4900 Meridian Street North, Huntsville, AL 35762.

URL: http://www.aamu.edu/Pages/default.aspx

Tel. 256-372-5000

F. Public Disclosure

The program Educational Objectives (PEOs), Student Outcomes (SOs), annual student enrollment and graduation data are posted and made accessible to the public through the university website at the following URL.

http://www.aamu.edu/Academics/engineering-technology/EE/Pages/Electrical-Engineering-Program.aspx

Additional information including the PEOs, curricula, graduation requirements, and course descriptions are posted and made accessible to the public through the AAMU Undergraduate Bulletin at the following URL.

http://www.aamu.edu/administrativeoffices/academicaffairs/Pages/Undergraduate-Bulletins.aspx

G. Deficiencies, Weaknesses or Concerns from Previous Evaluation(s) and the Actions Taken to Address Them

The AAMU BSEE program underwent its last ABET EAC General Review in October 2012. The July 31, 2013 FINAL STATEMET related to the 2012 General Review cited one "Program Concern," under Criterion 8. Since the 2012 review, additional work on this Concern has been conducted by the university.

Program Concern

1. **Criterion 8. Institutional Support**: The 2012 review cited one Program Concern that *faculty in the program have high teaching loads, receive lower than median salaries for comparable positions, and are not provided with adequate levels of resources for their professional development. In addition, they have only minimal travel support, no opportunity for course release, and no start-up packages for new faculty members. While new faculty members have been hired at adequate levels, the salaries of long-serving faculty members are compressed. As a result the program may not be able to retain qualified faculty and the faculty may not have the resources for adequate professional development. The potential therefore exists for the program to fall out of compliance with this criterion in the future.*

Response/ Actions

In every semester since 2012 the EE program has been granted approval by the college dean and the university provost in order to limit the regular teaching loads of the EE faculty, to the extent possible, to three lecture and/or laboratory sections per semester.

Although according to the AAMU Faculty Handbook the full teaching load for faculty in the undergraduate program is twelve credit hours, the EE faculty has been consistently exempted from this requirement. This has been done in order to provide the EE faculty with opportunity for professional development including scholarly pursuit. The starting salaries for new faculty hires have been raised and brought closer to competitive market levels commensurate with the faculty rank. This has enabled the EE program to attract and retain qualified faculty. Every year since 2012 the EE program budget has included funds earmarked for faculty travel. Generally, each year the travel funds are utilized by junior faculty and those who do not have access to travel funds from their externally funded research projects during that year. This has allowed the EE program to fund professional development related faculty travel as needed. The EE budget includes funds earmarked for membership dues for faculty membership in professional organizations. Each year the EE faculty can charge the annual membership dues for one professional organization up to $300 per faculty to the EE program budget. The university funded payments of annual membership dues for faculty membership in professional organizations constitutes another small step by the university in assisting faculty professional development. The university provides faculty with the opportunity to buy their time utilizing external funds generated by faculty research. This provides faculty with the opportunity to obtain course release. To the extent possible, the new faculty hires have been assigned reduced teaching loads during the first year of their employment at AAMU. This has provided new faculty with additional support for continued professional development. The university through the office of sponsored programs (OSP) has provided the new faculty hires with the opportunity to compete for seed grants. The new faculty can utilize the seed grants for professional development activities including further development of their research areas in pursuit of externally funded research grants. Several junior EE faculty members have competed for and won seed grants, which have been utilized for faculty professional development activities. The salaries of long serving faculty, however, have remained stagnant and below market levels.

GENERAL CRITERIA

CRITERION 1. STUDENTS

A. Student Admissions

A. 1. Admission Directly from High School

Students entering the BSEE program must meet all the requirements established by the University. University admission is designed to accommodate students with diverse backgrounds and educational goals. For unconditional admission high school graduates must have earned a score of 18 ACT/equivalent SAT and maintained a grade point average of "C" in the following subjects: English, mathematics, science, and history and political science. In addition, the entrance requirements in mathematics are three and one-half units; algebra, two units; plane geometry, one unit; and trigonometry and/or advanced mathematics, one-half unit. Students must have at least two units in science: chemistry, one unit; and physics, one unit.

A. 2. Admission through the Freshman Academy

Prior to entering the electrical engineering program, a student must complete all the requirements of the Freshman Academy. In addition, students must have maintained a minimum overall grade point average of 2.5/4.0 and completed at least the first course of calculus with a grade of “C” or better.

A. 3. Transfers from Other Institutions

Students desiring to transfer to the program must be in good academic standing at the college or university from which they are transferring. In addition, they must have maintained a grade point average of 2.5/4.0 or better, completed at least the first course of calculus with a grade of “C” or better, and completed the requirements of The Freshman Academy at Alabama A&M University, if they transfer in fewer than 30 semester hours.

Admission requirements can be found in the Undergraduate Bulletin at the following URL:

http://www.aamu.edu/administrativeoffices/academicaffairs/Pages/Undergraduate-Bulletins.aspx

B. Evaluating Student Performance

Students in the BSEE degree program are advised, instructed, monitored, mentored and evaluated by the EE faculty of the Department of Electrical Engineering and Computer Science. Beginning in the freshman year, students are assigned an academic advisor in the Academic Advising Center of the Office of Retention and Persistence (ORP) and a co-advisor in the EE Program. In general, freshmen begin to seek advice from their EE co-advisors by the middle of their first semester at AAMU. The co-advisors for the EE Program of the Department of Electrical Engineering and Computer Science start a folder for each student as they pre-register for the spring semester. By the end of the spring semester the co-advisors are familiar with most freshmen who plan to enter Electrical Engineering. Initial evaluation of entering students by the EE Program is based on mathematics placement by The Freshman Academy and student performance in EE 101. EE 101, Introduction to

Electrical Engineering, and EE 109, Engineering Computing, are the only required EE freshman-level courses in the BSEE degree program.

In EE 101 fundamental concepts in electrical engineering are introduced. Practical pre-calculus concepts are introduced and utilized. These include a review of algebra, basic trigonometric functions, Cartesian and polar coordinate systems, complex numbers, number systems, and matrices and determinants. The concept of engineering ethics is also introduced. Students are required to develop an electronics project and sharpen their communication skills through presentation of projects and research of historical topics in the electrical engineering discipline. Performance in this course provides a baseline for assessment of student strengths and weaknesses and the information required for initial department advisement activity. Virtually all EE courses and laboratories are taught by full-time tenured and tenure-track faculty members of the program.

All EE Faculty maintain regular office hours, and most have an open door policy. Students are encouraged and given every opportunity to consult with their EE advisors and course/laboratory instructors on a regular basis. During the course of the semester, the performance of students in all EE courses and laboratories are evaluated on a continuous basis through various modalities including homework assignments, short quizzes, exams, project reports, and class discussions. Instructors provide feedback to students and make them aware of their performance on a regular basis, and offer recommendations for improvement. Students in all their classes receive regular and periodic performance assessments from their instructors, periodic Grades-First alerts to the students and their academic advisors in case of under-performance in any of their classes, official midterm grades through the Banner system, and final letter grades through Banner at the end of each semester.

Students' registration is handled online through the Banner Student Self-Service registration system. The system requires the student to enter the unique registration PIN number in order to register. The student registration PIN number is valid only for one semester and can be assigned only by an academic advisor. A student, therefore, cannot proceed with the registration process without consultation with an academic advisor every semester. The advisor checks student's academic record and program of study, and advises the student accordingly and recommends appropriate courses to be taken.

Students in collaboration with their academic advisors utilize the web based tool Degree Works in order to monitor student's progress toward degree completion on a regular basis. In addition to the regular advisement sessions with their EE academic advisors, upon completion of sixty-four credit hours every student must meet with their EE academic advisor and complete the Junior Audit Packet. The Junior Audits are academic assessments performed by the students and their academic advisors in order to alert students of the courses and any other academic requirements needed for satisfactory progress toward graduation.

The Banner system does not allow students to register for courses unless all prerequisites are met. Under special circumstances a student may be granted permission to register for a course for which prerequisites have not been met. To do this, a special waiver form, Registration Permit Override Request Form, has to be filled out and signed by the Department Chairperson and the College Dean, and the registration for that course has to be done manually at the Department Office. The Chairperson signs the form after consultation with the course instructor, and establishing that the student, although missing the prerequisite, has the necessary academic preparation to handle the course.

C. Transfer Students and Transfer Courses

As noted above, students desiring to transfer to the EE program at AAMU must be in good academic standing at the college or university from which they are transferring. In addition, they must have maintained a grade point average of 2.5 or better, completed at least the first course of calculus with a grade of "C" or better, and completed the requirements of the Freshman Academy at Alabama A&M University, if they transfer in fewer than 30 semester hours.

As a public institution, Alabama A&M University must adhere to STARS, the Statewide Transfer & Articulation Reporting System for public colleges and universities in Alabama. A student transferring from an Alabama two-year college may choose to fulfill the degree requirements of the AAMU Bulletin which was in effect at the time of the student's initial enrollment at the Alabama two-year institution, provided that the time lapse between attending the two-year institution and AAMU enrollment is not more than one year. Students intending to transfer to AAMU are encouraged to consult with their advisors and obtain a STARS guide at http://stars.troy.edu/what_is_stars.html. The STARS System allows public two-year students in Alabama to obtain a Transfer Guide/Agreement for the major of their choice. This guide/agreement, if used correctly, guides the student through their first two years of coursework and minimizes loss of credit hours upon transfer to the appropriate four-year university in Alabama.

Following admission to AAMU, the transfer student must report to an EE advisor. The advisor reviews the student's academic transcript and the official course descriptions and syllabi published by the student's previous school. Only courses whose contents substantially overlap those of the EE curriculum are accepted toward the BSEE degree at AAMU. The EE advisor then completes a course substitution form, Departmental Transfer Credit Substitution Form, listing each transferred course for which an AAMU equivalent is identified. This form is then signed by the student, EE advisor, Department Chairperson, and Registrar, and becomes part of the student's academic record. The student is then advised to take the appropriate sequence of courses at AAMU.

D. Advising and Career Guidance

Academic advisement is provided to every student on a per semester basis in order to help students make satisfactory progress toward their degrees. Academic advisement for newly admitted and undecided freshmen is provided through the University admissions office and The Freshman Academy. Upon selection of EE as a major, students are directed to the EE faculty for advisement. In order to register for classes, students must see their academic advisors and obtain the registration PIN every semester. All freshmen take a sequence of two one-credit hour courses, ORI 101 and ORI 102, First Year Experience, where they are introduced to the University academic policies and procedures including financial aid and money management. Students are taught skills that will help them better transition to college life, including career exploration, good study habits, time management and test-taking skills.

Students have ample opportunity to obtain career related advice from the office of Career Development Services (CDS). Career Development Services' mission is a commitment to assist students and alumni in realizing career objectives, prepare for employment opportunities, and provide career planning services that will enable students to move confidently from the academic environment to the world of work. Each year, on multiple and regularly scheduled occasions, the CDS provides opportunities for employers and students to meet on campus at career fairs. Company representatives, from across the nation, attend these gatherings, display information and are available to speak with interested students about their company's employment opportunities. CDS also sponsors Interview Days, where employers conduct on-campus interviews with students for cooperative education or internship positions as well as permanent positions for graduating seniors.

Throughout the academic year CDS conducts regularly scheduled resume writing sessions, graduate and professional school expo and information sessions, and information sessions for students looking for summer internship opportunities. CDS also sponsors the Business/Industry Student Cluster, the Cooperative Education Club, and the Toastmaster International Club at AAMU. Students who receive support from CDS staff and participate in CDS-sponsored events are able to confidently transition from the classroom to the workplace.

One of the highlights of the year for students at Alabama A&M University is the Youth Motivation Task Force (YMTF) program. Twice each year, many AAMU alumni who are successful professionals at corporations across the country, converge on campus for two day periods in the fall and spring semesters and visit classrooms answering students' questions about various career related topics including life as a professional and potential career paths. Each year multiple groups of EE alumni who have productive careers in industry and government come back to campus and share their experiences with our students during class periods. During evening social hours students have the opportunity to talk with and solicit advice from these professionals. Many EE students have obtained internship appointments and employment after graduation as the result of contacts initiated through the YMTF program.

The Dean’s Speaker Series for the College of Engineering, Technology and Physical Sciences is a monthly lecture by invited luminaries from industry, government and academia. Students attend these meetings and interact with the speakers and leading individuals from local industry and government organizations.

EE faculty, and the Dean’s Office of the College of Engineering, Technology and Physical Sciences, actively solicit and review internship and employment opportunities for EE students, and advise students accordingly. The College and the Program maintain bulletin boards, where opportunities for internship, permanent employment, and graduate studies are posted. EE faculty members regularly provide recommendation letters for deserving students applying to graduate and professional schools.

Faculty of the EE program make concerted efforts to involve undergraduate EE students in their research projects as undergraduate research assistants. These activities include working with students on cutting-edge research projects at laboratories both on and off campus. Some graduates of the program have chosen to purse graduate studies and professional career tracks in technical areas which are directly related to their experience as undergraduate research assistants.

E. Work in Lieu of Courses

The University awards three semester credit hours (3 CH) in each area to students who score three (3) on the Advanced Placement Examination in the areas of Biology, Chemistry, English, Foreign Languages, History, Mathematics, Physics, Art and Music. Students scoring 4 or 5 may be awarded additional credit upon the recommendation of the appropriate department chairperson.

The EE program does not award any course credit for life experience, military experience, and test out.

Under special circumstances up to three (3) EE credit hours are awarded for pre-approved internship or Co-Op work conducted through the University Cooperative Work Experience (CWE) program. In order to receive academic credit for work, the student must write a proposal detailing the proposed activity and the expected results, and obtain approval from an EE faculty member who will agree to co-supervise the work. The proposal must also be approved by the Department Chairperson and the supervisor at the company where the proposed work will be done. Following the completion of the work period, the student must submit a formal report approved by the supervisor under whose mentorship the work was performed. In order to receive academic credit toward the BSEE degree, the report must be approved by the faculty co-supervisor (mentor) and the department Chairperson. The credit is accomplished by substitution of the three (3) credit hours of CWE coursework for an appropriate three (3) credit hour EE course, typically an elective (e.g. EE 4XX).

Dual enrollment is treated similarly to transfer credit as explained in Criterion 1.C above.

F. Graduation Requirements

The name of the degree awarded is Bachelor of Science in Electrical Engineering.

The degree of Bachelor of Science in Electrical Engineering (BSEE) is offered in four concentrations: General, Computer Engineering, Microelectronics-VLSI, and Nuclear Power.

In order to obtain the BSEE degree, the students must complete one of four curricular tracks published in the University Bulletin and the EE Student Handbook. The curriculum of each one of the BSEE concentrations is comprised of 130 credit hours.

The 130 semester credit hours comprising the BSEE curriculum include eighteen credit hours of mathematics including differential equations plus one other advanced mathematics course, eight credit hours of calculus based physics, including laboratory, four credit hours of chemistry, including laboratory, nine credit hours of English including six writing-intensive credit hours, six credit hours of history, three credit hours of economics, and six credit hours of humanities and fine arts. Every student must also take a three-credit hour course ME 481, quality/reliability assurance, where students are exposed to formal treatment of probability and statistical techniques and their engineering applications. All EE students must take a common set of 46 credit hours of required core EE courses including a three credit hour course in engineering computing, a three credit hour course in numerical methods, and the capstone design project, EE 470, Engineering Analysis and Design I, and EE 471, Engineering Analysis and Design II, comprising of a two-course sequence of four credit hours. Students in each of the four BSEE concentrations must take additional courses chosen from concentration-specific lists of prescribed and elective courses.

All EE students must consult with their academic advisors prior to registration every semester. The EE advisor reviews the student's academic record and makes recommendations about the appropriate courses to be taken each semester. Junior Audits must be conducted by students and their academic advisors the first semester of students' junior year (>= 64 earned hours) in order to alert students of courses and any other academic requirements needed for satisfactory progress toward degree completion. The web based tool Degree Works is utilized in order to help students and academic advisors monitor students' progress toward degree completion. Each rising senior in the EE Program, in consultation with the EE advisor, must complete the Senior Record Check Form prior to registration. If the student has transfer credits, the completed Departmental Transfer Credits Substitution Form is attached to the Senior Record Check Form. The form is signed by the student, advisor, EE Chairperson, and is forwarded to the Engineering, Technology and Physical Sciences Academic Coordinator for final check and approval prior to forwarding to the Registrar Office. The student is made aware of all the remaining courses s/he needs to complete in order to receive the BSEE degree.

G. Transcripts of Recent Graduates

As required by ABET, the program has provided one transcript of a December 2017 BSEE graduate to ABET. The EE Program will provide transcripts from some of the most recent graduates to the visiting team, as requested, along with any needed explanation of how the transcripts are to be interpreted. On the transcript, the degree is designated as Bachelor of Science Electrical Engineering. On the transcript, one of four BSEE Concentrations is also designated.

CRITERION 2. PROGRAM EDUCATIONAL OBJECTIVES

A. Mission Statement

A. 1. University Mission Statement

Alabama Agricultural and Mechanical University is a public, comprehensive 1890 Land-Grant institution, committed to access and opportunity, and dedicated to intellectual inquiry. The application of knowledge and excellence in teaching, research and service is responsive to the needs of a diverse student population and the social and economic needs of the state and region. The University offers contemporary baccalaureate, masters, educational specialist and doctoral level degrees to prepare students for careers in the arts, sciences, business, engineering, education, agriculture and technology. As a center of excellence, the University is dedicated to providing a student-centered educational environment for the emergence of scholars, scientists, leaders and critical thinkers, who are equipped to excel through their contributions and leadership in a 21st century national and global society.

A. 2. College of Engineering, Technology and Physical Sciences Mission Statement

The mission of the College of Engineering, Technology and Physical Sciences is integrated within and fully supports the mission of the Alabama A & M University. The mission of the College of Engineering, Technology and Physical Sciences is to provide the educational settings that allow well-prepared and dedicated students the opportunity to become educated in the sciences, engineering disciplines, and related competencies so that they may become professional practitioners of engineering and engineering technologies in those fields offered by Alabama A&M University. Upon completion of the program chosen, students will be sufficiently prepared to become productive professionals in the industrial, governmental or military sector, or, if they so desire, they will be eminently prepared to enter graduate school.

A. 3. Department of Electrical Engineering and Computer Science Mission Statement

The mission of the BSEE degree program at Alabama A&M University, consistent with that of the University and the College of Engineering, Technology and Physical Sciences is to provide quality education, research, and service to its constituents. The Department commits to provide qualified graduates in the growing field of electrical engineering by fostering:

1. Excellence in electrical engineering education;
2. Physical facilities and learning resources that are conducive to learning, research, extension and development;
3. A sense of scholarship, leadership and service;
4. A search for new knowledge through research and its application; and
5. Programs necessary to address the needs of capable students.

B. Program Educational Objectives

The Department fully considers the mission of the Institution, the College of Engineering, Technology and Physical Sciences and input from the University administration, EE Program Advisory Board, and other constituents in developing the EE Program Educational Objectives (PEOs). The program educational objectives are consistent with the University's mission and the ABET criteria.

The Program Educational Objectives, on the basis of which the currently utilized program assessment processes, performance metrics and evaluation procedures are developed and implemented, are listed below in Table 1. Thus, This Self Study Report was compiled using the PEOs of Table 1 as the performance yardstick. These PEOs are listed in the AAMU Undergraduate Bulletin found at the AAMU website and the EE Student Handbook.

https://www.aamu.edu/administrativeoffices/academicaffairs/Pages/Undergraduate-Bulletins.aspx

http://www.aamu.edu/Academics/engineering-technology/EE/Pages/Electrical-Engineering-Program.aspx

Table 1. Program Educational Objectives (PEOs)

1. Graduates will be equipped with the technical, communication and teamwork skills that will enable them to be competitive in the marketplace and build productive careers in electrical engineering or related fields.
2. Graduates will contribute to the economic vitality and security of our State and Nation by having acquired the technical knowledge, skill sets, social awareness and ethical traits necessary for successful careers in the global commercial sector, as well as the security, defense, and space oriented industries of North Alabama and throughout the Nation.
3. Graduates will have the knowledge, skill sets and lifelong learning habits that prepare them for pursuit of career development and advanced degrees, and will enhance our Nation’s productivity and economic competitiveness by increasing the diversity of the US technical workforce.

C. Consistency of the Program Educational Objectives with the Mission of the Institution

The educational objectives of the BSEE Program are fully consistent with the mission of Alabama Agricultural and Mechanical University. The relationship of the Program Educational Objectives (PEOs) to various components of the mission of the university is listed in Table 2.

Table 2. Consistency of the BSEE Program Educational Objectives with the AAMU Mission

PEO	University Mission Statement
1	*“The University offers contemporary baccalaureate, masters, educational specialist and doctoral level degrees to prepare students for careers in the arts, sciences, business, engineering, education, agriculture and technology.”*
2	*“The application of knowledge and excellence in teaching, research and service is responsive to the needs of a diverse student population and the social and economic needs of the state and region.” “As a center of excellence, the University is dedicated to providing a student-centered educational environment for the emergence of scholars, scientists, leaders and critical thinkers, who are equipped to excel through their contributions and leadership*

	in a 21st century national and global society."
3	*"The application of knowledge and excellence in teaching, research and service is responsive to the needs of a diverse student population and the social and economic needs of the state and region."*

D. Program Constituencies

The main constituents of the AAMU Electrical Engineering Program are local and national corporations and Federal Governmental agencies, primarily in the defense, security, aerospace, power generation and distribution fields, and the State of Alabama. Additional constituents of the program are: University administration, various other employers of our graduates, ABET, department faculty, alumni, current students and their parents.

North Alabama and the City of Huntsville in particular are fortunate to have a thriving engineering community, which relies heavily on the Department of Defense, NASA and the Tennessee Valley Authority (TVA). Huntsville is home to the Redstone Arsenal, which hosts a number of US Army and DoD engineering and research centers including the Army Materiel Command, the Missile Defense Agency and the Army Aviation and Missile Research Development and Engineering Center, among others. Redstone Arsenal is also home to the FBI Digital Forensics Laboratory. Furthermore, Huntsville is also home to the NASA – Marshall Space Flight Center, which hosts much of the work for the International Space Station, and is the lead center for the development of new heavy lift rocket systems. TVA is also a significant economic engine in the region with a number of power generating facilities in the North Alabama area, including several hydro-electric and coal-fired plants, and two large nuclear stations within an hour commute from the campus – the operational Brown's Ferry plant, and the Bellefonte plant under construction. Graduates of the AAMU BSEE Program are highly sought by many of the industrial entities in the immediate area, and by many other employers throughout the Southeast region and the US.

To the extent possible, representatives from these various constituents are included as members of the program Advisory Board. Table 3 lists the present membership and affiliation of the Electrical Engineering Advisory Board. The membership of the Board is diversified and represents the constituency of the program. The Board deals directly with issues of concern to the Electrical Engineering Program including issues associated with both ABET and SACS (Southern Association of Colleges and Schools) accreditation. The Board is also involved with the ABET accreditation process, serving as a "Red Team" for review of the Self-Study Report. The full EE Advisory Board normally meets twice a year, and Board sub-committees meet as needed. Advisory Board meetings follow a detailed schedule and dedicate a portion of each meeting to providing systemic input to the activities of the Program. Advisory Board minutes document this activity and are available for review. The goal is to make input from constituents a systematic process. The EE Program, through inputs from its Advisory Board, alumni, students, faculty, industry and government entities not represented in the Advisory Board, accreditation bodies, professional societies, and University administration, strives to best tailor its educational objectives to the constituents' needs.

Table 3. Electrical Engineering Advisory Board Membership

Member Name	Affiliation	Phone	email
Dr. Ray Watson, Chairperson	RCW Associates	256-726-3995	RCW-Assoc@comcast.net
Dr. K. Heidary	AAMU-EECS Chairperson	256-372-5587	Kaveh.heidary@aamu.edu
Mr. Eric Dees	Lockheed Martin	817-763-7120	eric.dees@lmco.com
Ms. Porscha Porter	AMRDEC	256-876-1649	Porscha.porter@us.army.mil
Mr. Chase A. North	TVA	423-751-7570	canorth@tva.gov
Mr. Jody Clay	Alabama Power	205-257-3800	JCCLAY@southernco.com
Mr. Michael Webb	Rolls-Royce	317-230-8229	Michael.Webb@rolls-royce.com
Mr. Raychon Betts	AMRDEC	256-842-8434	Raychon.Betts@us.army.mil
Mr. Chad C. Kelly	Boeing	314-777-7857	Chad.C.Kelly@boeing.com
Mr. Robert Parker	NASA/MSFC	256-544-2121	Robert.parker@msfc.nasa.gov
Mr. Rodney Fanner	NRC	404-997-4638	Rodney.Fanner@nrc.gove
Ms. Tabatha Holt	MJLM	256-890-1815	tholt@mjlm.com
Mr. Lionel Locke	TVA	256-729-7403	lwlocke@tva.gov@boeing.com
Ms. Kendra Williams	Northrop Grumman	310-812-4321	Kendra.williams@ngc.com
Mr. Jim Schaffer	Boeing	256-461-2662	James.r.schaffer@boeing.com
Mr. Davie Smith	DIA/MSIC	256-313-7400	des@msic.dia.mil
Mr. Miree Squire	Northrop Grumman	256-726-6380	Miree.squire@ngc.com
Mr. Arthur McDonald	Consultant	256-527-8145	Arthurmcdonald3805@comcast.net
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E. Process for Review of the Program Educational Objectives

The EE Program educational objectives are reviewed periodically by the EE Program Advisory Board. The process is schematically illustrated below in Figure 1. The PEOs are influenced by the University, College, and Departmental mission, the EE Advisory Board, ABET expectations, and alumni and employer feedback. The Advisory Board at its regularly scheduled meetings reviews all matters related to the Program including its educational objectives. Proposed changes to the educational objectives can be initiated by the EE faculty, Advisory Board, or the University administration. Any changes in the educational objectives must be approved by the Advisory Board. Following the approval by the Advisory Board, and the University administration, the revisions in educational objectives are reflected in the University Bulletin, EE Student Handbook, University website and other University publications as appropriate.

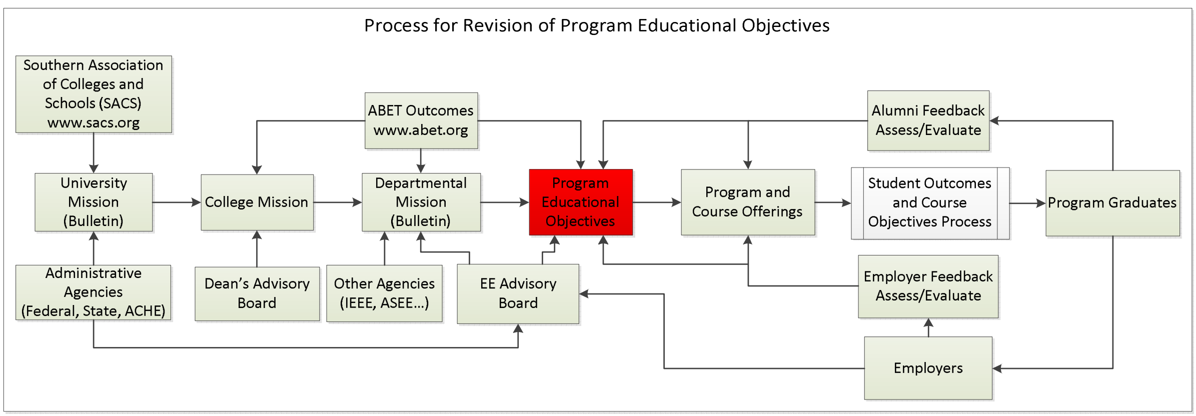

Figure 1. Process for Development and Revision of PEOs

Upon review of the ABET "2011-2012 Criteria for Accrediting Engineering Programs," document, it became apparent that there was need to update the Program Educational Objectives to reflect what graduates are expected to attain a few years after graduation, and identify the program's uniqueness. In contrast, the PEOs as they existed in 2012 were based on expectations of recent graduates. Therefore, this prompted the EE Program to commence the process of changing the PEOs. Following the detailed process described above, in 2012 a revised set of PEOs were proposed and approved in order to better reflect these expectations. Since 2013 the BSEE program has been operating in accordance to the set of PEOs shown in Table 1.

CRITERION 3. STUDENT OUTCOMES

A. Student Outcomes

The Electrical Engineering Program has established an assessment process that is used for the continuous improvement of the Program and its educational operations. Student Outcomes (SOs) correspond to the curricular requirements and graduate attributes required by the ABET General and Program Criteria. All graduates of the Electrical Engineering Program are expected to achieve these outcomes. The Student Outcomes are listed at the AAMU website and in the EE Student Handbook, and can be found at the following URL. https://www.aamu.edu/Academics/engineering-technology/EE/Pages/Electrical-Engineering-Program.aspx.

The Student Outcomes are also posted at various locations in the engineering building including EE laboratories and classrooms. The EE course syllabi, distributed to students in every class, list the Student Outcomes addressed by the respective courses. The documentation of the assessment processes and evaluation results of Student Outcomes are maintained by the EE Program.

The Electrical Engineering Program is engaged in an ongoing assessment process to evaluate its success in meeting the Program Educational Objectives and Student Outcomes in order to foster further development and continuous improvement of the EE Program. All graduates of the Electrical Engineering Program are expected to attain the outcomes corresponding to the curricular requirements and graduate attributes required by the ABET General Criteria for Baccalaureate Level Engineering Programs. The EE Program has adopted the ABET-EAC Student Outcomes as the required Student Outcomes.

Program graduates will 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 within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability;

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 (orally and written) ;

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; and

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

The Student Outcomes are assessed and the degree of attainment of outcomes are measured and documented using various direct and indirect measurement tools. Various instruments used for determination of the direct measures of the attainment of student outcomes include course rubrics and course outcomes spreadsheets that are utilized by the instructors for all the EE classes taught each semester. The outcomes spreadsheet for each class provides detailed information about the extent of attainment of each one of the particular outcomes that are addressed by that course. The attainment of each outcome associated with the course is recorded and tracked dynamically throughout the semester, for each student and the entire class. Student outcomes are aggregated across all EE courses in order to obtain a direct and quantitative measure of the extent of attainment of each student outcome at the program level. Other instruments utilized for direct and quantitative measurement of the extent of attainment of student outcomes include faculty senior design evaluations, and student design team peer evaluations. Qualitative outcomes assessment measures include faculty evaluations of undergraduate research assistants. Additional modes of indirect outcomes evaluation include feedback from employers of student interns and student feedback following job interviews, and Co-op and internship experiences, and external reviews of senior design projects. Indirect measurement instruments used for assessment of the level of attainment of student outcomes include various survey tools including Student Course Evaluation Form, Graduating Senior Survey Form and Alumni Survey Form.

B. Relationship of Student Outcomes to Program Educational Objectives

As described above in CRITERION 2, the Electrical Engineering PEOs are:

1. Graduates will be equipped with the technical, communication and teamwork skills that will enable them to be competitive in the marketplace and build productive careers in electrical engineering or related fields.
2. Graduates will contribute to the economic vitality and security of our State and Nation by having acquired the technical knowledge, skill sets, social awareness and ethical traits necessary for successful careers in the global commercial sector, as well as the security, defense, and space oriented industries of North Alabama and throughout the Nation.
3. Graduates will have the knowledge, skill sets and lifelong learning habits that prepare them for pursuit of career development and advanced degrees, and will enhance our Nation's productivity and economic competitiveness by increasing the diversity of the US technical workforce.

The relationships between the PEOs and the Student Outcomes (a-k) are mapped below in Table 4. As can be seen, there are a number of outcomes associated with each objective. Attainment of these outcomes positions program graduates to successfully achieve the overarching program educational objectives. The extent of attainment of the program educational objectives and student outcomes is determined through various direct and indirect measurement instruments.

Table 4. Relationships between Program Educational Objectives and Student Outcomes

Educational Objectives	**Student Outcomes**										
	a	b	c	d	e	f	g	h	i	j	k

Educational Objective #1	x	x	x	x	x		x		x	x	x
Educational Objective #2	x	x	x	x	x	x	x	x	x	x	x
Educational Objective #3	x	x	x	x	x		x	x	x	x	x

CRITERION 4. CONTINUOUS IMPROVEMENT

The ABET General Criteria provide a blueprint for continuous quality assurance via an established list of eight criteria that must be satisfied for accreditation seeking programs. In recognition of these, the structure and processes that define the AAMU BSEE program have been heavily scrutinized in preparation of this Self-Study Report for consistency and adherence to these ABET requirements. As a result, a number of interacting entities and constituencies that are instrumental in defining the dynamic structure of the AAMU-BSEE program have been identified. An effort to capture these entities and their relationships in a holistic view of the AAMU– BSEE program is shown in Figure 2. As can be seen, even at this high level, the program is influenced by a wide variety of entities, and the influence exerted on the program by any given entity can be very dynamic in time and/or magnitude. Furthermore, the mechanism by which each influence is applied to the program also widely varies. Some entities have influence by virtue of financial means (funding agencies), others via their solicited opinions and surveys (students, alumni, employers), and some offer regulation and oversight (e.g. State, University and Advisory Board). This mélange of interactions is very difficult to model, analytically describe and especially to quantify. Although much of the influences on the program are asynchronous and unpredictable, the faculty has established a number of regular procedures at different levels in the process to help monitor and improve the performance of the program at regular intervals.

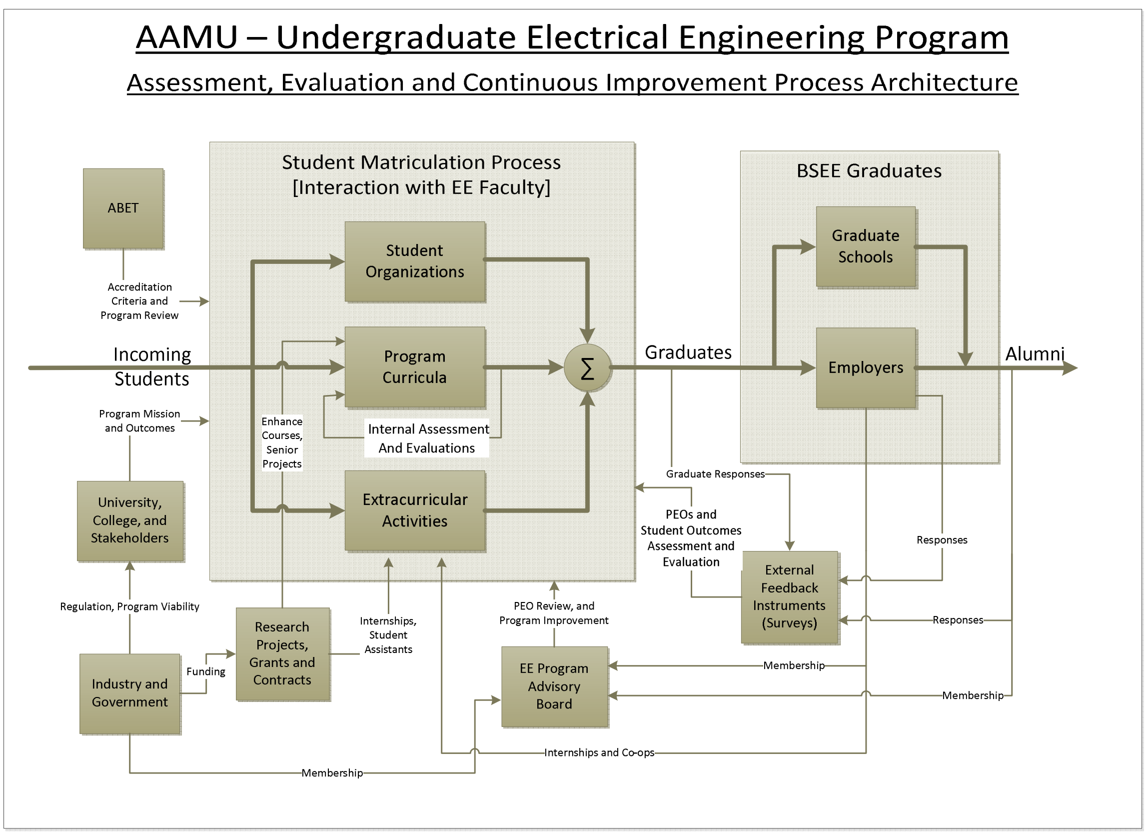

Figure 2: EE Program Assessment and Continuous Improvement Architecture

The primary focus of the program is the student body; beginning with their initial entry to the undergraduate program, following them throughout their growth at the university culminating at graduation, and then monitoring their subsequent progress as they become mature alumni. A number of assessment, review and evaluation procedures have been institutionalized to ensure systematic improvement of the educational quality of the program. Furthermore, input from a variety of external stakeholders and constituent groups have been critical in establishing the current state of the program, and will remain pivotal in guiding the evolution of the program for the foreseeable future.

The most active and complex process at issue is the matriculation of the student body through their undergraduate EE education. Students are developed and influenced via a number of modalities, the most significant and readily identifiable are; Student Organizations, Program Curricula (courses), and Extracurricular Activities. All of these modes are heavily characterized by students' interaction with the EE program faculty and other University faculty, and to a lesser extent are influenced by interaction with external constituents and stakeholders. Internal assessments and evaluations of student outcomes at both the course and program level are conducted at this level, and form the primary basis for course level continuous improvements.

The direct measurement of the degree of attainment of Student Outcomes at the course level including senior design team performance evaluations and the indirect measurements of Student Outcomes via various survey instruments are aggregated in order to assess and evaluate the extent to which Student Outcomes are met. The results of these periodic evaluations are utilized for continuous improvement of the BSEE program.

Upon completion of the degree requirements, new graduates enter the workforce and/or graduate school. Efforts are made to track the future employment plans of new graduates via survey instruments at graduation and via alumni surveys. Alumni at all levels are encouraged to maintain relationships with the program. Alumni and their employers are regularly solicited for their feedback on attainment of Program Educational Objectives and Student Outcomes, and to provide active input to the program via membership in the EE Program Advisory Board. Survey instruments to measure the success of Student Outcomes and Program Educational Objectives (PEOs), and solicitation of periodic reviews via the EE Program Advisory Board are the primary means of evaluation of the program at this level, and contribute to continuous improvements at the program level.

In addition to current students, alumni, employers, and EE Program Advisory Board, there are a number of other constituency groups that influence the program. These include: ABET; AAMU and the AAMU College of Engineering, Technology and Physical Sciences; various governmental agencies, including the State of Alabama and the Federal Government; various industry and trade organizations, i.e. IEEE and National Society of Black Engineers (NSBE). The influence of these varies from institutional support and regulatory oversight to active funding of scholarships and faculty research projects with student involvement. Input from these sources affect the PEOs via the program mission, and further impact the program by contributing state of the art technology and helping to bring cognizance of greater societal issues to the program.

Thus, the continuous improvement process for the AAMU EE program is dynamic and constantly evolving. It is influenced by feedback via a number of direct and indirect measurements – ranging from anecdotal input by advisory board members, faculty course evaluations to alumni and employer surveys… among other means.

A. Student Outcomes

The EE Program Student Outcomes (SOs) are identical to the ABET-EAC a-k Student Outcomes and are listed in Criterion 3-A above.

A schematic of how the SOs are expressed at the program and individual course level, and how they are measured and evaluated for input to the continuous improvement process is shown in Figure 3. Feedback for continuous improvement happens at two levels in this dynamic process. The inner loop feedback cycle occurs during each semester of course offering. It measures student success at the course level, which can be used as information for the instructors to modify individual courses. The outer feedback loop functions on an annual basis, where analyses of the SOs for the individual courses are aggregated to provide measureable data for the continuous improvement process at the program level.

The SOs, coupled with the PEOs and input from the program stakeholders, help shape the structure of the Program and the content of the curriculum. Each individual course within the Program is characterized by a set of Course Learning Outcomes that detail what students are expected to attain from the course. Each course syllabus contains this mapping matrix with outcomes specific to that course. Syllabi for all the courses in the BSEE program are shown in APPENDIX A - COURSE CYLLABI. Students' performance in the course is evaluated, and provides feedback for course level improvements. Also, the performance on each individual course is aggregated across the EE curriculum to provide a global course level measurement of the degree of attainment of Student Outcomes. These are coupled with other measures of the SOs and provide feedback for continuous improvement at the program level.

Each course and laboratory in the BSEE program addresses a particular set of a-k Student Outcomes. The level of attainment of Student Outcomes in each EE course is measured every time the course is offered. The course level SO measurement results are aggregated across all EE courses every year. These are subsequently combined with the results of other direct and indirect SO measurement tools including Senior Design evaluations, Graduating Senior Surveys, and the Senior Design Team Partner Assessment Surveys in order to determine the degree of attainment of Student Outcomes. The evaluation results are utilized for the continuous improvement of the BSEE program.

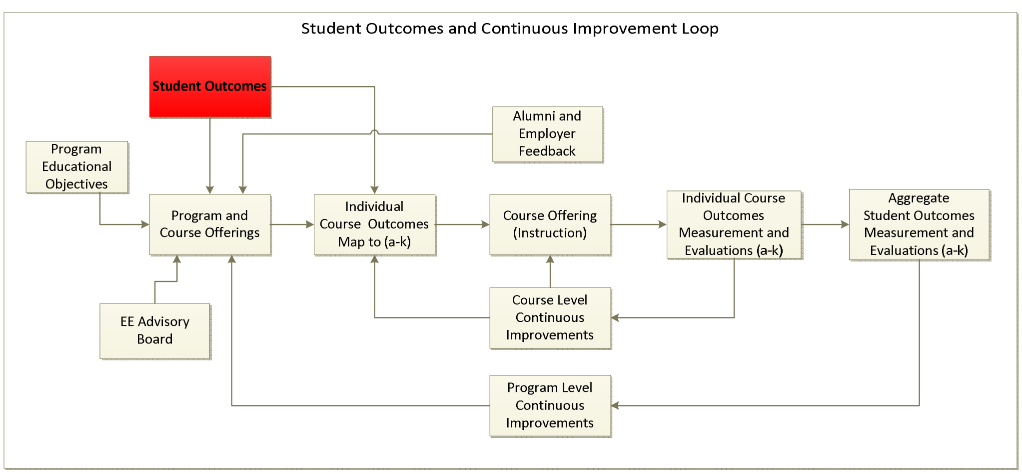

Figure 3. Student Outcomes and Continuous Improvement Loop

Figure 4 provides further details about how Course Outcomes are utilized to measure the degree of attainment of SOs and provide feedback into the continuous improvement process. The Course Outcomes (Course Learning Outcomes) are directly mapped to the relevant SOs supported by the course, and the mode(s) of measurement that applies to the outcome. As courses are conducted throughout the academic year, students' performance on the Course Outcomes is quantitatively assessed by the instructor. In addition to mapping SOs to the Course Outcomes, instructors must take that concept to another level, and map SOs to each assignment given in the course. Then, the numeric results obtained for each assignment via traditional grading, are assessed on each student outcome (a)-(k) that has been associated with that particular assignment by the instructor.

For example, a course as a whole may contribute to student outcomes (a), (b) and (c). If Quiz #2 is adjudged by the instructor to contribute only to student outcome (b), no weight is given to outcomes (a) and (c) for that assignment. Only assignments contributing to an outcome are utilized to score the outcome for the course. If an assignment has nothing to do with a given outcome, no weight is given to it.

These weighted SO scores are tracked throughout the semester, and translated to provide an ongoing measurement of the SO achievement while the course is being conducted. This is accomplished with the aid of an Excel spreadsheet application for each course to help moderate the amount of paperwork required for instructors. The application was developed by the EE program faculty in response to previous ABET reviews. The calculation for the overall SO attainment in the course is a function of the scores on individual assignments correlated to the outcomes pertaining to that assignment, then scaled to provide a 0 – 100% measurement. All assignments that pertain to a given SO are treated equally in the assessment of that SO.

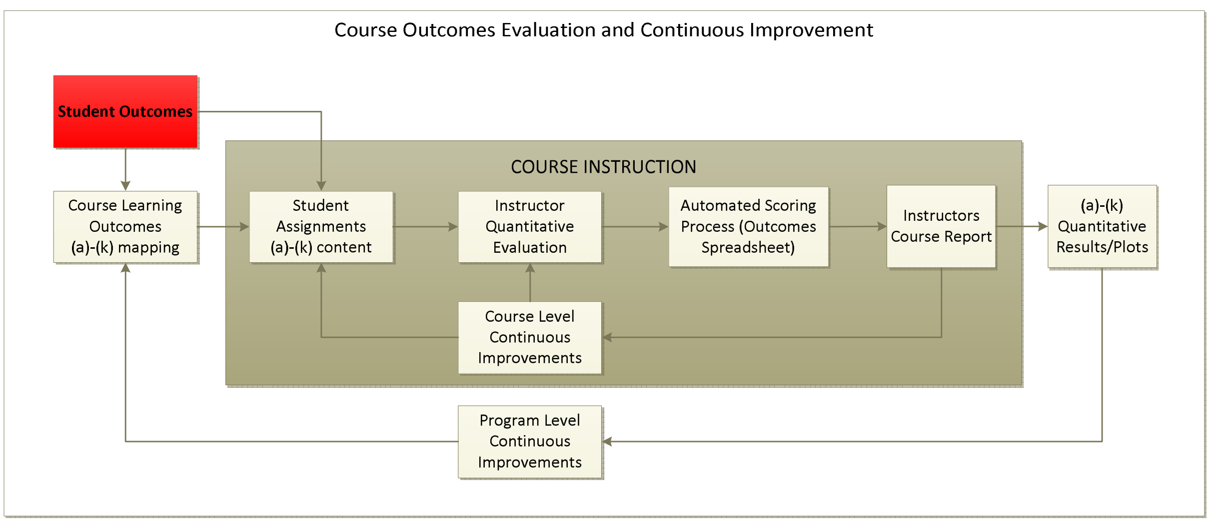

Figure 4. Course Outcomes Evaluation

The numeric results for the course SOs are then used to evaluate the success of the course via two means; 1) student performance bar graphs, and 2) the Instructors Course Report. The bar graphs provide a measurement of the performance of every student on each SO supported by the course, and the class average on that SO. The Instructors Course Report summarizes the overall SO performance in the course by grouping student performance on each SO into one of four categories High, Medium, Low, and Not Assessed (H, M, L, and N). The percentage of students meeting the H, M and L categories is recorded on the form. The form also contains sections for instructor notes on Observed Shortcomings and Corrective Actions Planned.

To summarize, each EE course addresses at least one of the EAC SOs. Each component of a particular course such as various homework assignments, quizzes, exams, project reports, experiments, oral and written presentations, etc. is related to one or more student outcomes that are addressed by that course. The performance of each student in the course is assessed with respect to each of the student outcomes that are addresses by that course. This assessment process provides the course instructor with real-time feedback and the ability to dynamically track the degree of attainment of each one of the course-specific SOs as the semester progresses, and take corrective actions if needed. At the conclusion of each semester, each student, in addition to the course score receives a numerical score on each one of the SOs that the course addresses.

The resulting bar graphs and Instructors Course Reports are generated for each required course and most elective courses taught in the BSEE curriculum. These results are displayed in the Course Folder Portfolios for each course and will be available for examination by the reviewer during the general review.

A detailed example of the Course Outcomes Evaluation process is shown in Appendix J.

The individual student performances and the Instructors Course Report and Assessment results are used to provide course level continuous improvements. The Observed Shortcomings and Corrective Actions Planned sections of the Instructors Course Reports and Assessment are utilized by the instructor(s) to provide documentation for continuous improvement efforts at the course level.

The SOs score distributions for a particular course provide the EE faculty with assessment metrics for determining the extent to which the course satisfies its intended student outcomes. Examining the SOs score distributions for a particular course over several semesters provides the EE program with information that can be used to identify weaknesses in a course, and is utilized for course-level improvements of the program. The course level SOs score distributions are aggregated across the BSEE core curriculum and Concentration course and are tracked periodically in order to provide a global measure of the degrees of attainment of student outcomes. This information is utilized to make changes in the curriculum and course contents and to assess the effects of those changes. Course level SO plots for the required BSEE program courses are displayed in Appendix H.

After multiple assessment rounds, the EE faculty has set the following performance targets. If at least seventy-percent of students in a class obtain the score of sixty-percent or higher on an outcome, the level of attainment of that outcome in the course is considered high (H). If the proportion of students who score higher than sixty-percent on an outcome is between sixty and sixty-nine percent, the level of attainment of that outcome in the course is considered medium (M). If the proportion of students who score higher than sixty-percent on an outcome is between fifty and fifty-nine percent, the level of attainment of that outcome in the course is considered low (L). If the proportion of students who score higher than sixty-percent on an outcome is less than fifty percent, the targeted outcome is not met by the course (x). Note that this measurement, although similar, is scored differently than the Course Outcomes scoring described above.

The course level assessment results of the degree of attainment of SOs are shown below in Table 5 and Table 6 for all eighteen BSEE core courses, and the BSEE concentration and elective courses, respectively. Table 5 and Table 6 list the assessment results for each course averaged across six annual assessment cycles. The rows and columns in Table 5 and Table 6 correspond to EE courses and the EAC SOs, respectively. Each row shows the degree of attainment of the targeted outcomes for the respective course averaged across six annual evaluation cycles.

Table 5. Course Level Student Outcomes Summary (2012-2018)

BSEE Core Courses

	a	b	c	d	e	f	g	h	i	j	k
101	x				x	L	H		H	M	H
109	L		L								L
201	L				L						M
201L	H	H		H			H				H
202	L				L						H
203	H				H						H
203L	H	H		H	H		H				H
204	H	H	H		H					H	H
301	H				H						x
303	H				H						x
304	x		x		L					M	M
320	x		x		L						H
320L	x	x	x								x
330	L	H	H		M						H
333	H				H						H
403	M				M						L
470	H	H	H		H	H	H			H	H
471	H	H	H		H		H			H	H

Table 6. Course Level Student Outcomes Summary (2012-2018)

BSEE Concentration and Elective Courses

	a	b	c	d	e	f	g	h	i	j	k
305	x				x					L	L
306	H		H		H						H
307	H					H		H			
308	L		M		L						x
340L	H	H	H		H						H
350	H	H	H		H					H	H
360L	H	H	H							H	H
404	H		H		H					H	
405L	H	H	H							H	H
410	H				H						H
420	H	H	H		H			H	H	H	H
421											
425	H	H	H		H		H			H	H
431	M				L					M	x
451	H	H	H		H						H
451L	H	H	H							H	H
452											
460	H				H						H
461	H				H						H

The data supporting these results are shown in Appendix I. The results plotted in Figure 61 through Figure 64 of Appendix I show the score distributions for each of the targeted outcomes of the respective course averaged over multiple offerings of the course. In each plot of Appendix I, the abscissa denotes various outcomes that are targeted by the respective course, and the ordinate represents the percentage of students whose scores on the particular outcomes fall within the indicated ranges. In addition to providing course level information, this data is re-characterized to evaluate the degree of attainment of the SOs at the program level.

Individual course outcomes are couched in terms of the SOs that they support, and the results of these individual course outcomes are aggregated to provide a direct measurement of the overall achievement of SOs. Thus, the course level assessment process can be used to provide feedback at the program level. Measurement of the overall SO achievement level provides feedback for program level continuous improvements.

The Course Outcomes measurements described above are the primary measurements considered for the evaluation of the degree of attainment of Student Outcomes (SOs). In addition to those, a number of other measurement instruments, both formal and informal are utilized to assess and evaluate the degree of attainment of the Student Outcomes. These include both direct and indirect measurement instruments. The direct Outcomes measurement instruments include course outcomes assessment spreadsheets, end-of-semester instructor course assessments, assessment of senior projects and teams by the faculty and senior design team peer assessments. The indirect Outcomes measurement instruments include student surveys, graduating senior surveys, faculty evaluation of undergraduate research assistants, student feedback following internships and job interviews, informal feedback from managers familiar with the work of student interns and alumni of our Program, and senior design project external reviews. The various measurement tools and frequency of use are enumerated in Table 7.

Table 7. Description and Frequency of Student Outcomes Measurement Tools

Measurement Tool	Description	Frequency of Measurement
1	Faculty course outcomes assessments	Semester
2	Faculty senior design reviews	Annually
3	Senior design peer assessment	Annually
4	Graduating senior surveys	Semester
5	External senior design reviews	Annually
6	Faculty evaluation of undergraduate research assistants	Ongoing
7	Feedback from employers of EE student interns	Ongoing
8	Feedback from students following internships and interviews	Ongoing

Table 8 lists the SOs and the corresponding tools which are utilized for regular measurement of the extent of their attainment. The assessment processes for Measurement Tools 1 – 4 are formalized, and provide consistently available measurements of the SOs. In contrast, the processes and results for Measurement Tools 5 – 8 are more asynchronous and primarily anecdotal in nature. Therefore, for purposes of display and production for ready comparison, only the quantifiable results from Tools 1 – 4 are shown here. This does not mean that Tools 5 – 8 are not considered in the continuous improvement process – only that their influence is irregular and not readily quantifiable.

Table 8. Mapping of Measurement Tools to Student Outcomes

Measurement Tool / Outcome	1	2	3	4

(a)	x	x		x
(b)	x	x		x
(c)	x	x		x
(d)	x	x	x	x
(e)	x	x		x
(f)	x	x	x	x
(g)	x	x	x	x
(h)		x		x
(i)	x	x	x	x
(j)	x	x		x
(k)	x	x		x

Student Outcomes evaluation at the program level is performed periodically by analyzing the results from Measurement Tools 1 – 4. The quantitative measures obtained by the direct assessment instruments are combined with the quantitative and qualitative measures obtained from the indirect measurement instruments and other informal tools to present a global measure of the extent to which the Program attains its Student Outcomes. Decisions for making improvements at the course level and program level are based on the outcomes assessment results.

- Measurement Tool 1: a direct measurement that aggregates the course outcomes from all required courses of the BSEE curriculum. The mean of students' SO scores for each course that supports a given SO are combined together in a simple average calculation, with each course's SOs being weighted equally. The supporting data for these is located in Appendix H and in the course folder portfolios, which will be available for the reviewer on the on-site visit.

- Measurement Tool 2: a direct measurement of faculty scoring results of the Senior Design Course sequence (EE 470 and EE 471), includes performance on six formal presentations throughout the academic year, and one poster session for each senior design team. The supporting data for these is located in the course folder portfolios, which will be available for the reviewer on the on-site visit.

- Measurement Tool 3: a direct measurement, which is conducted at the conclusion of the Senior Design Course sequence. Students score the performance of their peer teammates with respect to selected outcomes. The scoring form is shown in Appendix E, and details of the formulation of the scoring results are discussed in Appendix G. Raw supporting data for these is available for the reviewer on the on-site visit.

- Measurement Tool 4: an indirect measurement survey instrument, which is conducted each fall and spring semester, on graduating BSEE students. It provides their personal assessment of their level of attainment on the various SOs. The scoring form is shown in Appendix E, and details of the formulation of the scoring results are discussed in

Appendix F. Raw supporting data for these is available for the reviewer on the on-site visit.

The scoring for each Measurement Tool is scaled to a range of 0-100%. After multiple assessment rounds, the EE faculty has set the following performance target. The goal is to achieve score of 75 on each student outcome.

Figures 5 through 10 show the EAC a-k SOs assessment results for six evaluation cycles covering academic years 2012-13 through 2017-2018. Abscissa and ordinate represent Student Outcomes and scores, respectively, where score range is 0-100. Each group of vertical bars corresponds to the respective SO. Each SO is measured using one-to-four assessment tools. Assessment tools used are Measurement Tools 1 - 4 listed in Table 7 above, which consist of, respectively, instructor course assessments for all required EE courses (BSEE core courses across four concentrations listed in Table 5 above) addressing the particular outcome (Appendix H), faculty assessments of senior design projects (EE 470 and 471 course folders), senior design team peer assessments (Appendix G), and graduating senior surveys (Appendix F). The height of each bar represents the score of the respective outcome based on a particular color coded measurement tool.

After several assessment rounds the EE faculty has set the goal of seventy-five on the 0 – 100 scale as the targeted score for all eleven Student Outcomes. The horizontal lines in Figures 5 - 10 represent the goal set by the faculty. It is seen that virtually all the outcome scores reach or exceed the targeted goal according to at least one assessment tool. The scores of several outcomes, as measured by some assessment tools, fall below the targeted attainment level. The EE faculty utilizes the outcomes assessment results as feedback for continuous improvement of the program.

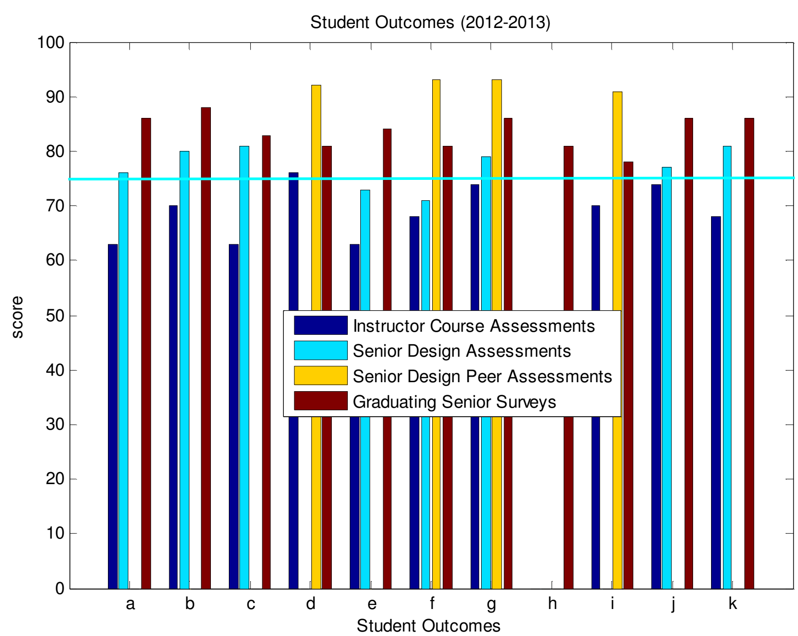

Figure 5. Student Outcomes for 2012-2013 Academic Year

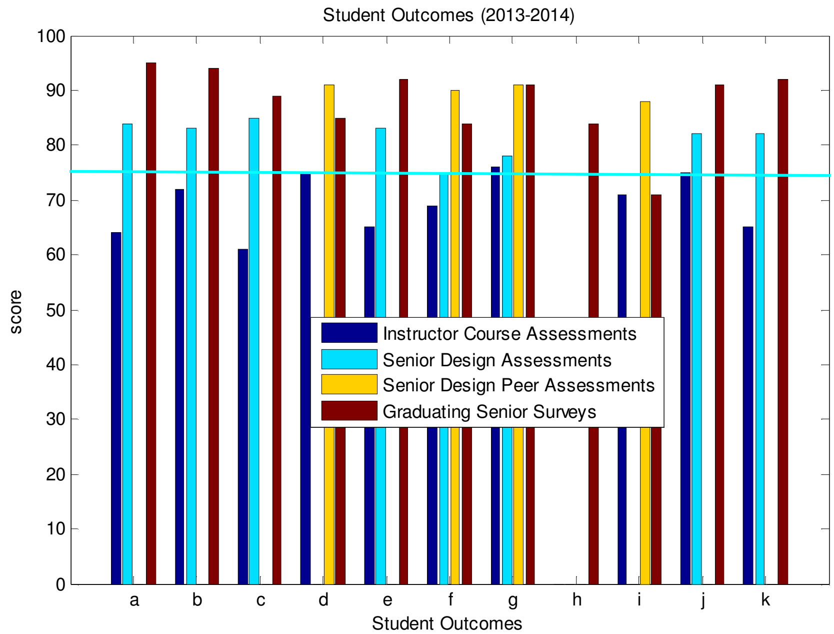

Figure 6. Student Outcomes for 2013-2014 Academic Year

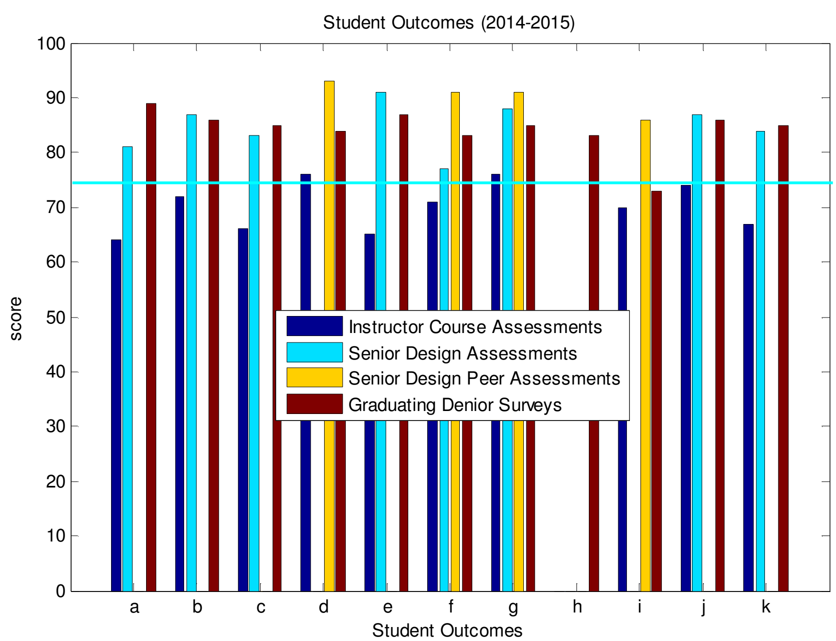

Figure 7. Student Outcomes for 2014-2015 Academic Year

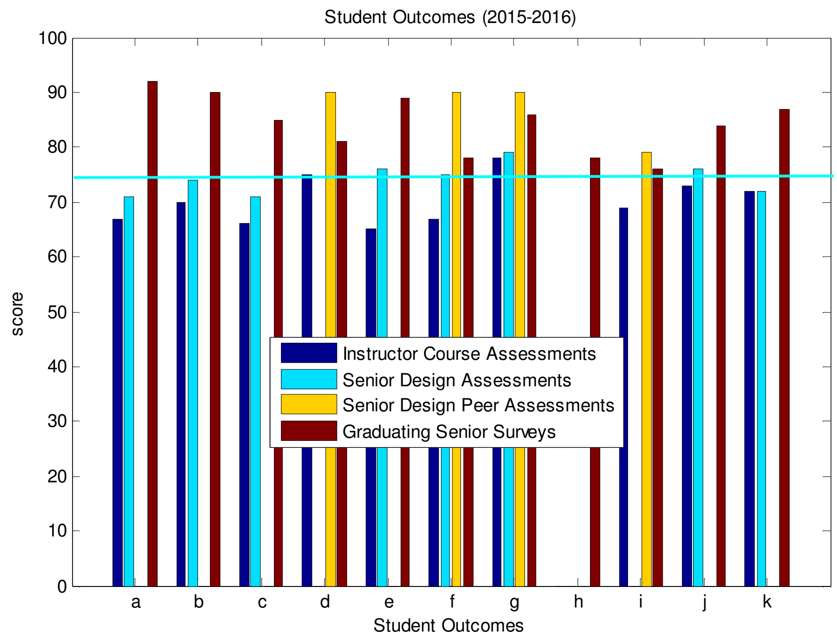

Figure 8. Student Outcomes for 2015-2016 Academic Year

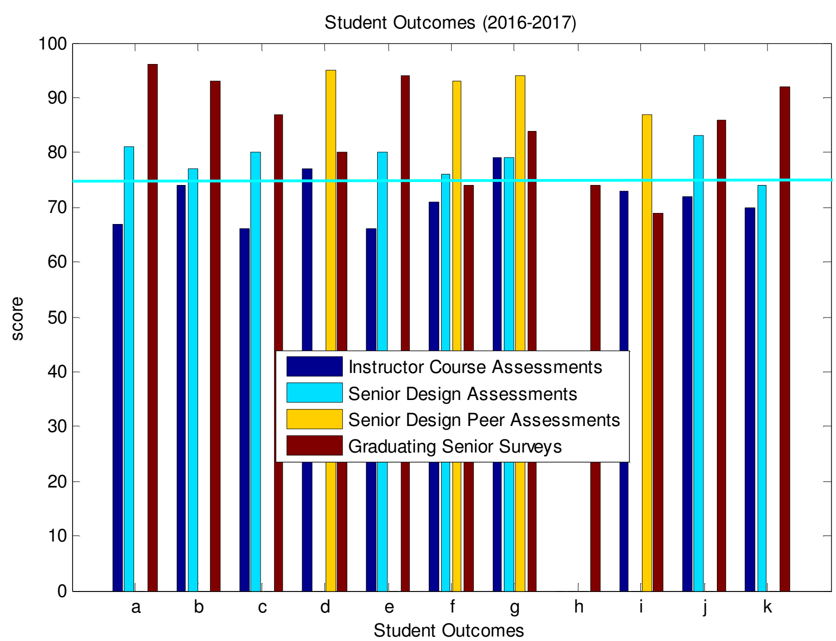

Figure 9. Student Outcomes, 2016-2017 Academic Year

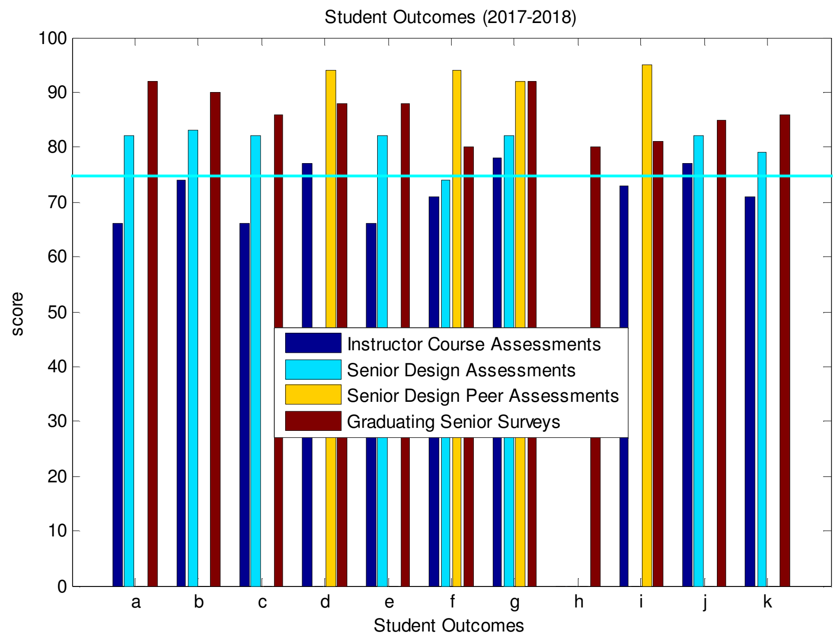

Figure 10. Student Outcomes, 2017-2018 Academic Year

SO (d) *(ability to function on multidisciplinary teams)* is currently measured directly via the instructor course assessment of selected laboratory courses, and senior design team peer assessment, and indirectly via the graduating senior survey. In previous academic years, however, the direct measurement tools for SO (d) consisted of instructor assessment of students in laboratory courses, and the assessment of senior design teams by the faculty mentors which were deemed to be subjective due to the fact that the instructor's exposure to student interaction with lab partners and the faculty mentors' exposure to the internal dynamics of the senior design teams were limited.

SO (f) *(understanding of professional and ethical responsibility)* is currently measured directly via the senior design course through the required ethics paper in EE 470, EE 101 through ethics related case studies, the senior design team peer assessment, and indirectly via the graduating senior survey. In previous academic years, however, one of the direct measurement tools for SO (f) consisted of instructor assessments of students in EE 101, examining ethics related case studies which was deemed insufficient.

SO (h) *(broad education necessary to understand the impact of engineering solutions in a global and societal context)* is only measured indirectly utilizing Measurement Tool 4. This SO, although addressed by some of the BSEE concentration and elective courses and measured directly in those courses, it is not directly measured in any of the BSEE core courses. The program faculty is currently exploring ways to provide a better means for quantifying the degree of attainment of this outcome.

Although engineering standards and design iteration process had always been covered in the senior design course sequence, in order to improve the degree of attainment of SO (j), in 2014, the faculty in consultation with the EE Advisory Board formalized this requirement by requiring senior design teams to incorporate discussion of engineering standards and design iteration in the oral presentations.

The evaluation process demonstrates that the minimum requirements are met by all of the student outcomes when considered as an average of the various Measurement Tools. The extent of attainment of the student outcomes however, vary across the different Measurement Tools, and differ among various outcomes. Some of the student outcomes such as Student Outcomes *(a)* and *(e)*, for example, are measured directly and very frequently in almost all EE courses and laboratories. The evaluation processes examining the extent to which these outcomes satisfy the defined standards are therefore based on larger data sets and are deemed more reliable. Some other student outcomes such as Student Outcomes *(f), (h),(i)* do not lend themselves readily to direct measurement, and the data associated with their measures is scarce, and the measurement results may therefore be subjective and less reliable.

The results of the evaluation process of the degree to which Student Outcomes are attained is maintained by the EE Program in the Program Assessment Files and is partially maintained in the University Quality Enhancement Plan, SACS Academic Assessment files and Strategic Planning Online.

B. Continuous Improvement

The results of the evaluation process conducted for assessment of the extent of attainment of the program educational objectives and the student outcomes constitute the main sources from which decisions with regard to potential changes in the EE Program are based. Every semester, student outcomes assessment for every EE course is carried out. Faculty, individually, in small groups, and the entire EE faculty collectively examine the student outcomes assessment results and identify any potential weaknesses and opportunities for improvement of the course or the prerequisite courses in addressing the associated outcomes. At a more global scale, faculty in consultation with the program constituents including the university administration and EE Advisory Board engages in data driven program improvement processes via curriculum changes including addition of new courses and modification of the BSEE core requirements.

The flow diagram in Figure 11 illustrates the relationship between the assessment processes for the PEOs and the Student Outcomes (SOs). The PEO assessment in the outer loop is primarily a long term (~3 year) cycle characterized by alumni and employer surveys. The SO assessments in the inner loop are of shorter cycle (<=1 year) characterized by course, program and graduate assessments. The dashed arrows indicate interaction between the PEOs and SOs. The results of some of the PEOs are directly related to the SOs, and continuous improvement actions at the PEO level influence actions taken at the SO level and vice versa.

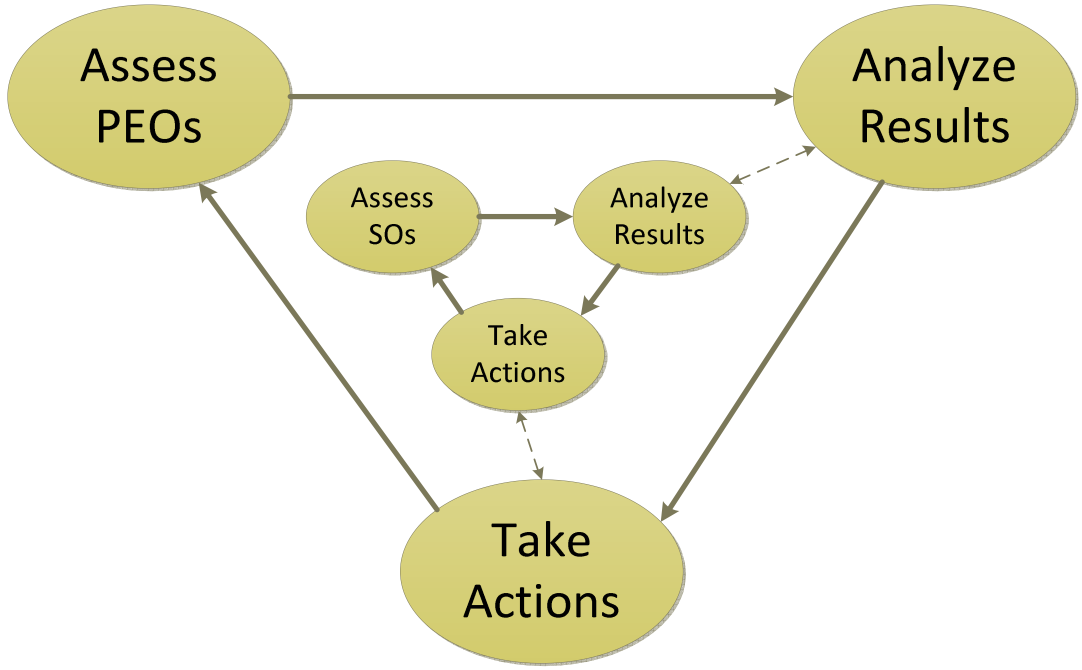

Figure 11. Flow Diagram for PEO and SO Assessment Processes

A number of "Program Improvement" efforts in support of the Continuous Improvement process have been undertaken in the BSEE program since the last general review. Significant Program Improvements that have come about as a result of the Continuous Improvement process are detailed in Table 9.

Table 9. Program Improvement Summary

#	Program Improvement Description	Year	Affected Program Area	Constituencies Initiating Improvement	Impacted Outcomes (SOs)	Supported Objectives (PEOs)	Estimated Affected Students (%)	Measurement of Effectiveness
1	Revision of Program Educational Objectives	2012	Current Students	Faculty, University Administration, Alumni, Advisory Board, ABET	a-k	1-3	100	4
2	Revision of Student Outcomes	2013	Current Students	Faculty, University Administration, Alumni, Advisory Board, ABET	a-k	1-3	100	4
3	Addition of the Nuclear Laboratory for research and senior design	2013	Current Students	Faculty, University Administration, Alumni, Advisory Board	a-k	1-3	25	3.5
4	Addition of engineering standards and design iteration process as required elements of the senior design presentations	2014	Current Students	Faculty, Advisory Board	c, d, h, j	1-3	100	4
5	Addition of Nuclear Power Concentration to the BSEE degree program	2015	Current Students	Faculty, University Administration, Alumni, Advisory Board	a-k	1-3	25	4
6	Development of new course EE 306, Survey of Energy Systems, and addition to Nuclear Power Concentration	2015	Current Students	Faculty, University Administration, Advisory Board	a, c ,e, k	1-3	25	3.5
7	Development of new course EE 307, Fundamentals of Nuclear Engineering, and addition to Nuclear Power Concentration	2015	Current Students	Faculty, University Administration, Advisory Board	a, f, k	1-3	25	3.5
8	Development of new course EE 421, Power Systems II, and addition to Nuclear Power	2015	Current Students	Faculty, University Administration, Advisory Board	a, c, d, e, f, h, j	1-3	25	3.5

	Concentration							
9	Development of new course EE 460, Nuclear Reactor Engineering I, and addition to Nuclear Power Concentration	2015	Current Students	Faculty, University Administration, Advisory Board	a, e, k	1-3	25	3
10	Development of new course EE 461, Nuclear Reactor Engineering II, and addition to Nuclear Power Concentration	2015	Current Students	Faculty, University Administration, Advisory Board	a, e, k	1-3	25	3
11	Development of new course EE 308, Thermal Systems Engineering, and addition to Nuclear Power Concentration	2016	Current Students	Faculty, University Administration, Advisory Board	a, c, e, k	1-3	25	3
12	Addition of EE 303, Electromagnetic Field Theory, as a requirement to the Nuclear Power Concentration	2016	Current Students	Faculty, University Administration, Advisory Board	a, e, k	1-3	25	4
13	Addition of EE 308, Thermal Systems Engineering, as a requirement to the Nuclear Power Concentration	2016	Current Students	Faculty, University Administration, Advisory Board	a, c, e, k	1-3	25	3
14	Deletion of ME 310, Thermodynamics, and ME 312, Heat & Mass Transfer, from the Nuclear Power Concentration	2016	Current Students	Faculty, University Administration, Advisory Board	a, e, k	1-3	25	3
15	Expansion of the Microelectronic Characterization Lab by adding Room 280 to this laboratory	2017	Current Students	Faculty, University Administration, Advisory Board	a-k	1-3	25	-
16	Development of new course EE 422, Smart Grid Cyber Security, offered as elective	2017	Current Students	Faculty, University Administration	a, c, d, e, f, h, j	1-3	20	-
17	Development of new course EE 426, Next Generation Mobile	2017	Current Students	Faculty, University Administration	a, c, d, e, f, h, j	1-3	20	-

	Networks, offered as elective							
18	Addition of ORI 102, Survival Skills for University Life II	2013	Current Students	University Administration	g, i	1-3	100	4
19	Addition of the Junior Audit to student advisement process	2017	Current Students	University Administration, Faculty	a-k	1-3	100	3.5
20	Added new and more advanced laboratory instruments including scopes, signal generators, digital multimeters, etc. to the basic circuits and electronics laboratory (Room 263)	2014 & 2016	Current students	Faculty, ABET, Current Students	a-k	1-3	100	4
21	Added SOC716 VNIR Hyperspectral Imaging System to the Reconfigurable Computation Laboratory (Room 278)	2015	Current students	Faculty	a, b, c, j, k	1-3	10	3.5
22	Added new microprocessor and FPGA boards to the Digital Systems and Microprocessor Laboratory (Room 270)	2014 & 2016	Current students	Faculty, Advisory Board, ABET, Current Students	a-k	1-3	100	4
23	Added new Steed furnace system to the microelectronics fabrication laboratory (Room 135)	2017	Current students	Faculty, Advisory Board, ABET, Current Students	a-k	1-3	33	4.0
24	Added new Karl Suss mask aligner to the microelectronics fabrication laboratory (Room 135)	2016	Current students	Faculty, Advisory Board, ABET, Current Students	a-k	1-3	33	4.0
25	Acquired thirty new computers for the EE Simulation Laboratory (Room 272)	2015	Current students	Faculty, Advisory Board, ABET, Current Students	a-k	1-3	100	4.0

The columns of the table contain information as follows:

- a brief description of each Program Improvement is given;
- the year that the improvement was initiated;
- the program area that is affected by the Program Improvement;
- the constituency(ies) that initiated and/or provided the impetus for the Program Improvement;
- the Student Outcome(s) that should be influenced by the Program Improvement;
- the PEO(s) that are affected by the improvement;
- the estimated percentage of students that are affected by the Program Improvement; and,
- a direct measurement of the effectiveness of the Program Improvement on the 4 point scale {Strong Improvement (4), Improvement (3), Neutral to Minimal Improvement (2), Ineffective Improvement (1), Strongly Ineffective Improvement (0)} as determined by survey of Program faculty.

As a component of the continuous improvement process, in 2011 the EE faculty in consultation with the university administration and the Advisory Board started the process to streamline and revise the Program Educational Objectives. These efforts were motivated in part by the requirement for establishing more unambiguous demarcations between PEOs on one hand and Student Outcomes on the other. Furthermore, it was concluded that the PEOs must better stipulate a set of broad goals whose extent of achievement can best be determined by the professional success and career trajectories of our alumni a few years after their graduation from the Program. Other reasons for the PEO revision included the evolution and growth of our Program and its prominent role in advancing workforce diversity in the high-tech arena both locally and nationally. In keeping with ABET guidelines, the faculty after consultation with colleagues inside and outside the university and following multiple iterations, presented the revised set of PEOs to the Advisory Board for approval. The new set of PEOs were adopted in 2012 and are listed in Table-1. The PEOs in conjunction with Student Outcomes constitute the basis for program evaluation and continuous improvement.

The EE Faculty in consultation with the university administration and the Advisory Board initiated the process of streamlining the Student Outcomes in 2013. Prior to 2013, in addition to the ABET-EAC Student Outcomes a-k, the Program utilized a set of Program Auxiliary Outcomes in order to monitor and improve the Program and its operation. Following the adoption of new PEOs in 2012, it was determined that the Program Auxiliary Outcomes, due to their significant overlap with ABET-EAC Student Outcomes a-k and the newly adopted PEOs, were redundant. The systematic assessment and evaluation of a-k Student Outcomes and timely actions taken in response to the evaluation results as well as periodic assessment and evaluation of PEOs would assure maintaining the quality of the Program and its continuous improvement and growth.

The assessment of the employment data of recent graduates as well as the career trajectory of alumni of the program were among the factors considered for creating the Nuclear Power Concentration within the BSEE degree program. The EE faculty, Advisory Board, and the university administration considered the proportionally significant representation of the Program's graduates in the electric power industry, the important role played by the nuclear power industry in Alabama, as well as national environmental and economic trends in creating this new BSEE concentration in Nuclear Power. The degree requirements and course syllabi were developed in close consultation with the Advisory Board, other universities, and the nuclear power industry. The curriculum and course contents were greatly influenced by input from alumni as well as government and industry partners.

In 2016 the course EE 303, Electromagnetic Field Theory, was added as a requirement to the Nuclear Power concentration. Initially, when the Nuclear Power (NP) concentration curriculum was developed it included two required courses ME 310, thermodynamics, and ME 312, heat & mass transfer. In order to keep the number of credit hours for the NP concentration the same as the existing three BSEE concentrations, namely 130 semester credit hours, EE 303 was removed from the NP curriculum. This was a temporary arrangement until the EE faculty developed EE 308, thermal systems engineering, which includes selected topics from thermodynamics, fluid dynamics, and heat transfer, knowledge units needed by engineers working in the nuclear power industry. The development of course content for EE 308 was done in consultation with nuclear power industry partners in order to assure that all the concepts in ME 310 and ME 312 which are relevant to nuclear reactor operation, are placed in EE 308. In 2016, ME 310 and ME 312 were replaced with EE 308, thereby freeing three credit hours, which allowed adding EE 303 to the NP concentration. This was done because of the centrality of electromagnetic concepts to the BSEE curriculum across all its concentrations.

Input from Advisory Board, and other constituents including government and industry professionals who attend Senior Design presentations, have led to improvement of the engineering ethics education through the Senior Design course sequence. Alumni feedback and recommendations by the Advisory Board have led the program to offer the elective course EE 490, Machine Learning. Feedback from EE alumni, industry trends, and consultation with Advisory Board have led to development of new elective courses EE 422, Smart Grid Cyber Security, and EE 426, Next Generation Mobile Networks. The effects of these changes on the BSEE program and the attainment of student outcomes are yet to be determined.

Input from alumni and faculty assessment of the employment market for the Program graduates have led the faculty in deciding to strengthen the curriculum in the area of power systems. The Program is examining changes to strengthen areas related to renewable energy by introducing new courses or changing the contents of some of the existing courses. The EE Program has been improved to meet EE market demands in Power Systems Engineering.

The EE program faculty is engaged in the continuous improvement process through periodic evaluation of the student outcomes assessment results and utilization of the evaluation results for improving course contents and modes of delivery. The following examples list some of the changes that have resulted from the evaluation of student outcomes assessment results.

In 2013, the evaluation of student outcomes assessment results in EE 451L, IC Fabrication Lab, and senior design led to modification of the course content by adding several fabrication process practices, which became possible through the acquisition of an advanced e-beam evaporation system. This change led to marked improvements in the attainment of student outcomes. In order to further improve attainment of student outcomes, the EE 451L course content was modified again in 2017, after acquisition of advanced mask aligner and spin coater systems. The effects of the latest changes are not yet known. In 2015, the evaluations of student outcomes assessment results in EE 451 and EE 451L, IC Fabrication and Lab, and senior design, led to modification of EE 350, VLSI Design and Testing. The EE 350 content was changed by strengthening the physical layout of CMOS-based VLSI electronic circuit modules. The effect of modifying the content of EE 350 resulted in improving attainment of student outcomes in the following courses.

In 2017, as the result of evaluation of student outcomes in EE 360L, Communications Lab, the course content was modified by adding more simulation exercises prior to the hands-on experiments, which has led to improving attainment of student outcomes. The utilization of Blackboard as a vehicle for improving the attainment of student outcomes started by some EE instructors several years ago, and the results have been generally positive. Therefore, since 2013 the EE instructors have increased their utilization of Blackboard.

The periodic evaluation of student outcomes assessment results in several courses including EE 320, EE 320L, and senior design have led to changes in the content and delivery of EE 320L in 2013, 2014, and 2018. The lab assignments and course projects in EE 320L have been periodically updated in order to incorporate the latest DDR and FPGA devices. The changes in EE 320L have resulted in improving attainment of student outcomes. The evaluation of student outcomes assessment results in several sophomore and junior level classes in 2014 led to changes in the content and mode of delivery of EE 201, Linear Circuit Analysis I. Several hands-on activities were added to EE 201 by using Analog Discovery Boards in class, which resulted in the partial elimination of the transient circuit analysis modules from the course content. After three semesters of trial, it was determined that this change did not result in any measurable improvement of attainment of student outcomes in EE 201 and the following courses EE 202 and EE 203. Therefore, in 2016 the hands-on experimental modules were eliminated from the EE 201 course content.

The evaluation of student outcomes assessment results in several junior level courses and senior design led to changes in the content and textbook of EE 204, Digital Circuit Design and Analysis, by increasing emphasis on VHDL language construct. It is expected that the change will provide better continuity from EE 204 to the follow-on classes and improve attainment of student outcomes. The evaluation of student outcomes assessment results in EE 304, Numerical Methods and Digital Computing, led to implementation of infinite quizzes on Blackboard, which allows students to take quizzes as many times as they choose, due to availability of randomized problem sets. This change has resulted in marked improvement of attainment of student outcomes in EE 304, by encouraging students to study more and allowing the instructor more time for content delivery.

C. Additional Information

Copies of assessment instruments and materials referenced in Criterion 4.A, 4.B and 4.C will be available for review at the time of the visit. Minutes of faculty meetings and Advisory Board meetings where assessment results were evaluated will also be available.

CRITERION 5. CURRICULUM

A. Program Curriculum

The degree of Bachelor of Science in Electrical Engineering (BSEE) is offered in four concentrations of General, Computer Engineering, Microelectronics -VLSI, and Nuclear Power. The BSEE degree program in all four concentrations consists of 130 semester credit hours. The student plans of study are listed in Table 10, Table 11, Table 12, and Table 13, for the BSEE Concentrations of General, Computer Engineering, Microelectronics-VLSI, and Nuclear Power, respectively. The course flow diagrams for BSEE are shown in Figures 12 through 15 for General, Computer Engineering, Microelectronics-VLSI, and Nuclear Power concentrations, respectively.

The BSEE curriculum is designed and implemented in alignment with the program educational objectives (PEOs), which are listed in Criterion 2, Table 1. Specifically,

- PEO #1, " Graduates will be equipped with the technical, communication and teamwork skills that will enable them to be competitive in the marketplace and build productive careers in electrical engineering or related fields," is addressed through the methodical sequence of course and laboratory requirements, an array of concentration and elective courses, and a required two-semester capstone senior design sequence. The required mathematics and science courses provide the foundations upon which the introductory and intermediate electrical engineering courses are based. The fundamental principles of electrical engineering are taught in required EE courses and laboratories, where students become familiar with materials, devices, circuits, processes, and subsystems that constitute complex electrical engineering systems. Through various required laboratory experiences, homework and project assignments students become familiar with and utilize various electronic measurement, analysis and characterization instruments. Through required courses and laboratories students become familiar with and proficient in using industry standard simulation tools. Students attain communication skills through various required written and oral reports in laboratories and courses. Communication and teamwork skills are also addressed through multiple formal senior design presentations and written reports in the senior-year capstone design sequence. The compulsory and elective senior-level courses provide the depth and breadth of knowledge necessary to connect the basic level understanding of electronic materials, devices, circuits, processes, and subsystems, to the design, fabrication and operation of complex electrical systems. The curriculum, through the capstone design sequence in the senior year, teaches students the process of synthesizing various elements of knowledge, including mathematics and basic science, various engineering topics and computational methods to collaboratively design a system or a process to meet certain requirements.
- PEO #2, "Graduates will contribute to the economic vitality and security of our State and Nation by having acquired the technical knowledge, skill sets, social awareness and ethical traits necessary for successful careers in the global commercial sector, as well as the security, defense, and space oriented industries of North Alabama and throughout the Nation," is addressed through required sequence of course and laboratory experiences including the senior-year capstone design sequence and concentration as well as advanced elective courses in preparing graduates of the Program for entry level electrical

engineering positions in industry and government. The requisite social awareness and ethical traits are addressed through discussions, presentations, assignments, and student papers in several EE courses including Introduction to Electrical Engineering EE 101, the capstone senior design sequence EE 470 and EE 471, and the general education courses of the BSEE curriculum including the required history sequence, the required writing intensive English sequence, and humanities electives.

- PEO #3, "Graduates will have the knowledge, skill sets and lifelong learning habits that prepare them for pursuit of career development and advanced degrees, and will enhance our Nation's productivity and economic competitiveness by increasing the diversity of the US technical workforce," is addressed through required sequence of course and laboratory experiences including the senior-year capstone design sequence as well as the concentration and elective courses in preparation for advanced graduate studies and/or entry level technical positions in industry and government with potential for career growth. The lifelong learning habits is addressed partially through various student professional organizations including the student chapters of Institute of Electrical and Electronic Engineers (IEEE), and the National Society of Black Engineers (NSBE), which are active in the college, and arrange seminars and presentations on a regular basis. The students are exposed to the impact of engineering solutions on the society through seminars and lectures by industry experts including presentations by intellectual property experts in the senior design course. This objective is also addressed through active faculty participation in counseling students about potential career paths and graduate education. Students become familiar with the fast pace of technology and the need to keep their knowledge and training current through various class assignments, their work on the senior design project, potential industrial and government internships, and working with EE faculty as undergraduate research assistants. Increasing the diversity of the US technical workforce is addressed through training students who upon graduation are well prepared for entry level engineering positions in industry and government, as well as pursuit of advanced graduate studies in electrical engineering and other technical fields.

The BSEE Program Student Outcomes are listed in Criterion 3-A. The attainments of all of the outcomes are addressed by the BSEE curriculum in its entirety. The curriculum is comprised of four major components including: mathematics and basic science; required and elective humanities and economics courses including six semester credit hours of writing-intensive English composition, six semester credit hours of world history, and nine semester credit hours of literature, music and fine arts; required EE core courses and laboratories including the capstone senior design sequence; EE Concentration courses, and the elective EE and CS courses.

Each Student Outcome is supported by one or more components of the EE curriculum. Each constituent of the curriculum, to varying degrees, addresses one or multiple Student Outcomes (SOs).

- SO(a), *"An ability to apply knowledge of mathematics, science, and engineering,"* is supported through mathematics and basic science requirements as well as various required courses and laboratories in the EE curriculum.

- SO(b), *"An ability to design and conduct experiments, as well as to analyze and interpret data,"* is attained primarily through various required laboratory experiences and the senior design project.
- SO(c) – SO(g), *"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; An ability to function on multi-disciplinary teams; An ability to identify, formulate, and solve engineering problems; An understanding of professional and ethical responsibility; An ability to communicate effectively,"* are all addressed through the senior design project.
- SO(c) and SO(e), are also addressed through some design-intensive required courses such as EE 204, EE 330 and EE 403. The required economics and elective humanities courses also contribute to attainment of student outcome c.
- SO(f), in addition to EE courses, is also addressed through humanities requirements, and student organization activities.
- SO(g) is addressed through writing-intensive composition courses, EE 101, other select EE courses as well as the senior design sequence.
- SO(h) – SO(j), *"The broad education necessary to understand the impact of engineering solutions in a global and societal context; A recognition of the need for, and an ability to engage in life-long learning; A knowledge of contemporary issues,"* are partially addressed through humanities courses, student organization activities, and faculty advisement.
- SO(k), *"An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice,"* is addressed by required laboratory and simulation experiences throughout the curriculum in addition to the senior design sequence.

The following flowcharts depicted in Figure 12, Figure 13, Figure 14, and Figure 15 illustrate the prerequisite structures of the Program's required courses for the BSEE concentrations General, Computer Engineering, Microelectronics-VLSI, and Nuclear Power. Course acronyms and corresponding course names for each BSEE degree concentration are defined in Tables 10 through 13.

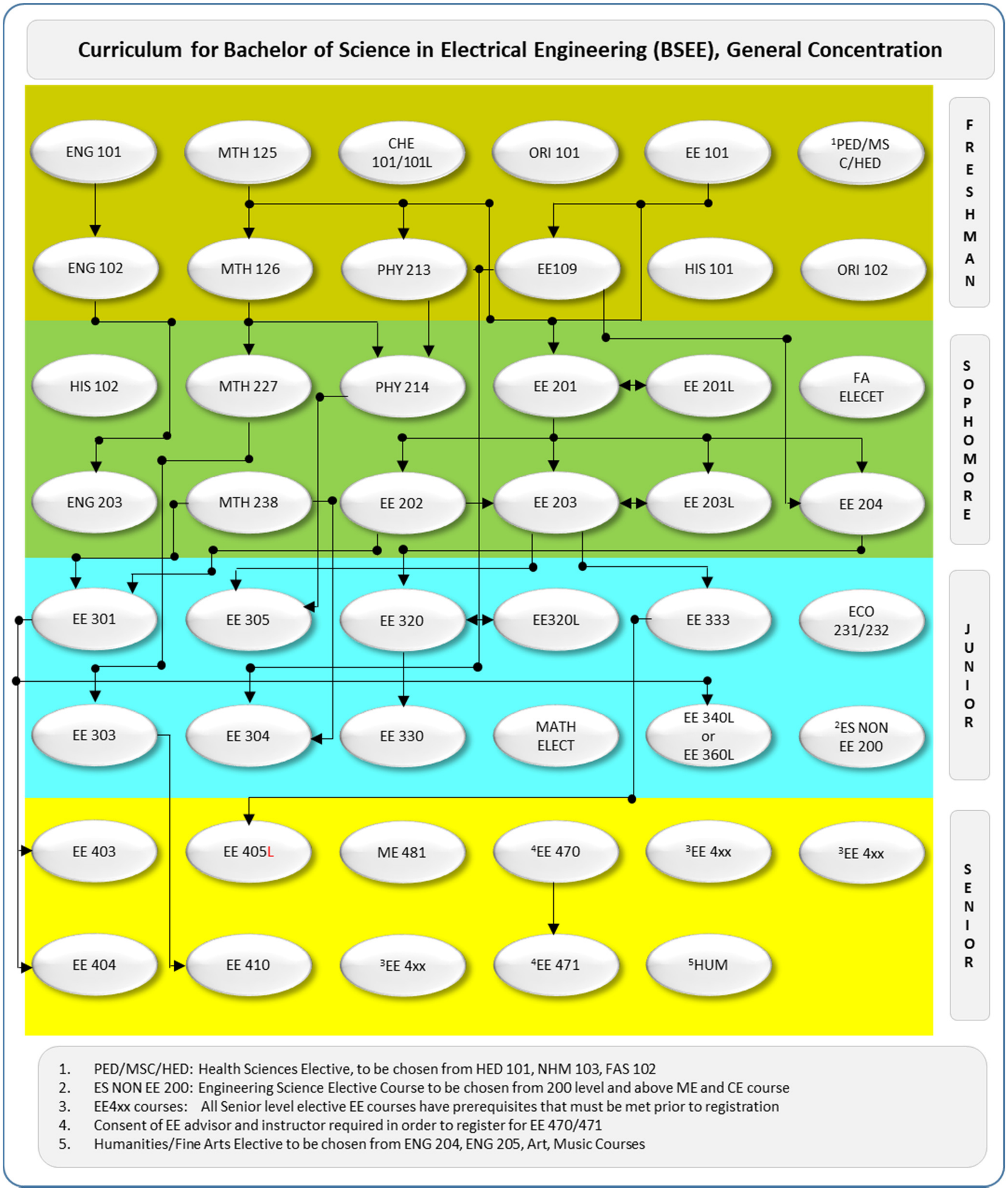

Figure 12. BSEE—General Concentration—Course Flow Diagram

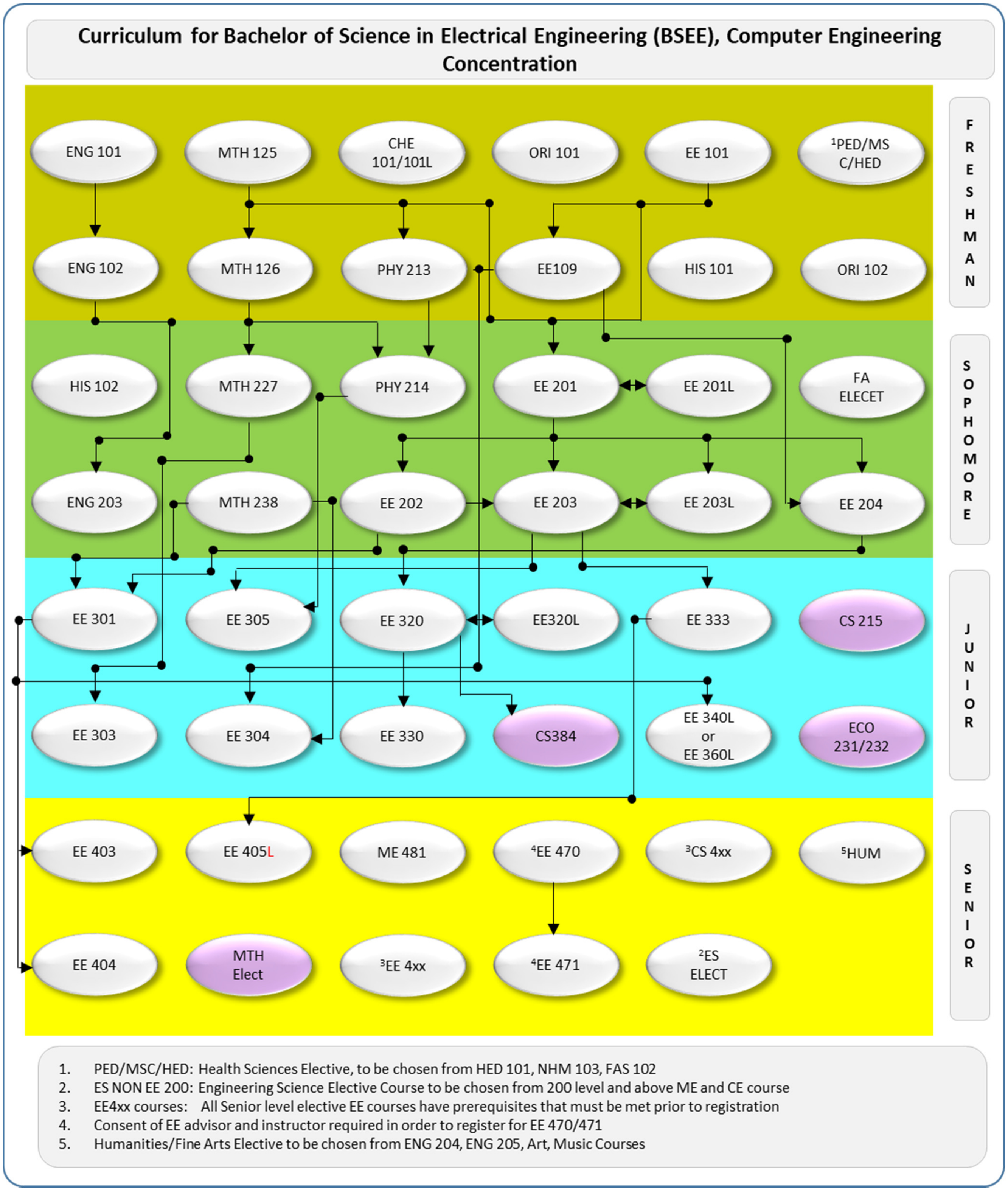

Figure 13. BSEE—Computer Engineering Concentration —Course Flow Diagram

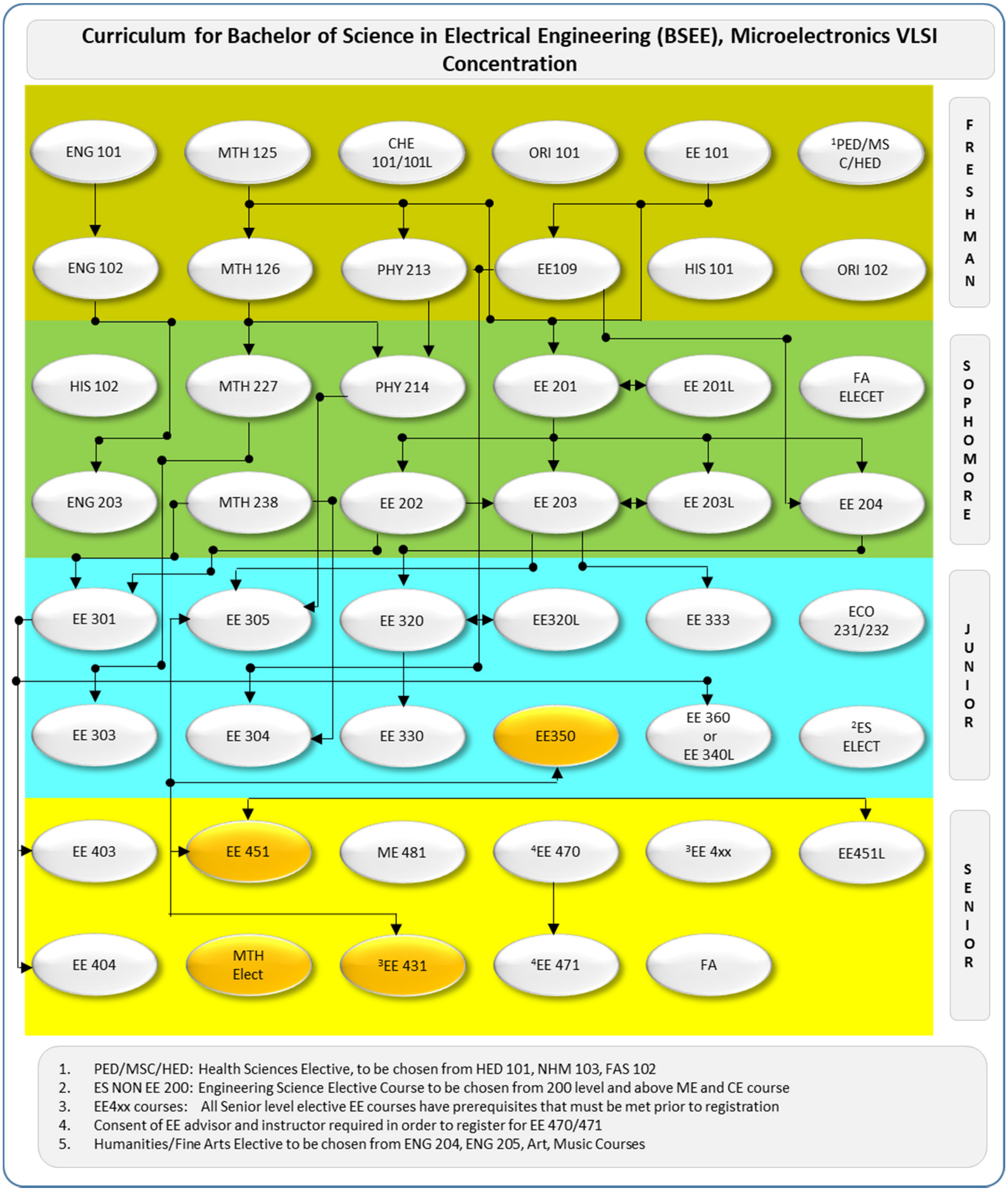

Figure 14. BSEE—Microelectronics VLSI Concentration—Course Flow Diagram

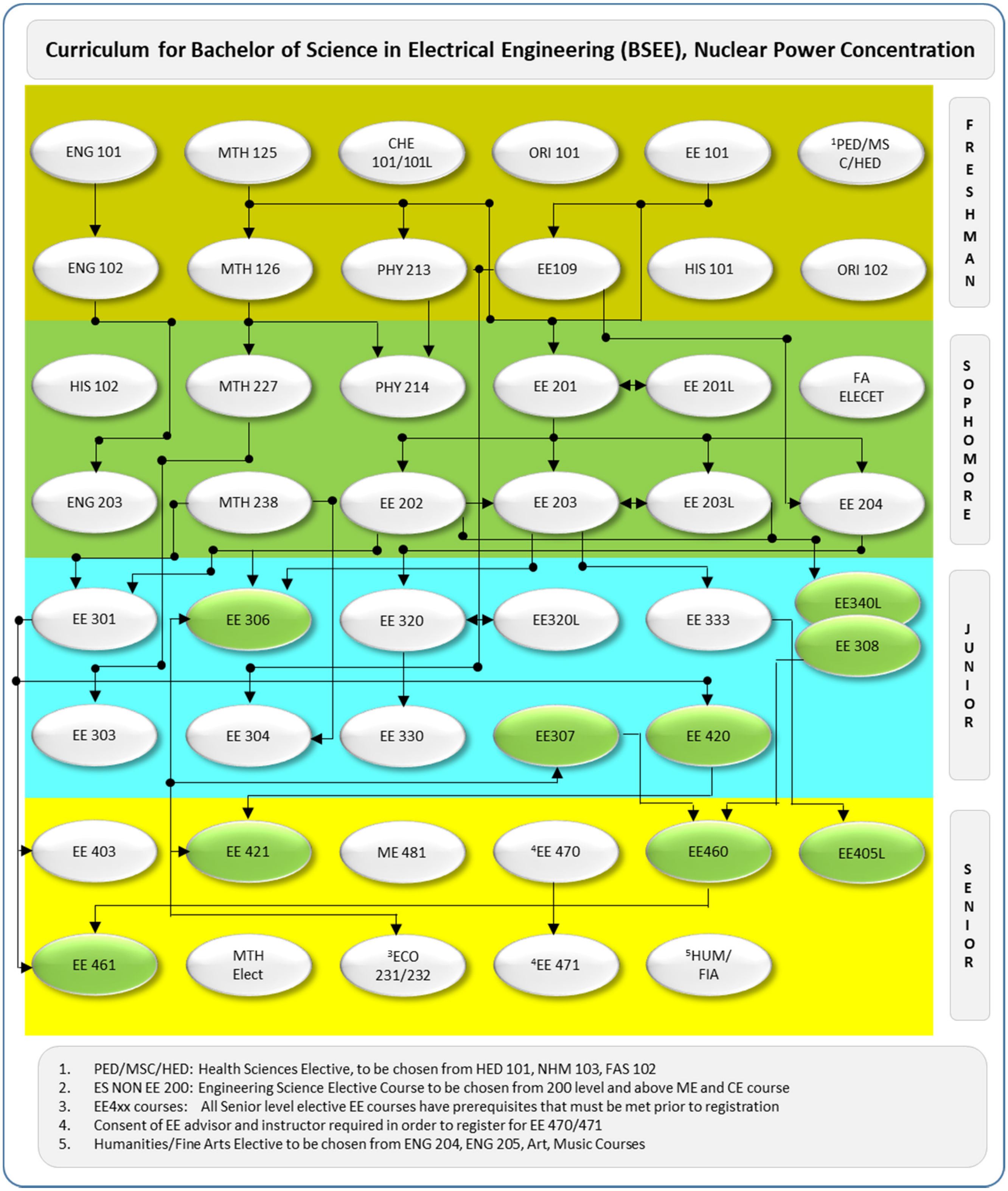

Figure 15. BSEE—Nuclear Power—Course Flow Diagram

The required mathematics and basic sciences component of the BSEE curriculum comprises fifteen semester credit hours of mathematics including calculus (12 CH) and differential equations (3 CH), and twelve credit hours of laboratory science including calculus based physics (8 CH) and chemistry (4 CH). In addition, the curriculum requires every student to choose a three credit hour course from a list of approved mathematics courses including topics such as linear algebra, partial differential equations, complex analysis, probability and statistics. Mathematical topics such as linear algebra and matrices are introduced formally in EE 101, Introduction to Electrical Engineering, and are treated at more advanced levels in EE 304, Numerical Methods and Digital Computation. The BSEE degree program, therefore, meets the mathematics and basic sciences minimum semester credit hours requirement of 32. Coverage of complex variables is accomplished through required courses such as EE 202, Linear Circuit Analysis II, and EE 301, Signals and Systems. Discrete mathematics is covered in EE 204, Digital Circuit Design and Analysis. All students in the BSEE program are also required to take the three credit hour course ME 481, Quality and Reliability Assurance, which contains formal treatments of probability and statistics including engineering applications of these concepts. Students in the BSEE degree program are further exposed to advanced mathematical concepts including differential equations, linear algebra, complex variables and discrete mathematics through the required EE courses.

All students in the BSEE degree program are required to take at least fifty-five credit hours of engineering topics. The curricula of three BSEE Concentrations of General, Computer Engineering, and Microelectronics-VLSI include three credit hours of non-EE engineering course to provide graduates with engineering breadth. Students in these concentrations are free to choose any 200-level and above Mechanical and Civil Engineering course to satisfy this requirement. The Nuclear Power Concentration curriculum includes required courses EE 306, Survey of Energy Systems, EE 307, Fundamentals of Nuclear Engineering, and EE 308, Thermal Systems Engineering, which provide engineering breadth to graduates. This is in addition to the required three credit hours course ME 481, Quality and Reliability Assurance, which contains formal treatments and engineering applications of probability and statistics, required by all four concentrations. The curriculum requirements contain twenty-four credit hours of general education courses including six credit hours of history, nine credit hours of English including six credit hours of writing-intensive English composition, three credit hours of economics, and six credit hours of humanities and fine arts.

Students in the BSEE degree program are introduced to the process of engineering design throughout the curriculum. Several required BSEE courses, in addition to engineering science, analysis methods, simulation, measurement and experimental content, contain, to various degrees, elements of engineering design. All BSEE degree candidates must complete four credit hours of capstone engineering design, comprised of a sequence of two Senior Design courses, EE 470, Engineering Analysis and Design I, and EE 471, Engineering Analysis and Design II.

In the senior design sequence, teams of students, normally comprised of 2 - 4 members each, select a project in the fall semester of their final year, and under supervision of a faculty mentor, work on the project for two consecutive semesters. Design project proposal ideas are generated by faculty, government, industry, or students, and after EE faculty approval, are presented to students in the first senior design class, EE 470, Engineering Analysis and Design I, in the fall semester. Students are given the opportunity to select a project and their team members, and commence working on the project once they obtain the consent of an EE faculty to act as their mentor. Senior design teams, whose projects are proposed externally, may have an external project advisor in addition to the EE faculty mentor.

In order to successfully complete their senior design projects, students must utilize knowledge and skills acquired in basic and intermediate courses including research, problem definition, project budget, problem formulation, engineering problem solving, analysis, simulation, coding, design iterations, fabrication, test and measurement, engineering standards, communication and presentation proficiency. Students learn to collaborate by working in teams, divide responsibilities, scheduling, and project management. Some projects may involve regulatory and economic issues.

In addition to a final report, student teams are required to give six formal presentations to an audience comprised of the senior design class, the entire EE faculty, and observers from within and outside the university. Senior design teams must also participate in the EE Poster Presentation, and the University STEM Day Conference, at the end of school year, where university faculty, students, EE Advisory Board, and observers from industry and government review the design projects and interact with design teams. The senior design experience helps to prepare graduates for engineering practice, by further sharpening their technical, presentation, teamwork, and project management skills.

The BSEE degree program, in general, does not allow cooperative education to satisfy curricular requirements. However, under special circumstances up to three (3) EE credit hours are awarded for preapproved internship or Co-Op work. In order to receive academic credit for such work, the student must write a proposal detailing the proposed activity and the expected results, and obtain approval of an EE faculty member, who will agree to co-supervise the work. The proposal must also be approved by the Department Chairperson and the supervisor at the company where the proposed work will be done. Following completion of the work period, the student must submit a formal technical report to the faculty mentor. In order to receive academic credit, the technical report must be approved and graded by the faculty mentor and approved by the department Chairperson. Following the approval process, the student will earn three credit hours, which will replace one of the EE 4xx electives of the BSEE curriculum.

Course folders containing course syllabi, textbooks, handouts, sample student work including homework, tests, projects, papers, etc. will be available for all EE courses and laboratories offered during the year covered by the self-study report. Course folders will also include Student Outcomes assessment results.

Table 10. Curriculum for Bachelor of Science in Electrical Engineering (BSEE), General Concentration

Course (Department, Number, Title) List all courses in the program by term starting with first term of first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE.[1]	*Subject Area (Credit Hours)*				Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered[2]
		Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (√)	General Education	Other (computing)		
Freshman Year (First Semester)							
ENG 101 Composition I	R			3		*18 S, 17 F*	*27*
MTH 125 Calculus I	R	4				*18S, 17 F*	*36*
CHE 101/101L Gen. Chemistry/ Gen. Chemistry Lab	R	4				*18S, 17F*	*53,28*
ORI 101 Orientation	R			1		*18S, 17F*	*87*
EE 101 Introduction to Elec. Eng.	R	1	1	1		*18S, 17F*	*24*
PED/MSC/HED Elective	SE			2		*18S, 17F*	*49*
Freshman Year (Second Semester)							
ENG 102 Composition II	R			3		*18S, 17F*	*26*
MTH 126 Calculus II	R	4				*18S, 17F*	*33*
PHY 213 General Physics with Calculus I	R	4				*18S, 17F*	*38, 38*
EE 109 Engineering Computing	R				*3*	*18S, 17F*	*25*
HIS 101 World History I	R			3		*18S, 17F*	*96*

ORI 102 Orientation	R			1		*18S, 17F*	*46*
Sophomore Year (First Semester)							
HIS 102 World History II	R			3		*18S, 17F*	*98*
MTH 227 Calculus III	R	4				*18S, 17F*	*30*
PHY 214 General Physics with Calculus II	R	4				*18S, 17F*	*32,32*
EE 201 Linear Circuit Analysis I	R		3			*18S, 17F*	*38*
EE 201L Linear Circuit Analysis I Lab	R		1			*18S, 17F*	*12*
Fine Arts Elective	SE			3		*18S, 17F*	*36*
Sophomore Year (Second Semester)							
ENG 203 World Literature I	R			3		*18S, 17F*	*37*
MTH 238 Appl. Diff. Eqns.	R	3				*18S, 17F*	*28*
EE 202 Linear Circuit Analysis II	R		3			*18S, 17F*	*22*
EE 203 Analog Circuit Design/Analysis I	R		3			*18S, 17F*	*17*
EE 203L Analog Circuit Design/Analysis I Lab	R		1			*18S, 17F*	*16*
EE 204 Digital Circuit Design/Analysis	R		3 (v)			*18S, 17F*	*25*
Junior Year (First Semester)							
EE 301 Signals & Systems I	R		3			*17F, 16F*	*37*
EE 305 Semiconductor Engineering I	R		3			*17F, 16F*	*26*
EE 320 Computer Architecture	R		3			*17F, 16F*	*37*

EE 320L Digital Systems Lab	R		1			*17F, 16F*	*21*
EE 333 Analog Circuit Design/Analysis II	R		3			*17F, 16F*	*31*
Economics (ECO 231 or ECO 232)	SE			3		*18S, 17F*	*34*
Junior Year (Second Semester)							
EE 303 Electromagnetic Field Theory	R		3			*18S, 17S*	*34*
EE 304 Num. Methods/Digital Comp.	R	1			*2*	*18S, 17S*	*35*
EE 330 Microprocessors	R		3 (v)			*18S, 17S*	*33*
Math Elective (MTH 237, PHY 303, MTH 303, MTH 452, MTH 453)	SE	3				*18S, 17F*	*31*
EE 340L Energy Conversion Lab or EE 360L Comm. Lab	SE		1			*18S, 17F*	*23*
Engineering Science Elective (non-EE 200 or above engineering course)	SE		3			*18S, 17F*	*31*
Senior Year (First Semester)							
EE 403 Feedback Sys Analysis/Design	R		3 (v)			*17F, 16F*	*30*
EE 405L Simulation Techniques Lab	R		1			*17F, 16F*	*29*
ME 481 Qual/Reliability Assurance	R		3			*17F, 16F*	*32*
EE 470 Engineering Analysis & Design I	R		2 (v)			*17F, 16F*	*33*
EE 4xx Elective (or EE 350)	SE		3			*18S, 17F*	*5,6,10,13,18*
EE 4xx Elective	SE		3			*18S, 17F*	*5,6,10,13,18*
Senior Year (Second Semester)							

EE 404 Communication Theory	R		3			*18S, 17S*	*26*
EE 410 Microwave Engineering	R		3			*18S, 17S*	*10*
EE 4xx Elective	SE		3			*18S, 17F*	*5,6,10,13,18*
EE 471 Engineering Analysis & Design II	R		2 (v)			*18S, 17S*	*29*
Humanities/Fine Arts Elective (ENG 204, ENG 205, ART, Music courses)	SE			3		*18S, 17F*	*40*
Add rows as needed to show all courses in the curriculum.							
TOTALS-ABET BASIC-LEVEL REQUIREMENTS		32	64	34			
OVERALL TOTAL CREDIT HOURS FOR COMPLETION OF THE PROGRAM							
PERCENT OF TOTAL		25%	49%	26%			
Total must satisfy either credit hours or percentage	Minimum Semester Credit Hours	32 Hours	48 Hours				
	Minimum Percentage	25%	37.5 %				

1. **Required** courses are required of all students in the program, **elective** courses (often referred to as open or free electives) are optional for students, and **selected elective** courses are those for which students must take one or more courses from a specified group.
2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the maximum enrollment in each element. For selected elective courses, indicate the maximum enrollment for each option.

Table 11. Curriculum for Bachelor of Science in Electrical Engineering (BSEE), Computer Engineering Concentration

Course (Department, Number, Title) List all courses in the program by term starting with first term of first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE.[1]	*Subject Area (Credit Hours)*				Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered[2]
		Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (√)	General Education	Other (Computing)		
Freshman Year (First Semester)							
ENG 101 Composition I	R			3		*18 S, 17 F*	*27*
MTH 125 Calculus I	R	4				*18 S, 17 F*	*36*
CHE 101/101L Gen. Chemistry/ Gen. Chemistry Lab	R	4				*18S, 17F*	*53,28*
ORI 101 Orientation	R			1		*18S, 17F*	*87*
EE 101 Introduction to Elec. Eng.	R	1	1	1		*18S, 17F*	*24*
PED/MSC/HED Elective	SE			2		*18S, 17F*	*49*
Freshman Year (Second Semester)							
ENG 102 Composition II	R			3		*18S, 17F*	*26*
MTH 126 Calculus II	R	4				*18S, 17F*	*33*
PHY 213 General Physics with Calculus I	R	4				*18S, 17F*	*38, 38*
EE 109 Engineering Computing	R				3	*18S, 17F*	*25*
HIS 101 World History I	R			3		*18S, 17F*	*96*

ORI 102 Orientation	R			1		*18S, 17F*	*46*
Sophomore Year (First Semester)							
HIS 102 World History II	R			3		*18S, 17F*	*98*
MTH 227 Calculus III	R	4				*18S, 17F*	*30*
PHY 214 General Physics with Calculus II	R	4				*18S, 17F*	*32,32*
EE 201 Linear Circuit Analysis I	R		*3*			*18S, 17F*	*46*
EE 201L Linear Circuit Analysis I Lab	R		*1*			*18S, 17F*	*12*
Fine Arts Elective	SE			3		*18S, 17F*	*36*
Sophomore Year (Second Semester)							
ENG 203 World Literature I	R			3		*18S, 17F*	*37*
MTH 238 Appl. Diff. Eqns.	R	3				*18S, 17F*	*38*
EE 202 Linear Circuit Analysis II	R		3			*18S, 17F*	*22*
EE 203 Analog Circuit Design/Analysis I	R		3			*18S, 17F*	*17*
EE 203L Analog Circuit Design and Analysis I Lab.	R		1			*18S, 17F*	*16*
EE 204 Digital Circuit Design/Analysis	R		3 (v)			*18S, 17F*	*25*
Junior Year (First Semester)							
EE 301 Signals & Systems I	R		3			*17F, 16F*	*37*
EE 305 Semiconductor Engineering I	R		3			*17F, 16F*	*26*
EE 320 Computer Architecture	R		3			*17F, 16F*	*37*

EE 320L Digital Systems Lab	R		1			*17F, 16F*	*21*
EE 333 Analog Circuit Design/Analysis II	R		3			*17F, 16F*	*31*
CS 215 Data Structures	R				3	*18S, 17F*	*31*
Junior Year (Second Semester)							
EE 303 Electromagnetic Field Theory	R		3			*18S, 17S*	*34*
EE 304 Num. Methods/Digital Comp.	R	1			2	*18S, 17S*	*35*
EE 330 Microprocessors	R		3 (v)			*18S, 17S*	*33*
EE 360L Comm. Lab or EE 340L Energy Conversion Lab	SE		1			*18S, 17F*	*23*
CS 384 Operating Systems	R				3	*18S, 17F*	*33*
Economics (ECO 231 or ECO 232)	SE			3		*18S, 17F*	*34*
Senior Year (First Semester)							
EE 403 Feedback Sys Analysis/Design	R		3 (v)			*17F, 16F*	*30*
EE 470 Engineering Analysis & Design I	R		2 (v)			*17F, 16F*	*33*
EE 405L Simulation Techniques Lab	R		1			*17F, 16F*	*32*
CS 4xx Elective	SE				3	*18S, 17F*	*36*
ME 481 Qual/Reliability Assurance	R		3			*17F, 16F*	*31*
Humanities/Fine Arts Elective (ENG 204, ENG 205, ART, Music courses)	SE			3		*18S, 17F*	*40*
Senior Year (Second Semester)							
EE 404 Communication Theory	R		3			*18S, 17S*	*26*

EE 471 Engineering Analysis & Design II	R		2 (v)			*18S, 17S*	*29*
EE 4xx Elective or EE 350	SE		3			*18S, 17F*	*18*
Math Elective (MTH 237, PHY 303, MTH 303, MTH 452, MTH 453)	SE	3				*18S, 17F*	*31*
Engineering Science Elective (non-EE 200 or above engineering course)	SE		3			*18S, 17F*	*31*
Add rows as needed to show all courses in the curriculum.							
TOTALS-ABET BASIC-LEVEL REQUIREMENTS		32	*55*	*43*			
OVERALL TOTAL CREDIT HOURS FOR COMPLETION OF THE PROGRAM							
PERCENT OF TOTAL		25%	*42%*	*33%*			
Total must satisfy either credit hours or percentage	Minimum Semester Credit Hours	32 Hours	48 Hours				
	Minimum Percentage	25%	37.5 %				

1. **Required** courses are required of all students in the program, **elective** courses (often referred to as open or free electives) are optional for students, and **selected elective** courses are those for which students must take one or more courses from a specified group.
2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the maximum enrollment in each element. For selected elective courses, indicate the maximum enrollment for each option.

Table 12. Curriculum for Bachelor of Science in Electrical Engineering (BSEE), Microelectronics -VLSI Concentration

Course (Department, Number, Title) List all courses in the program by term starting with first term of first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE.[1]	*Subject Area (Credit Hours)*				Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered[2]
		Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (√)	General Education	Other (Computing)		
Freshman Year (First Semester)							
ENG 101 Composition I	R			3		*18 S, 17 F*	*27*
MTH 125 Calculus I	R	4				*18 S, 17 F*	*36*
CHE 101/101L Gen. Chemistry/Gen. Chemistry Lab	R	4				*18S, 17F*	*53,28*
ORI 101 Orientation	R			1		*18S, 17F*	*87*
EE 101 Introduction to Elec. Eng.	R	1	1	1		*18S, 17F*	*24*
PED/MSC/HED Elective	SE			2		*18S, 17F*	*49*
Freshman Year (Second Semester)							
ENG 102 Composition II	R			3		*18S, 17F*	*26*
MTH 126 Calculus II	R	4				*18S, 17F*	*33*
PHY 213 General Physics with Calculus I	R	4				*18S, 17F*	*38, 38*
EE 109 Engineering Computing	R				3	*18S, 17F*	*25*
HIS 101 World History I	R			3		*18S, 17F*	*96*

ORI 102 Orientation	R			1		*18S, 17F*	*46*
Sophomore Year (First Semester)							
HIS 102 World History II	R			3		*18S, 17F*	*98*
MTH 227 Calculus III	R	4				*18S, 17F*	*30*
PHY 214 General Physics with Calculus II	R	4				*18S, 17F*	*32,32*
EE 201 Linear Circuit Analysis I	R		*3*			*18S, 17F*	*38*
EE 201L Linear Circuit Analysis I Lab	R		*1*			*18S, 17F*	*12*
Fine Arts Elective	SE			3		*18S, 17F*	*36*
Sophomore Year (Second Semester)							
ENG 203 World Literature I	R			3		*18S, 17F*	*37*
MTH 238 Appl. Diff. Eqns.	R	3				*18S, 17F*	*28*
EE 202 Linear Circuit Analysis II	R		3			*18S, 17F*	*22*
EE 203 Analog Circuit Design/Analysis I	R		3			*18S, 17F*	*27*
EE 203L Analog Circuit Design and Analysis I Lab.	R		1			*18S, 17F*	*16*
EE 204 Digital Circuit Design/Analysis	R		3 (v)			*18S, 17F*	*25*
Junior Year (First Semester)							
EE 301 Signals & Systems I	R		3			*17F, 16F*	*37*
EE 305 Semiconductor Engineering I	R		3			*17F, 16F*	*26*
EE 320 Computer Architecture	R		3			*17F, 16F*	*37*

EE 320L Digital Systems Lab	R		1			*17F, 16F*	*21*
EE 333 Analog Circuit Design/Analysis II	R		3			*17F, 16F*	*31*
Economics (ECO 231 or ECO 232)	SE			3		*18S, 17F*	*34*
Junior Year (Second Semester)							
EE 303 Electromagnetic Field Theory	R		3			*18S, 17S*	*34*
EE 304 Num. Methods/Digital Comp.	R	1			2	*18S, 17S*	*35*
EE 330 Microprocessors	R		3 (v)			*18S, 17S*	*33*
EE 350 VLSI Design & Testing	R		3 (v)			*18S, 17S*	*13*
EE 340L Energy Conversion Lab or EE 360L Comm. Lab	SE		1			*18S, 17F*	*23*
Engineering Science Elective (non-EE 200 or above engineering course)	SE		3			*18S, 17F*	*31*
Senior Year (First Semester)							
EE 403 Feedback Sys Analysis/Design	R		3 (v)			*17F, 16F*	*30*
EE 451 IC Fabrication	R		3			*17F, 16F*	*10*
EE 451L IC Fabrication Lab	R		1 (v)			*17F, 16F*	*7*
EE 4XX Elective	SE		3			*18S, 17F*	*18*
EE 470 Engineering Analysis & Design I	R		2 (v)			*17F, 16F*	*33*
ME 481 Qual/Reliability Assurance	R		3			*17F, 16F*	*32*
Senior Year (Second Semester)							
EE 404 Communication Theory	R		3			*18S, 17S*	*26*

EE 431 Semiconductor Engineering II	R		3			*18S, 17S*	*13*
EE 471 Engineering Analysis & Design II	R		2 (v)			*18S, 17S*	*29*
Math Elective (MTH 237, PHY 303, MTH 303, MTH 452, MTH 453)	SE	3				*18S, 17F*	*31*
Humanities/Fine Arts Elective	SE			3		*18S, 17F*	*40*
Add rows as needed to show all courses in the curriculum.							
TOTALS-ABET BASIC-LEVEL REQUIREMENTS		32	*64*	*34*			
OVERALL TOTAL CREDIT HOURS FOR COMPLETION OF THE PROGRAM							
PERCENT OF TOTAL		25%	*49%*	*26%*			
Total must satisfy either credit hours or percentage	Minimum Semester Credit Hours	32 Hours	48 Hours				
	Minimum Percentage	25%	37.5 %				

1. **Required** courses are required of all students in the program, **elective** courses (often referred to as open or free electives) are optional for students, and **selected elective** courses are those for which students must take one or more courses from a specified group.
2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the maximum enrollment in each element. For selected elective courses, indicate the maximum enrollment for each option.

Table 13. Curriculum for Bachelor of Science in Electrical Engineering (BSEE), Nuclear Power Concentration

Course (Department, Number, Title) List all courses in the program by term starting with first term of first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE.[1]	*Subject Area (Credit Hours)*				Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered[2]
		Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (√)	General Education	Other (Computing)		
Freshman Year (First Semester)							
ENG 101 Composition I	R			3		*18 S, 17 F*	*27*
MTH 125 Calculus I	R	4				*18 S, 17 F*	*36*
CHE 101/101L Gen. Chemistry/Gen. Chemistry Lab	R	4				*18S, 17F*	*53,28*
ORI 101 Orientation	R			1		*18S, 17F*	*87*
EE 101 Introduction to Elec. Eng.	R	1	1	1		*18S, 17F*	*24*
PED/MSC/HED Elective	SE			2		*18S, 17F*	*49*
Freshman Year (Second Semester)							
ENG 102 Composition II	R			3		*18S, 17F*	*26*
MTH 126 Calculus II	R	4				*18S, 17F*	*33*
PHY 213 General Physics with Calculus I	R	4				*18S, 17F*	*38, 38*
EE 109 Engineering Computing	R				3	*18S, 17F*	*25*
HIS 101 World History I	R			3		*18S, 17F*	*96*

ORI 102 Orientation	R			1		*18S, 17F*	*46*
Sophomore Year (First Semester)							
HIS 102 World History II	R			3		*18S, 17F*	*98*
MTH 227 Calculus III	R	4				*18S, 17F*	*30*
PHY 214 General Physics with Calculus II	R	4				*18S, 17F*	*32,32*
EE 201 Linear Circuit Analysis I	R		*3*			*18S, 17F*	*38*
EE 201L Linear Circuit Analysis I Lab	R		*1*			*18S, 17F*	*12*
Fine Arts Elective	SE			3		*18S, 17F*	*36*
Sophomore Year (Second Semester)							
ENG 203 World Literature I	R			3		*18S, 17F*	*37*
MTH 238 Appl. Diff. Eqns.	R	3				*18S, 17F*	*28*
EE 202 Linear Circuit Analysis II	R		3			*18S, 17F*	*22*
EE 203 Analog Circuit Design/Analysis I	R		3			*18S, 17F*	*27*
EE 203L Analog Circuit Design and Analysis I Lab.	R		1			*18S, 17F*	*16*
EE 204 Digital Circuit Design/Analysis	R		3 (v)			*18S, 17F*	*25*
Junior Year (First Semester)							
EE 301 Signals & Systems I	R		3			*17F, 16F*	*37*
EE 306 Survey of Energy Systems	R		1	2		*17F, 16F*	*16*
EE 320 Computer Architecture	R		3			*17F, 16F*	*37*

EE 320L Digital Systems Lab	R		1			*17F, 16F*	*21*
EE 333 Analog Circuit Design/Analysis II	R		3			*17F, 16F*	*31*
EE 308 Thermal Systems Engineering	R		3			*17F, 16F*	*10*
EE 340L Energy Conversion Lab	R		1			*17F, 16F*	*23*
Junior Year (Second Semester)							
EE 303 Electromagnetic Field Theory	R		3			*18S, 17S*	*34*
EE 304 Num. Methods/Digital Comp.	R	1			2	*18S, 17S*	*35*
EE 330 Microprocessors	R		3 (v)			*18S, 17S*	*33*
EE 307 Fundamentals of Nuclear Engineering	R	1	2			*18S, 17S*	*11*
EE 420 Power Systems I	R		3			*18S, 17S*	*27*
Senior Year (First Semester)							
EE 403 Feedback Sys Analysis/Design	R		3 (v)			*17F, 16F*	*30*
EE 421 Power Systems II	R		3			*17F*	*10*
EE 460 Nuclear Reactor Engineering I	R		3			*17F*	*6*
EE 470 Engineering Analysis & Design I	R		2 (v)			*17F, 16F*	*33*
EE 405L Simulation Techniques Lab	R		1			*17F, 16F*	*32*
ME 481 Qual/Reliability Assurance	R		3			*17F, 16F*	*32*
Senior Year (Second Semester)							
EE 461 Nuclear Reactor Engineering II	R		3			*18S*	*9*

EE 471 Engineering Analysis & Design II	R		2 (v)			*18S, 17S*	*29*
Math Elective (MTH 237, PHY 303, MTH 303, MTH 452, MTH 453)	SE	3				*18S, 17F*	*31*
Economics (ECO 231 or ECO 232)	SE			3		*18S, 17F*	*34*
Humanities/Fine Arts Elective	SE			3		*18S, 17F*	*40*
Add rows as needed to show all courses in the curriculum.							
TOTALS-ABET BASIC-LEVEL REQUIREMENTS		33	*61*	*36*			
OVERALL TOTAL CREDIT HOURS FOR COMPLETION OF THE PROGRAM							
PERCENT OF TOTAL		25%	*47%*	*28%*			
Total must satisfy either credit hours or percentage	Minimum Semester Credit Hours	32 Hours	48 Hours				
	Minimum Percentage	25%	37.5 %				

1. **Required** courses are required of all students in the program, **elective** courses (often referred to as open or free electives) are optional for students, and **selected elective** courses are those for which students must take one or more courses from a specified group.
2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the maximum enrollment in each element. For selected elective courses, indicate the maximum enrollment for each option.

   Instructional materials and student work verifying compliance with ABET criteria for the categories indicated above will be made available to the visiting team.

B. Course Syllabi

Appendix A includes a syllabus for each course used to satisfy the mathematics, science, and discipline-specific requirements required by Criterion 5 or any applicable program criteria

CRITERION 6. FACULTY

A. Faculty Qualifications

The Electrical Engineering Program has nine full-time faculty positions. Currently, the Program has eight full-time teaching faculty, including five tenured faculty at the ranks of professor, one tenure-track associate professor, one non-tenured faculty at the rank of professor, and one non-tenure-track faculty at assistant professor rank. At present, the search is ongoing to fill a tenure-track faculty position at the rank of assistant/associate professor with expertise in electric power systems, which became vacant as the result of Dr. Insu Kim's resignation in January 2018.

All the current eight faculty members have terminal degrees in electrical engineering or closely related fields. Most EE faculty members have had considerable academic, industrial and/or postdoctoral research experience prior to joining the Program. Five faculty members have been with the Program for more than ten years, and two have been with the program since its inception in 1998. Faculty qualifications are summarized in Table 14, and their vitas are shown in Appendix B.

All EE faculty members are engaged in significant professional development activities including writing and editing books and monographs, publishing papers in refereed journals and conference proceedings, filing patent applications for their inventions, organizing technical conferences, conducting externally funded research, serving on review committees, and industrial consulting.

The EE faculty has the qualifications and expertise to adequately cover all the curricular areas of the Program. Faculty members have expertise in the general and specialty areas of electrical engineering including materials, devices, circuits, electronics, systems, and networks. Professors Alim, Budak, and Xiao have expertise in the areas of electronic materials, devices, microelectronics, and VLSI. Professor Scott has expertise in areas of digital circuits and systems, computer architecture, software, and control. Professors Yaqub, Yang, and Heidary have expertise in areas of circuits, electronic design, signals and systems, control, power, communications, microwaves, and electromagnetic. Professors Scott and Yaqub have expertise in system integration and engineering design. Professors Alim, Budak, and Egarievwe have expertise in nuclear engineering including nuclear materials, nuclear sensors and detection, and reactor engineering. Professor Alim has expertise in high voltage protection including insulating materials and surge protection. Professor Budak has expertise in energy harvesting materials and devices. According to the current plans, the open faculty position will be filled with an expert in the power systems area. All EE faculty members are engaged in professional development activities including research and consulting work.

Faculty members are active in pursuit of externally funded research opportunities through which they have successfully developed dual-use advanced laboratories for undergraduate teaching and research. Research in the EE program is an integral part of the educational experience provided to our students. To the extent possible the EE faculty strives to intertwine their teaching and research activities by making their research accessible to our students. The EE faculty regularly engages undergraduate students in their research and development activities.

B. Faculty Workload

Normal teaching load for each EE faculty is three class or laboratory sections per semester, and mentoring one or two senior design teams. Each senior design team is comprised of 2-4 students. Faculty is expected to maintain 10-12 regular office hours per week for student advisement and assistance. EE faculty members are expected to serve on department, college, and university committees as needed. All Faculty members engage in academic advisement of EE students including Senior Record Checks and the graduation clearance process. The faculty is actively engaged in all EE-related curricular decisions including establishing, monitoring and modifying of degree requirements, course contents, course outcomes, textbooks, laboratory experience, elective offerings, new course and laboratory development, etc. The faculty, in consultation with other program constituents including the EE Advisory Board, is intimately involved in developing the program educational objectives and student outcomes. The faculty is directly involved in the development and implementation of outcomes assessment tools, outcomes measurement processes, setting of expected levels of attainment of student outcomes, and utilization of outcomes assessment results for continuous improvement of the BSEE Program.

The Faculty members advise student organizations such as IEEE, NSBE, and provide students with career and graduate school related advice and guidance. The EE faculty members serve on various departmental, college and university committees, including Faculty Search, Academic Standards, Tenure and Promotion, and Faculty Senate. The faculty is expected to engage in career development activities and keep their professional expertise current.

A summary of the faculty workload is shown in Table 15.

C. Faculty Size

The size and technical expertise of the EE Faculty is adequate for the Program at its current stage of development. Student-to-faculty ratio in the EE Program is roughly 25:1. Each EE Faculty, in addition to Senior Design mentorship, teaches three sections each semester. Every faculty is engaged in student advisement, university, college, and department service through various committee memberships, course and laboratory development and improvement, and faculty professional development activities. Every EE Faculty maintains at least 10-12 hours per week for regular office hours dedicated to interaction with our students and providing academic counseling, advice and guidance. EE Faculty members are engaged in externally sponsored cutting-edge research and strive to integrate their research with teaching. They make their research accessible to our students and to the extent possible get undergraduate students directly involved in their research projects. The EE Faculty engages regularly in technical and scholarly interactions with professional practitioners in industry and government. Often, these interactions involve organizations that employ our students and graduates. The EE Faculty, through technical collaborations with industrial and government employers of the Program students and alumni, actively solicit feedback regarding the performance of our students and alumni in the workplace.

D. Professional Development

The EE program has limited travel budget that provides funds for each faculty to attend one conference or workshop annually. However, through professional dedication and hard work of the faculty and the generosity of our industrial and government sponsors, the EE Program Faculty have access to state-of-art laboratory facilities and advanced computational resources. These resources have allowed the EE Faculty to engage in externally sponsored cutting-edge research and development activities, which provide the Program with multiple benefits. The faculty research efforts, in addition to providing opportunities for faculty to advance state of knowledge and keep their technical expertise current, also provide the EE Program laboratories with state-of-art instruments, faculty members with additional funds for travel and other professional development activities, and our students with the opportunity for involvement in advanced research and summer and part-time employment in our laboratories. In recent years, EE Faculty and students have engaged in research collaborations with Government laboratories such as NASA Marshall Space Flight Center, Goddard Space Flight Center, Brookhaven National Laboratory, Nuclear Regulatory Commission, US Army Aberdeen Proving Grounds, Oakridge National Laboratory, US Army Aviation and Missile Research, Development and Engineering Center (AMRDEC), US Army Research Office, Department of Homeland Security, US Air Force Office of Scientific Research, Missile Defense Agency, etc. by participating in summer faculty exchange and student internship programs.

Every academic year all the EE faculty members attend two mandatory daylong AAMU Faculty Staff Conferences in August and January. These conferences often include faculty development workshops on effective teaching, quality enhancement process, and improving student advisement and retention. Also, the AAMU Center for Excellence in Teaching and Learning (CETL) conducts regularly scheduled workshops, seminars, and webinars for university faculty on effective strategies for teaching and advising. Other workshops such as effective utilization of technology for improving attainment of student outcomes are conducted by CETL regularly. New as well as experienced EE faculty regularly participate in CETL workshops and training sessions in order to sharpen their teaching, presentation, and student advisement skills.

In recent years, in addition to the AAMU on-campus workshops, the EE faculty has participated in many other professional development activities, some of which are listed here. Dr. M. Alim: attended NASA Battery workshop and seminar (2013); attended Zinc Oxide manufacturing workshop (2013). Dr. S. Yang: attended AlaSim2014, Alasim2015, Alasim2016, Alasim2017, SoutheastCon2014, SoutheastCon2015, and SoutheastCon2016, HBCU-ECP workshops in 2016 and 2017. Dr. Xiao: participated in NSF panels including the ECCS MRI Panel (June, 2014); the Panel on Sensors, MEMS and Superconductor devices (April, 2015), and the Panel on Energy (April, 2018); attend the DoD HBCU/MI workshop in Arlington, VA (October 25 - 26, 2016); attend the Outreach and Education Meeting at Southern University of New Orleans, New Orleans, LA (September 14-15, 2016); attend the DOE HBCU/MI workshop at Florida A&M University, Tallahassee, FL (September 21-22, 2017); Attend the Joint Faculty Workshop for the DOE research project at Southern University of New Orleans, New Orleans (April 19-20, 2017). Dr. S. Budak: attended the American Vacuum Society AVS-64th International Symposium & Exhibition in Tampa, FL (November 2017); NSF-RISE workshop on nanoscience in Huntsville, AL (June 2017); Joint

Faculty Technical Workshop in New Orleans, LA (April 2017); Quality Education for Minorities (QEM) Network, Proposal Development Workshop on Research Mentoring of Early Career STEM Faculty at Historically Black Colleges and Universities (HBCUs), Baltimore, MD (February 2016); 18th International Conference on Surface Modification of Materials by Ion Beams in Turkey (September 2013).

E. Authority and Responsibility of Faculty

The EE Faculty takes genuine ownership of the Program and is directly involved in all decisions affecting the Program. Decisions affecting the curricular requirements of the EE Program, such as addition and deletion of courses as well as modification of course content are initiated by the Faculty, and must be approved by the Program and College curricular committees and then forwarded to the University Academic Standards Committee for approval. The program educational objectives and student outcomes were developed by the EE Faculty in consultation with Program constituents including the EE Advisory Board, the College Dean and University Administration. The provost and university administration including the college dean develop the mission of the university, and the mission of the college. The EE Program faculty is responsible for developing the educational objectives and student outcomes of the EE Program, consistent with those of the university and the college. Potential modifications to the program educational objectives and student outcomes are initiated at the Program level by the Faculty in consultation with Advisory Board, and other Program constituents including the college dean, and university administration. The student outcomes assessment tools including the graduating senior and alumni survey forms were developed by the faculty in consultation with the dean and the Advisory Board. The development of methodologies and various tools for assessment of student outcomes and the evaluation of assessment results are the responsibility of EE faculty. The EE faculty in consultation with university administration including college dean establishes the desired levels of attainment of student outcomes and periodically determines the level of attainment of various outcomes and reports the outcomes assessment evaluation results to the university administration. The EE faculty has primary responsible for the continuous improvement of the EE Program.

Table 14. Faculty Qualifications – Electrical Engineering

Faculty Name	Highest Degree Earned- Field and Year	Rank [1]	Type of Academic Appointment[2] T, TT, NTT	FT or PT[3]	Years of Experience			Professional Registration/ Certification	Level of Activity[4] H, M, or L		
					Govt./Ind. Practice	Teaching	This Institution		Professional Organizations	Professional Development	Consulting/summer work in industry
Alim, Mohammad	Ph.D., Electrical Engineering, 1986	P	T	FT	12	20	20	None	M	M	L
Budak, Satilmis	PhD, Physics, 2003	P	T	FT	3	11	11	None	M	M	L
Egarievwe, Stephen	PhD, Physics, 1998	P	NTT	FT	3	15	9	None	M	M	L
Heidary, Kaveh	PhD., Electrical Engineering, 1993	P	T	FT	5	22	20	None	M	M	M
Scott, Andrew	PhD, Engineering and Computer Science, 1998	P	T	FT	8	16	16	None	M	M	H
Xiao, Zhigang	PhD, Electrical Engineering, 2004	P	T	FT	0	18	13	None	M	M	M
Yaqub, Raziq	PhD, Electrical Engineering, 1998	ASC	TT	FT	10	4	2	None	M	M	H
Yang, Shujun	PhD, Electrical Engineering, 2006	AST	NTT	FT	4	8	8	None	L	M	L

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

1. Code: P = Professor ASC = Associate Professor AST = Assistant Professor I = Instructor A = Adjunct O = Other
2. Code: T = Tenured TT = Tenure Track NTT = Non Tenure Track
3. Code: FT = Full-time PT = Part-time Appointment at the institution.
4. The level of activity (high, medium or low) should reflect an average over the year prior to the visit plus the two previous years.

Table 15. Faculty Workload Summary – Electrical Engineering

Faculty Member (name)	PT or FT[1]	Classes Taught (Course No./Credit Hrs.) Term and Year[2]	Program Activity Distribution[3]			% of Time Devoted to the Program[5]
			Teaching	Research or Scholarship	Other[4]	
Alim, Mohammad	FT FT	S2018: EE 307/3, EE 431/3, EE 471/2 F2017: EE 305/3, EE 308/3, EE 470/2	75 75	25 25		100 100
Budak, Satilmis	FT FT	S2018: EE 202/3, EE 203L/1, EE 203L/1 F2017: EE 101/3, EE 201/3, EE 202/3	75 75	25 25		100 100
Egarievwe, Stephen	FT FT	S2018: EE 109/3, EE 461/3 F2017: EE 109/3, EE 306/3, EE 460/3	75 75	25 25		100 100
Heidary, Kaveh	FT	S2018: EE 201/3, EE 201/3 F2017: EE 201/3	50 50	25 25	25 25	100 100
Kim, Insu	--- FT	S 2018: None F 2017: EE 203/3, EE 333/3, EE 340L/1	0 75	0 25		0 100
Scott, Andrew	FT FT	S2018: EE 204/3, EE 304/3, EE 330/3 F2017: EE 204/3, EE 320/3, EE 320L/1	75 75	25 25		100 100
Xiao, Zhigang	FT FT	S2018: EE 201L/1, EE 350/3, EE 360L/1 F2017: EE 405L/1, EE 451/3, EE 451L/1	75 75	25 25		100 100
Yaqub, Raziq	FT FT	S2018: EE 404/3, EE 420/3 F2017: EE 201L/1, EE 203L/1, EE 421/3	75 75	25 25		100 100
Yang, Shujun	FT FT	S2018: EE 201L/1, EE 303/3, EE 410/3 F2017: EE 201L/1, EE 301/3, EE 403/3	75 75	25 25		100 100
Massey, Stoney	PT PT	S2018: 101/3, EE 203/3 F2017: EE 101/3	- -	- -	- -	- -
Bording, Phil	PT PT	S 2018: EE 490/3 F 2017: EE 425/3	- -	- -	- -	- -

FT = Full Time Faculty or PT = Part Time Faculty, at the institution

For the academic year for which the self-study is being prepared.

Program activity distribution should be in percent of effort in the program and should total 100%.

Indicate sabbatical leave, etc., under "Other."

Out of the total time employed at the institution.

CRITERION 7. FACILITIES

A. Offices, Classrooms and Laboratories

A. 1 Offices

The administrative, faculty, and clerical offices of the Electrical Engineering Program are housed in Arthur J. Bond Engineering and Technology Building (ETB). Administrative and faculty offices, including EECS Chairperson, EECS secretary, and EE faculty offices are clustered in the same wing on the same floor and are easily accessible to students. Each faculty office with 140 sq. ft. of floor space provides a comfortable setting for the faculty to work and meet with students. Each office is equipped with phone, computer, printer, scanner, filing space, bookcase, high speed internet, wireless connectivity, etc. In addition to individual faculty office space, the EE program has additional rooms providing copy and printing facilities and storage for student records and office supplies. For meetings, the EE faculty has access to two conference rooms on the same floor of ETB as EE faculty offices. For seminars and large meetings the EE program has access to the general use ETB auditorium, equipped with audio-visual facilities and seating capacity of over 200, located on the same floor as faculty offices. In addition to the above faculty and administrative offices, the EE program has three offices that are generally utilized by research, visiting, and adjunct faculty and graduate students.

A. 2 Classrooms

All the EE classes including EE laboratory courses are taught in the Arthur J. Bond Engineering and Technology Building with easy access to other AAMU campus buildings including the University Learning Resources Center, which houses the main library. In addition to the wall mounted writing boards in all EE classes and laboratories, some rooms are equipped with ceiling mount computer projectors and screens. There is an open computer laboratory, with extended operation hours, located on the first floor of ETB with easy access for EE students. There are open computer labs, with extended operation hours, in several other buildings on campus which are accessible to all students. In addition to the common computer labs in ETB and elsewhere on campus, students in the EE program have access to a computer laboratory, located in ETB Room 271, which contains 30 workstations and two printers. The EE computer laboratory is generally open to students from 7:00 AM to 8:00 PM. The EE program has a second computer lab in ETB Room 272, which holds 30 workstations and two printers, and is generally open to students when not in use by an EE class.

A. 3 Laboratories

There are eleven laboratories supporting delivery of the BSEE curriculum. These laboratories occupy an area of 10,000 sq. ft. of floor space in ETB. The Clean Room/Fabrication Process Laboratory is located on the first floor of the ETB and the other ten laboratories are all located on the second floor in close proximity to EE faculty offices and classrooms. The second floor laboratories include: circuits and electronics laboratory, digital systems and microprocessor laboratory, communications laboratory, energy conversion laboratory, simulations laboratory, reconfigurable computation laboratory, electronic characterization laboratory, nuclear laboratory, senior design laboratory, and EE open computer laboratory. Brief descriptions of EE laboratories are given below.

Circuits and Electronics Laboratory (Room 263)

This lower division laboratory is dedicated to teaching basic electrical circuits, and electronics. The primary utilization of this laboratory is for teaching all sections of two of the required laboratory courses in the BSEE curriculum, EE 201L, Linear Circuit Analysis I Lab, and EE 203L, Analog Circuit Design and Analysis I Lab. The laboratory has multiple student experiment stations, each equipped with basic instruments required to perform experiments and carry out measurements related to fundamental principles of electrical circuits and electronic concepts. Laboratory equipment include protoboards, oscilloscopes, multimeters, power supplies, signal generators, spectrum analyzers, and other teaching tools. In EE 201L students conduct experiments and perform measurements demonstrating basic principles of circuit theory, including Ohm's law, Kirchhoff's laws of current and voltage, superposition, Thevenin and Norton models, etc., and gain familiarity with simple transient and AC circuits as well as basic instrumentation and measurement techniques. In EE 203L students conduct experiments and perform measurements involving diode and transistor circuits. The laboratory is open during EE 201L and EE 203L laboratory sessions, and is available to senior design students as needed and determined by the faculty mentors.

Digital Systems and Microprocessor Laboratory (Room 270)

This laboratory has 20 student workstations. Each station consists of a computer (12 - HP i5 ProDesk and 12 – Lenovo X2 PCs) and associated system mock-up hardware (Freescale project boards with multiple MCU devices HCS12 and HCS08 with variety of sensors). The lab is networked and each station has software tools for creating files, assembling code, and downloading code into the micro-controllers. The primary utilization of this laboratory is for teaching all sections of the required three credit hour course, EE 330 Microprocessor, in which one half of the semester hours are spent in the classroom and one half of the semester is spent in the laboratory. The students in EE 330 have taken computer architecture course EE 320 and digital systems lab EE320L, but have had limited exposure to a real processor. In this course, students are taught the structure of the Freescale processor. This structure is linked to the material taught in EE 320, Computer Architecture. Students are exposed to machine language and assembly language through the use of a simulator so that they can see how the resources change as each instruction is executed. Students learn to use a text editor, an assembler, and the micro-controller monitor to download and execute programs. Students are given interface assignments as they learn the problems associated with human-machine interface starting with a simple switch and a single light emitting diode (LED) followed by 7 segment LEDs and liquid crystal displays (LCDs) and perform analog-to-digital (A/D) conversion. Assignments progress to the point where students are able to write the necessary assembly language and corresponding C language. This laboratory is open during EE 330 class sessions, and is available to senior design students as needed and determined by the faculty mentors.

Communications Laboratory (Room 274)

This laboratory is primarily used for teaching the one credit hour course, EE 360L Communications Laboratory, which is one of two laboratory classes EE 360L and EE 340L, one of which must be taken by every student in the BSEE program. The laboratory has six student workstations, each equipped with a TIMS (Telecommunication Instructional Modeling System) system unit, including the lower-rack fixed modules, and all the basic, and various advanced plug-in circuit modules. Each station is also equipped with the virtual instrumentation set consisting of A/D converter, computer and associated software modules. Students in this laboratory are exposed to building blocks necessary for hardware realization of many analog and digital communication systems. They use hardware blocks to implement and observe operation of simple communication sub-systems to complete communication links including channel realization. Students taking the one-credit-hour Communications Laboratory course divide their time between this laboratory and the Simulation Laboratory in Room 272. Students conduct experiments and gain hands-on experience with telecommunication principles such as modulation, demodulation, and coding. In addition to the EE 360L, the laboratory is used occasionally for demonstration of concepts taught in two required courses of the BSEE degree program, EE 301 Signals and Systems, and EE 404 Communication Theory. This laboratory is open during EE 360L laboratory sessions, and is available to senior design students as needed and determined by the faculty mentors.

Energy Conversion Laboratory (Room 279)

This laboratory is primarily used for teaching the one credit hour course, EE 340L Energy Conversion Lab, which is one of two laboratory classes EE 360L and EE 340L, one of which must be taken by every student in the BSEE program. The laboratory has multiple experiment stations, each equipped with transformers, generators, machines, and various measurement instruments. The laboratory is utilized for teaching basic principles of power systems and rotating machines. Students perform experiments using transformers and AC / DC rotating devices. In addition to EE 340L, the laboratory is used occasionally for demonstration of concepts taught in the required three credit hour course, EE 403 Feedback Systems Analysis and Design. This laboratory is open during EE 340L laboratory sessions, and is available to senior design students as needed and determined by the faculty mentors.

Simulation Laboratory (Room 272)

This is a dedicated teaching laboratory. The laboratory contains 30 – HP i5 ProDesk desktop computers. The 30 HP computers are used as general-purpose teaching tools with access to the EE server software suite. This laboratory with concomitant software, MATLAB/Simulink, Freescale Code Warrior, Microsoft Visual Studio, NI Multisim, Xilinx ISE and Vivado, Digilent Adept among others are used for teaching a variety of classes: EE109, Engineering Computing, EE320L, Digital Systems Lab, EE 405L, Simulation Techniques Lab, EE 410L, Microwaves Lab, the Simulation components of EE 201L, EE 203L, and various other courses including EE 350, VLSI Design and Testing, and EE 441, Digital Signal Processing.

In addition to the desktop computers, the laboratory consists of approximately 40 FPGA project boards (30 Digilent Nexys4 + 10 Digilent Nexys3 boards) which feature Xilinx FPGA devices. The boards are introduced in the digital circuit design and analysis course EE

204, and are utilized in depth in the laboratory course, EE 320L, Digital Systems Lab. The students are required to develop a number of standard combinational circuits and a few sequential circuits illustrating state machines and small memory devices. The FPGA boards provide valuable experience in design and implementation of digital devices.

When not in use as classroom, the lab is open to EE students with extended hours of operation.

Reconfigurable Computation Laboratory (Room 278)

The primary utilization of this laboratory is for research and Senior Design Projects, EE 470 and EE 471. The laboratory is used by students working on computational and imaging related projects. This laboratory is an integrated research and teaching laboratory environment dedicated to imaging, tracking, and other ATR related activities including FPGA based hardware implementation of complex algorithms. The 850-ft^2 laboratory is utilized by EE students working on senior design projects related to areas of hardware implementation of complex algorithms, imaging, target recognition and tracking. The laboratory has several workstations, all of which are equipped with the latest 64 bit multi-core processors. The machines feature the Windows environment, and recent releases of the Linux operating systems. The machines are loaded with the latest versions of engineering simulation and analysis software packages including Matlab, Multisim, Labview, Zemax, FEKO, Xilinx ISE, etc. Laboratory instruments include optical bench, Surface Optics SOC716 VNIR sixteen–band high-speed hyperspectral imaging system, 256-band VNIR Surface Optics hyperspectral camera, laser scanner, turntable, dual-axis scanning MEMS mirrors, and various FPGA development systems for training and low density logic implementation, as well as a high performance FPGA platforms, including a NI BEE3 equipped with high capacity Xilinx FPGA devices, and an IBM Power9 CAPI system with Altera Stratix device. This laboratory is available to senior design students as needed and determined by the faculty mentors.

Clean Room/Fabrication Process Laboratory (Room 135A)

This laboratory is utilized for teaching the basics of microelectronic fabrication process to students in the BSEE degree program. The laboratory is primarily used for teaching EE 451, IC Fabrication, and EE 451L, IC Fabrication Lab, senior design, and research. Both courses EE 451 and EE 451L are required for students in the Microelectronics-VLSI Concentration of the BSEE degree program. Students in the General and Computer Engineering concentrations may take these courses towards fulfillment of the senior elective requirements of the BSEE degree. Students use the laboratory facility to layout, simulate, fabricate and test microelectronic subsystems and gain hands on fabrication process experience. The Clean Room/Fabrication Process Laboratory is a 2500 sq. ft. clean room facility with state of the art environmental control systems and equipment. The Clean Room is ISO Class 6 rated, with Class 5 and Class 4 workspace. The facility contains the basic process and fabrication tools necessary to instruct in microelectronics and MEMS technology or to develop new technology. The facility is equipped with wet and dry chemical processing and fabrication tools for silicon VLSI and thin film technology including thin film deposition systems, plasma ashing and etching systems, diffusion, oxidation and annealing systems, photolithography processing and mask alignment tools capable of sub-micron dimensions, packaging tools and analysis and testing tools including vector network analyzers, as well as extensive electronic and microwave simulation tools for process and device evaluation. Software and simulation tools are available for design and simulation of 3-D MEMS structures including structures designed to work in the dc to 100 GHz range. Fabrication equipment include a state-of-the-art custom computer controlled six-tube Steed diffusion furnace system with expansion capability for LPCVD polysilicon and silicon nitride, Kurt J. Lesker PVD 75 sputtering deposition system, Kurt J. Lesker PVD 75 e-beam/thermal evaporation system, CEE model 200CBX spin/bake unit, SUSS MA6 Gen4 pro mask aligner system, Tempress dicing saw, Ted Pella XP Precision Sectioning Saw, Westbond die bonder, Rudolph ellipsometer, Technics planer plasma etch system, Technics etcher/stripper, several class-100 laminar flow dry and wet workstations, Signitone/Lucas four-point probe, Nikon and Olympus microscopes, Nanometrics film measurement system, MRK image analysis and dimensional measurement system, MMR hall and Seebeck measurement system, ULVAC advanced laser PIT thermal diffusivity instrument, Blue M softbake and hardbake ovens, particle counter, Tencor Profilometer, Simitool Spin Rinser Dryers, Wentworth wafer prober, K&S wire bonder and David Mann photomask pattern generator and step & repeat cameras. The facility is plumbed with dry nitrogen from external liquid storage tanks and provided with a DI water system operating as a closed loop system to maintain better than 18MΩ water purity. The laboratory is open during EE 451 and EE 451L laboratory sessions and is available to senior design students as needed and determined by the faculty mentors.

Characterization Laboratory (Rooms 268 A-B and 280)

The primary utilization of the Characterization Laboratory is for research and senior design projects in EE 470, EE 471. The laboratory is also used to demonstrate principles of electronic material measurements and characterization to students in EE 431, Semiconductor Engineering II. The laboratory contains instruments for analysis, characterization and testing of microelectronics material, devices and circuits. Principal laboratory equipment include JEOL Model JSM-6610LV scanning electron microscope with energy-dispersive X-ray spectroscopy (EDS) and nanometer pattern generation system (NPGS) for e-beam lithography, Oxford Energy Dispersive Spectroscopy (EDS); and a nanometer pattern generation system (NPGS) by the Nabity Company. This equipment is complemented by characterization and testing instruments necessary to accomplish the characterization objectives including semiconductor parametric analyzers for C-V (capacitance-voltage) measurements, and ac small-signal electrical characterization impedance and gain phase analyzers. A Hall Effect system supported by Van der Pauw resistivity measurement system is also available. The laboratory has complete access to the microelectronics process laboratory including its complement of inspection microscopes, wafer probing equipment, plasma etchers and film measurement systems. The characterization laboratory supports research in material characterization, device design and development, performance demonstration under non-nominal conditions and device manufacture. The laboratory is used in training the BSEE students involving processes and techniques of microelectronic device testing and analysis. Students are exposed to the performance realities of the "real" devices under stress, and are trained to analyze the cause of failures in the devices they design. Students are instructed in the requirements, procedures and techniques of qualification, stress and accelerated lifetime testing. They learn the basic process of failure analysis. The lab in Room 280 is work in progress for enhancing the capabilities of the characterization laboratory. The laboratory is available to senior design students as needed and determined by the faculty mentors.

Nuclear Laboratory (Room 265)

The primary utilization of this laboratory is for nuclear research and senior design project work. There are five stations for experimentation and characterization: 1) Characterization of electrical properties of semiconductor nuclear radiation detectors station, equipped with Keithley 6487 Picoammeter and Voltage Source, Keithley 169 Multimeter, and Auto Range Digital Multimeter; 2) Measurement of detector responses to high energy radiations (X-rays and gamma-rays) and identification of special nuclear materials station, equipped with REXON Scintillation Detector (Type NAI), ORTEC High Voltage Power Supply (Model 556), ORTEC Preamplifier (Model 575A), ORTEC Amplifier (Model 113), ORTEC Multichannel Analyzer (MCA), ORTEC NIM Bin Power Supply (Model 4001A), GW-INSTEC Oscilloscope with Digital Storage and Visual Persistence (Model GDS-3354), and Spectrum Techniques sealed radioactive materials Model RSS 8 Gamma Source Set (Isotopes: ^{133}Ba, ^{14}C, ^{109}Cd, ^{60}Co, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{55}Fe, ^{125}I, ^{129}I, ^{54}Mn, ^{22}Na, ^{210}Pb, ^{210}Po, ^{90}Sr, ^{204}Tl and ^{65}Zn); 3) Post-growth semiconductor annealing station, equipped with Three-Zone Furnace (Model 1000C-1.5-4-4-4), Edwards Diaphragm Vacuum Pump XDD1 with T-Station 75, Thermocouples, and Nicety DT 804 Digital Multimeter; 4) Nuclear detectors device fabrication and chemical treatment station, equipped with Air Science Ductless Fume Hood, Fisher Scientific Heater and Stirrer, Fisher Scientific Timer, polishing pads, and reagent chemicals; 5) Infrared transmission microscopy station, equipped with AmScope Optical/Infrared Microscope, MD900E Digital Camera, and Newport Research Corporation optical table. The laboratory is available to senior design students as needed and determined by the faculty mentors.

Senior Design Laboratory (Room 268)

This laboratory provides work space for EE students and mentors for work on senior design projects. The laboratory equipment include basic signal sources and measurement instruments, components, and tools for hardware implementation, testing, and troubleshooting of senior design projects.

B. Computing Resources

All students at AAMU have access to advanced computing infrastructure including secure high-speed wireless access to online resources. Advanced computing resources are available to students in academic buildings, library, and dormitories, some with extended hours of operation including weekends.

Students in the BSEE program have access to multiple open computer clusters throughout campus including the open lab on the ground floor of the Learning Resources Center, which remains open 0800-2300 including weekends. In addition to campus-wide open clusters, students have access to the ETB open lab in Room 101, and the EE open computer lab in Room 271. These labs are open 0800-2000 on weekdays. The computation resources available to BSEE students include the following hardware resources as shown in Table 16, and the software resources as shown in Table 17.

The computation resources available to students and faculty are adequate for supporting the educational, scholarly, and professional activities of EE students and faculty.

Table 16. Computing Hardware Resources

Resource	Location	Description
A	ETB Room 272	Thirty workstations. 30 – HP i5 ProDesk desktop computers.
B	ETB Room 270	Twenty-four workstations. 12-HP i5 ProDesk and 12 – Lenovo X2 PCs.
C	ETB Room 134	Thirty workstations. 30-Lenovo AMDx3 Dual Core 2.6 GHz.
D	ETB Room 236	Thirty-one workstations. 31 – Hewlett Packard Elite Desk800 i5.
E	ETB 241	Thirty-five workstations. 35 – Hewlett Packard Elite Desk800 i7
F	ETB 243	Thirty-three workstations. 33 – Hewlett Packard Elite Desk800 i5.
G	ETB 271	Thirty workstations. In progress.
H	AL Supercomputer	162-Processor SGI ALTIX 450 system, and 1800-Processor Dense Memory Cluster system.

Table 17. Program Software Resources

Package	Platform	Description
MATLAB/ SIMULINK	A,B,C,G	Matrix Laboratory from Mathworks. Contains a number of toolboxes. Utilized by students in many courses, laboratories and projects.
MS-Office	A,B,C,D,E,F,G	Microsoft Office - WORD, EXCEL, PowerPoint, Standard word processing and spreadsheet application. Used by students to generate laboratory and project reports, categorize, manipulate and present data, create presentations, etc.
MS- Visual Studio	A,B,C,D,E,F,G	Microsoft Development Tools: VB, C++, JAVA, C#, Used to generate computer code for specific software applications. Use ranges from small single purpose programs to large-scale programming projects.
UNIX environment	E,F,G	Software Development: GNU Tools, Intel and Portland Group C/C++/F90 compilers, MPI. Used to introduce students to the UNIX environment. Requires remote access and file sharing protocols such as SSH (secure shell), SCP (Secure Copy), and numerous commands required to navigate within the shell environment and accomplish compiling and file manipulation tasks.
CodeWarrior Compilers	A,	Freescale Assembler/C/C++ compiling tools to support development of Freescale family of microprocessors.
Tanner Tools	A,B	Professional level layout and editing tools for semiconductor design. Allows the user to create each layer of a chip design suitable for creation of production mask. Design checking rule libraries based on industry standard are utilized.
MULTISIM/Electronic Workbench	A,B	Circuit Layout and Graphical Simulation Teaching Tools. Allows students to easily create a high-level PSPICE simulation utilizing graphical components from pull-down menus. Features a large number of standard analog and digital components.
LabView	C,G	Complete development system by National Instruments for building hardware/software interfaces. Allows students to connect actual hardware and/or simulate hardware, and manipulate the systems with user programmable commands. Permits interactivity with MS - Visual Studio programming applications, and has its own graphical programming environment.

LINUX	A,B,H	Network bootable live distribution of Ubuntu 12.04 on local machines. Resident Linux stack on high performance compute clusters at Alabama Supercomputer.
FEKO	Selected A	Finite element based modeling software to simulate high frequency electromagnetic devices. Allows students to investigate a variety of physical geometries for RF applications including antennas, filters, phase shifters, etc.
SONNET	Selected A	Modeling software for microwave circuit design.
MPI	B, H	Message Passing Interface for parallel systems. Allows students to create multi-tasking software capable of running on multiple CPUs connected on a TCP/IP network.
MS-Project	B	Microsoft Project package is used to layout project schedules. Schedules include project timelines as well as resource allocation. Projects are created based on a hierarchical task based structure. PERT and GANTT chart views are available.

C. Guidance

Proper operation of laboratory equipment and instruments including safety considerations are taught to students in every laboratory class, including EE 201L, EE 203L, EE 320L, EE 340L, EE 360L, EE 405L, and EE 451L. The effective utilization of computational resources including familiarity and fluency with the various simulation software applications are taught in multiple courses and laboratories that require students to use these tools.

D. Maintenance and Upgrading of Facilities

The process of maintaining and upgrading of laboratory and computational resources used by students and faculty in the BSEE program is handled at both the department and the college levels. Budget for the maintenance of dual-use laboratory equipment that is used for both teaching and research, are generally provided through externally funded research project budgets. Funds for the initial procurement of dual-use instruments are obtained through faculty research grants and contracts, and the budget for maintaining these equipment including calibration and repair are included in the respective research budgets. After the conclusion of the period of performance of the research project through which the equipment is procured, the faculty continues to include maintenance fees for existing dual-use equipment in new proposals. Funds for maintenance and upgrade of equipment and instruments that are used only for teaching are included in the annual budget of the EE program. The EE annual budget includes $25,000 for contact services associated with the Clean Room/Fabrication Process Laboratory (Room 135A). The EE annual budget also includes about $10K for upgrade of minor laboratory instruments that are utilized strictly for teaching. Periodically, the university administration allocated especially earmarked funds to the College for upgrade of laboratory equipment. The EE program has utilized these funds to upgrade its teaching laboratories in the last six years. Periodically, the College of Engineering, Technology, and Physical Sciences upgrades the computing resources by purchasing new computers and printers for various computer labs and faculty offices. The capital outlay for these periodic investments is provided by the University. The funds for maintaining all user licenses for software tools in various computer laboratories and faculty offices are included in the annual college budget through the dean's office.

E. Library Services

J. F. Drake Memorial Learning Resources Center (LRC)

Drake LRC is the main library for the students and faculty of Alabama Agricultural and Mechanical University. The building is a three-level structure containing more than 76,000 square feet of floor space designed to accommodate 300,000 volumes and seat 1,000 users. Comprehensive renovation of the Drake LRC facility was completed in 2002. Through the renovation provisions for collaborative learning are now prominent throughout the second and third floors. The second floor learning commons provides access to more than 20 computers for students to access the Internet and library resources. Also, the Reading Room provides leisure space for students to engage in quite reading. The Makerspace (fab) and the APP labs were established 2016. Additionally, a fully interactive Multi-Purpose/Distance

Learning Auditorium which seats 171 is available on the first floor along with a computer lab and conference room.

Organizationally, the LRC has adequate and qualified staff to provide library services and programs to a diverse clientele on campus, in the community, and at distance sites. A team of professional librarians serves as the librarian liaison to each academic discipline to ensure the needs of the department and academic programs are communicated for the acquisition of library resources including ordering books and subscriptions. Drake LRC maintains and sustains a collection of resources that meets the curricula need of all AAMU students including those in the BSEE program. Drake LRC has a Collection Development Policy that is reviewed annually with detailed policies and procedures for faculty, staff, and students to make recommendations for the purchase of resources to be added to the collections. This policy includes the procedures to order and notify the requester when the materials have been processed and their location. The Collection Development Policy can be found on the library's webpage (www.aamu.edu/library). Moreover, Drake LRC Librarians reach out to faculty via email when publisher's notifications of new resources are receives for their interest in purchasing. This is inclusive of print and electronic resource.

Drake LRC is a multi-media informational center, which focuses on access in a plethora of formats. Moreover, Drake LRC is embracing the digital world to ensure faculty and students have access to the library content at any time from any location. While print is very important to the research world, Drake LRC is aware of the number of students engaged in online or distance learning. Therefore, provisions are made for online learners when purchasing resources. Instructions for students to access library resources off campus, to request how to use a resource or request a librarian reference interview are available from the library's webpage (www.aamu.edu/library). Drake LRC maintains eighty two operational hours per week that is adequate for teaching and learning. Extended hours are maintained during mid-term and final examination periods. The holding statistics are as follows:

- Total Volume count - 620,122
- Book Collection 252,707
- Bound Journals 25,883
- Government Publications 194,756
- Microform Collection 140,857
- AV Materials 5,919

The LRC is in close proximity of the Arthur J. Bond Building (AJB) where the BSEE program faculty offices, classrooms, and laboratories are housed. In addition to the main library building, the LRC also has a satellite location in the AJB Engineering Building containing books, journals, and computers of primary interest to engineering faculty and students. It is staffed by a full-time librarian. The library resources available to students and faculty are adequate for supporting the educational, scholarly, and professional activities of EE students and faculty.

F. Overall Comments on Facilities

All the facilities utilized by students in the BSEE program including classrooms, laboratories, and libraries are located on the campus of Alabama A&M University and adhere to university safety codes. The AAMU Office of Environmental Health and Safety provides environmental health and safety service to the university community through technical and regulatory compliance assistance, information and training programs, consulting services and periodic auditing of environmental health and safety practices. The EE laboratory instructors review laboratory safety and emergency procedures at the start of each semester.

CRITERION 8. INSTITUTIONAL SUPPORT

H. Leadership

The Electrical Engineering (EE) Program is an academic component of the Department of Electrical Engineering and Computer Science (EECS). The Chairperson of EECS Department leads the EE program as its program coordinator and reports to the Dean of the College of Engineering, Technology and Physical Sciences (CETPS). The CETPS Dean reports to the Provost and Vice President for Academic Affairs and Research, who reports to the President of AAMU. An organizational chart indicating the BSEE program's position in the University hierarchy is provided in Figure 16. The quality, continuity, and continuous improvement of the BSEE program are ensured by its well qualified and dedicated core faculty, who have vested interest in a thriving educational program, and the proactive EE Advisory Board. The EE faculty through the department chairperson has open lines of communication to the college dean and the university administration. The university administration is committed to providing adequate resources to the EE faculty in order to grow and improve the quality of the EE program. The EE faculty consists of nine full-time positions. Five members of the EE faculty are currently tenured at the rank of professor. Five members of the EE faculty have been associated with the program for more than ten years, and two have been with the program since its inception in 1998. The EE program is run based on the principle of shared governance, and the faculty under the leadership of the EECS Chairperson takes proactive roles in every major decision affecting the program at the department level including the BSEE curriculum, faculty promotions and hiring new faculty. The EE faculty collectively and through the EECS Chairperson and the EE Advisory Board is involved in all decisions at the College level that affect the program.

I. Program Budget and Financial Support

Alabama A&M University is a state supported institution and funding to sustain the EE program is derived primarily from state appropriations and student tuition via the University. The program's annual budget is determined through a systemic process which involves faculty input, budget request, hearing, and approval steps. The annual budget request process starts in early spring when the program coordinator in consultation with the faculty prepares the budget request form for the following academic year. The budget request, through the department chairperson, is then forwarded to the Dean of the College of Engineering, Technology and Physical Sciences. Following the submission of the budget request, the Dean meets with the department chairpersons and program coordinators in order to formulate budget priorities and resource allocation plans for the next academic year. After finalization and approval of the budget request at the College level it is submitted to the Provost and Vice President for Academic Affairs and Research. Formal budget hearings at the University level are conducted in mid to late spring where Vice Presidents, Deans, Chairpersons, and Program Coordinators may be asked to defend their requests in the presence of the university budget officials and the President. Following the budget hearings, final adjustments to the budget and approval by the President is made and the approved budget is given to the program. The AAMU administration is committed to provide the EE program with sufficient funds to maintain the quality of its educational program.

Each year, the EE program through the Dean's office receives additional funds from the University's Title III Strengthening Grants Program for faculty travel and professional development. Since 2012, on several occasions, the program has received additional university funds through the Dean's office, separate from the Program's annual budget, for purchase of laboratory instruments and computers. In 2014 and 2015 these additional funds were utilized to equip the basic circuits and electronics laboratory (Room 263) with state of the art instrumentation including high performance digital oscilloscopes, multi-meters, and signal generators. In 2016 computers, printers, and scanners in all faculty offices, as well as computers in the simulation laboratory (Room 272) were replaced. In 2017 thirty additional Freescale project boards with multiple MCU devices HCS12 and HCS08 with variety of sensors were added to the Digital Systems Lab (Room 270). In 2018, the computers and printers in the EE open computer lab (Room 271) will be replaced.

The EE faculty is actively involved in externally sponsored research which directly benefits the program on many levels. Funds derived from these projects have consistently been utilized to enhance the EE laboratories in support of student outcomes. Some of the more recently acquired major instruments include: $150K Surface Optics SOC716 VNIR sixteen–band high-speed hyperspectral imaging system for the Reconfigurable Computing Lab in 2015; $ 330K Advanced Mask Aligner and Spin Coater Unit for the Clean Room/Fabrication Process Laboratory in 2016; $ 480K Advanced Atomic Layer Deposition System for the Clean Room/Fabrication Process Laboratory in 2018. In the last six years, the Reconfigurable Computation Laboratory, the Characterization Laboratory, and the Senior Design Laboratory, have also been equipped using external funds from multiple projects. The external research funds are also utilized for hiring undergraduate research assistants. Some of the undergraduate research assistants, following graduation from AAMU have secured employment or have elected to pursue graduate studies in areas closely related to their research work at AAMU.

Through the Tutorial Assistance Network (TAN) program AAMU hires academically gifted upperclassmen as Supplemental Instruction (SI) leaders to assist course instructors in offering additional help to students by providing tutorial and supplemental instruction. The EE instructors in foundational courses including EE 101, EE 109, EE 201, EE 202, EE 203, and EE 204 consistently utilize SI leaders in order to provide additional help to students in those classes outside the class period. All grading of student exams, homework, reports, and other class performance in the EE program are done by the faculty.

Alabama A&M University through the Centers for Excellence in Teaching and Learning (CETL) provides instructional faculty at all levels with the most effective strategies for engaging and teaching today's college students. Not only is CETL used as a professional development resource for faculty across the university, it also conducts regularly scheduled professional development workshops for the staff. Alabama A&M University supports teaching through conducting several teaching and assessment workshops annually. In addition to the regularly scheduled CETL teaching workshops, twice a year, at the start of fall and spring semesters, the university conducts the all day Faculty Staff Conferences. A component of the Faculty Staff Conference involves inviting nationally recognized experts from outside and inside the university to conduct innovative teaching and assessment workshops for faculty. The EE program encourages the faculty to avail themselves of these professional enhancement opportunities.

The EE program is provided with sufficient funds for the maintenance of its laboratories through its annual budget. An annual budget of $25K for contractual services including the maintenance of the Clean Room Fabrication Process Laboratory (Room 135A) for regularly scheduled replacement of gasses and DI water services, and $10K for basic laboratory maintenance expenditure including components and consumables is provided in the EE budge. Annual funds for the maintenance of all software tools utilized by the EE program students and faculty are provided through the Dean's budget. Periodic one-time upgrades to EE teaching laboratories have been funded by the university through the Dean's office.

The University provides the EE program with sufficient funds to hire and keep the faculty and staff, as well as to equip and maintain the necessary laboratory infrastructure in order to sustain the program. The faculty, staff and laboratory infrastructure in the EE program is at a level which is sufficient for assuring that student outcomes are attained by the students in the program.

J. Staffing

The instructional staff of the EE program is comprised of nine full-time faculty positions including the EECS Chairperson. Currently there are eight full-time faculty and one open faculty position, which will be filled in August 2018. Occasionally the EE program utilizes part-time adjunct faculty to teach a limited number, one or two sections each year, of classes. The faculty at its current level is sufficient to cover all the instructional requirements of the program.

The EECS department has one full-time administrative secretary. The program shares one computer and network technician with several other programs in the College. The EE program does not have a dedicated technician.

K. Faculty Hiring and Retention

The program must justify the need for filling faculty positions that become vacant due to faculty retirements and departures. After approval at the College level, the request for filling the vacant faculty position, which includes position description, justification, desired academic and professional qualifications, and the list of members of the EE faculty search committee is forwarded to the Provost. Following approval at that level, it is forwarded to the Vice President for Finance and the President. The approved faculty positions are advertised by the Office of Human Resources and all application materials are submitted to that office online. The faculty search committee reviews the materials submitted by applicants and makes recommendations to the Chairperson. The Chairperson in consultation with the search committee chooses the candidate, and through the Dean requests the Provost's approval for hiring the new faculty.

The EE program strives to maintain a highly collegial atmosphere, where faculty is involved in all major decisions affecting the program at the program and department levels. The program is run based on the principle of shared governance, and the faculty has a true sense of ownership in the program. Every effort is made at the program level to keep teaching loads at a level that allow faculty sufficient time for improving the BSEE curriculum, course content and laboratory infrastructure, pursuit of scholarly activities and professional development. The level of faculty compensation has remained stagnant over the past several years. The University, however, has allowed faculty with sufficient research funding to supplement their nine-month salary by overload pay and summer employment funded through their externally funded research projects.

The EE faculty is comprised of a group of dedicated, accomplished, and content teacher-scholars who take pride in the thriving educational program they have helped to establish. The faculty has the required resources to assure that student outcomes are attained.

L. Support of Faculty Professional Development

Faculty professional development activities such as travel, workshops and seminars are partly funded through the EE program budget and partly through Title III funding provided to the Dean's office. Title III funds provide, on average, roughly $1K per faculty for professional development activities on an annual basis, and the department annual budget includes on average $1K per faculty for professional development activities. Approval for utilization of Title III travel funds is granted based on availability of funds at the program and college levels. The EE faculty has been successful in obtaining external research funding on a sustained basis. Faculty professional development activities are partially funded through externally supported research. Over the years, combined internal and external funding sources have provided the EE faculty with sufficient professional development funds. The University has an established faculty sabbatical policy, which allows faculty who qualify to spend one semester on sabbatical leave with full pay. In the past six years, no EE faculty has taken a sabbatical leave.

Alabama A&M University supports teaching through conducting several teaching and assessment workshops annually. In addition to the regularly scheduled CETL teaching and assessment workshops, twice a year, at the start of fall and spring semesters, the university conducts the all day Faculty Staff Conferences. A component of the Faculty Staff Conference involves inviting nationally recognized experts from outside and inside the university to conduct innovative teaching and assessment and continuous improvement workshops for faculty.

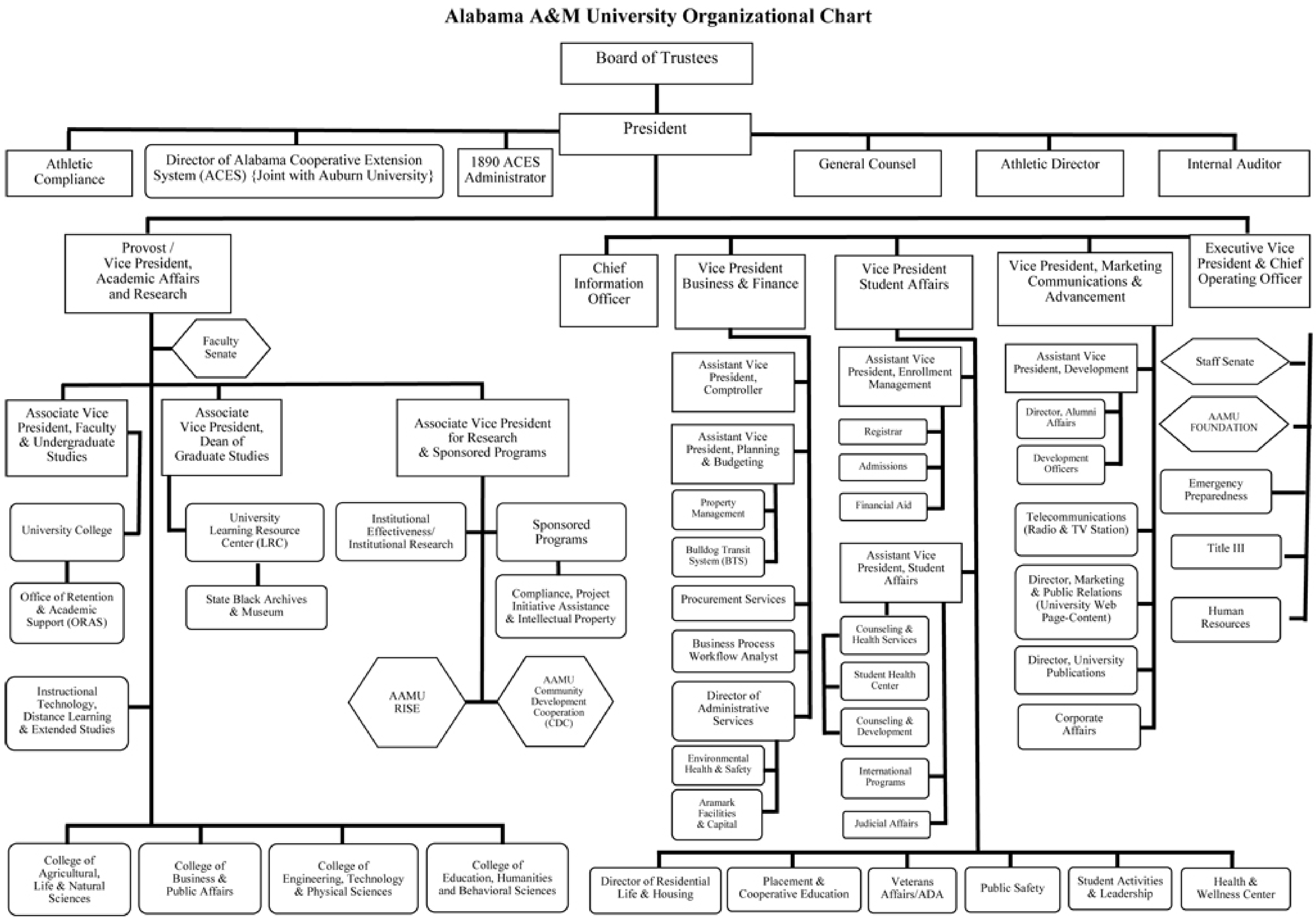

Figure 16. Organizational Chart of Alabama A&M University

PROGRAM CRITERIA

Curriculum

All students in the BSEE degree program are required to take at least fifty-five credit hours of engineering topics. The students following three curricular concentrations of General, Computer Engineering, and Microelectronics-VLSI take three credit hours of non-EE engineering course to provide graduates with engineering breadth. Students in these three concentrations are free to choose any 200-level and above Mechanical and Civil Engineering course to satisfy this requirement. The students in the Nuclear Power concentration gain breadth through required courses of EE 306, Survey of Energy Systems, and EE 308, Thermal Systems Engineering. This requirement is in addition to the required three credit hours course ME 481, Quality and Reliability Assurance, which contains formal treatments and engineering applications of probability and statistics. The curriculum requirements contain twenty-eight credit hours of general education courses including six credit hours of history, nine credit hours of English including six credit hours of writing-intensive composition, three credit hours of economics, and six credit hours of humanities and fine arts.

The required mathematics and basic sciences component of the BSEE curriculum comprises fifteen credit hours of mathematics including calculus (12 CH) and differential equations (3 CH), and twelve credit hours of laboratory science including calculus based physics with laboratory (8 CH) and chemistry with laboratory (4 CH). In addition, the curriculum requires every student to choose a three credit hours course from a list of approved mathematics courses including topics such as linear algebra, partial differential equations, complex analysis, probability and statistics. Mathematical topics such as linear algebra and matrices are introduced formally in EE 101, Introduction to Electrical Engineering, and are treated at more advanced levels in EE 304, Numerical Methods and Digital Computation. The BSEE degree program, therefore, meets the mathematics and basic sciences minimum semester credit hours requirement of 32. All students in the BSEE program are also required to take the three credit hour course ME 481, Quality and Reliability Assurance, which contains formal treatments of probability and statistics including engineering applications of these concepts. Students in the BSEE degree program are further exposed to advanced mathematical concepts including differential equations, linear algebra, complex variables, vector algebra, and discrete mathematics through various required EE courses.

Students in the BSEE degree program are introduced to the process of engineering design throughout the curriculum. Several required BSEE courses, in addition to engineering science, analysis methods, simulation, measurement and experimental content, contain, to varying degrees, elements of engineering design. All BSEE degree candidates must complete four credit hours of capstone engineering design, comprised of a sequence of two Senior Design courses EE 470, Engineering Analysis & Design I, and EE 471, Engineering Analysis & Design II.

In the Senior Design course sequence, teams of students, normally comprised of 2-4 members each, select a project in the fall semester of their final year, and under supervision of a faculty mentor, work on the project for two consecutive semesters. Design project proposal ideas are generated by faculty, government, industry, or students and, after EE faculty approval, are presented to students in the senior design class EE 470, Engineering Design and Analysis I, in the fall semester. Students are given the opportunity to select a project and their team members, and commence working on the project once they obtain the consent of the course instructor and an EE faculty to act as their project mentor. Senior design teams, whose projects are proposed externally, may have an external advisor in addition to the EE faculty mentor.

In order to complete their senior design projects students must utilize knowledge and skills acquired in basic and intermediate courses including research, problem definition, problem formulation, engineering problem solving, analysis, simulation, coding, design iterations, engineering standards, fabrication, test and measurement, communication and presentation proficiency. Students learn to collaborate by working in teams, divide responsibilities, scheduling, and project management. Some projects may involve regulatory and economic issues.

In addition to the final report, student teams are required to give six formal presentations to an audience comprised of the senior design class, the entire EE faculty, and observers from within and outside the university. Senior design teams must also participate in the EE Poster Presentation, and the University STEM Day Conference, at the end of school year, where university faculty, students, EE Advisory Board, and observers from industry and government review the design projects and interact with design teams. In the last six years, EE faculty and students have published several papers based on senior design projects in refereed journals and conference proceedings.

The senior design experience helps to prepare graduates for engineering practice, by further sharpening their technical, presentation, teamwork, and project management skills. The BSEE curriculum satisfies program criteria for electrical engineering programs.

Appendix A Course Syllabi

EE 101 Introduction to Electrical Engineering

Credits and contact hours: 3, 3

Instructor: Dr. Satilmis Budak

Text book: Fundamental Concepts in Electrical and Computer Engineering with Practical Design Problems, 2nd Edition, ISBN: 1-58112-971-8, 2007

Course description: Fundamental concepts in electrical engineering are introduced. Practical pre-calculus concepts are utilized. Students are required to develop an electronics project. Students develop communication skills through presentation of projects and research of historical topics in the electrical engineering discipline.

Co-requisite: MTH 115

Required Course

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Student Outcome	Assessment Tool
Develop and deliver PowerPoint presentations and word processing docs.	g, k	Oral presentations, paper
Understand the historical roots of EE, and the EE program at AAMU	g, j, k	Quiz, oral presentations
Understand engr. education requirements, ABET and EE salary potentials	g, i, j, k	Quiz, oral presentations
Transform numbers between different bases, and understand basic logic skills	a, k	Homework, Quiz
Demonstrate basic algebra and trigonometry skills	a	Homework, Quiz
Understand polar/rectangular coordinate conversions	a	Homework, Quiz
Utilize vector, matrix operations and simultaneous linear solutions	a	Homework, Quiz
Understand and analyze basic ethical dilemma situations	f, g	Oral presentations, paper
Analyze basic resistive circuits with loop techniques	a, e, k	Homework, Quiz
Identify electronic components, assemble and solder basic components	g, k	Lab project

Relation of course to Student Outcomes:

Student Outcomes	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(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	**X**
(f) an understanding of professional and ethical responsibility	**X**
(g) an ability to communicate effectively	**X**
(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	**X**
(j) a knowledge of contemporary issues	**X**
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	**X**

Topics: Welcome to the Department of Electrical Engineering; ABET engineering definition; a) Branches of engineering; what is engineering to me? (essays & presentations); Engineering Ethics, History of EE at AAMU; Writing Technical Reports/Presentations, EE Contributors (research & presentations), Engineering Salaries (research & presentations), Algebra Review; Number systems; MATLAB commands, Sines and Cosines; Trigonometric Functions, Cartesian and Polar Coordinates, Matrices and Determinants, MATLAB; Solution of determinants, DC Circuits, MULTISIM, Circuit Component Familiarization, Soldering, Projects/Presentations.

EE 109 Engineering Computing

Credits and contact hours: 3, 3

Instructor: Dr. Stephen Egarievwe

Text book: Dale, Nell and Weems, Chip. Programming and Problem Solving with C++, Jones and Bartlett, Sixth Edition, Brief Edition, 2014.

Course description: This course introduces students to the concepts of utilizing computer systems for solution of engineering problems using the C/C++ programming language. Formulation and development of problem solving strategies are explored. Basic data representation and program flow control structures are discussed, as well as techniques for input/output of data. Intermediate level data and program structures are introduced.

Corequisite: MTH 115

Required course

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Student Outcome	Assessment Tool
Understand the basic organization of computing systems	a	Homework, Quiz, Exams
Develop basic flow charts and algorithms	a, c	Homework, Quiz, Exams
Understand and write basic control structures (if then, else, while, for…)	a, k	Homework, Quiz, Lab Projects, Exams
Understand standard and file based I/O in C++	a, k	Lab Projects, Exams
Utilize and develop simple data structures and arrays in C++	a, c, k	Lab Projects, Exams
Develop modular based programs with functions and subroutines in C++	a, c, k	Lab Projects, Exams
Understand and utilize memory allocation techniques for C++	a, c, k	Lab Projects, Exams

Relation of course to Student Outcomes:

Student Outcomes	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(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	**X**
(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.	**X**

Topics: Basic Computer Organization, Engineering problem analysis (e.g. flowcharts and algorithms), Basic C++ programming constructs, Conditional Control Structures, Loop Control Structures, Data I/O Techniques, Modular programming with functions, Arrays and matrices, Programming with pointers, Programming with structures.

EE201 Linear Circuit Analysis I

Credits and contact hours: 3, 3

Instructor: Dr. Satilmis Budak

Text book: Basic Engineering Circuit Analysis, John Wiley, Eleventh (11^{th}) Edition, 2015

Course description: Resistance and Ohm's Law, Kirchhoff's Laws, nodal and loop analysis, superposition, source transformation, Thevenin's and Norton's Theorems, maximum power transfer, capacitance, inductance, transient analysis and introduction to ac sinusoidal analysis and phasors.

Prerequisites: EE 101, Corequisite: MTH 115

Required course

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Student Outcome	Assessment Tool
Resistance and Ohm's Law, Kirchhoff's Laws	a, e	Homework, Quiz, Exams
Nodal and loop analysis	a, e	Homework, Quiz, Exams
Superposition, source transformation, Thevenin's and Norton's Theorems	a, e	Homework, Quiz, Exams
Maximum power transfer	a, e, k	Homework, Quiz, Exams
Capacitance, inductance, transient analysis and introduction to ac sinusoidal analysis and phasors	a, e, k	Homework, Quiz, Exams

Relation of course to Student Outcomes:

Student Outcomes	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(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	**X**
(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.	**X**

Topics: Basic Concepts, Introduction, units, voltage, current and power, Resistive Circuits, Ohm's law and Kirchhoff's laws, Resistances in series, parallel and equivalent resistance, Mesh analysis, formulation and solution of node equations, Circuits containing dependent sources, Network theorems; superposition theorem, Thevenin's and Norton's theorems, maximum power transfer, applications, Capacitance and Inductance, First and Second order Transient Circuits, AC Steady-State Analysis, Introduction to sinusoidal analysis and phasors.

EE201L Linear Circuit Analysis I Lab

Credits and contact hours: 1, 3

Instructor: Dr. Satilmis Budak

Reference book: Basic Engineering Circuit Analysis, John Wiley, Eleventh (11th) Edition, 2015

Course description: This course is the companion lab to EE-201 and includes analysis, simulation, setting up and test of some fundamental DC and AC circuits with resistors, capacitors inductors, and some digital and analog chips.

Corequisite: EE 201

Required course

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Student Outcome	Assessment Tool
Resistive Circuits	a, b, d, g, k	Pre-study, Multisim, Experiment, Lab Report
Mesh analysis and node analysis	a, b, d, g, k	Pre-study, Multisim, Experiment, Lab Report
Superposition Theorem	a, b, d, g, k	Pre-study, Multisim, Experiment, Lab Report
Thevinin's and Norton's Theorem	a, b, d, g, k	Pre-study, Multisim, Experiment, Lab Report
Diode and Applications	a, b, d, g, k	Pre-study, Experiment, Lab Report
Operational Amplifier and Application	a, b, d, g, k	Pre-study, Experiment, Lab Report
Digital Logic Components and Verification of De Morgan's Theorem	a, b, d, g, k	Pre-study, Experiment, Lab Report
Oscilloscope and Applications	a, b, d, g, k	Pre-study, Experiment, Lab Report
Transient Response of RC Circuits	a, b, d, g, k	Pre-study, Experiment, Lab Report
Phase Relations in AC Circuits	a, b, d, g, k	Pre-study, Experiment, Lab Report
Series Resonance	a, b, d, g, k	Pre-study, Experiment, Lab

		Report

Relation of course to Student Outcomes:

Student Outcomes	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	**X**
(c) an ability to design a system, component, or process to meet desired needs	
(d) an ability to function on multi-disciplinary teams	**X**
(e) an ability to identify, formulate, and solve engineering problems	
(f) an understanding of professional and ethical responsibility	
(g) an ability to communicate effectively	**X**
(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.	**X**

Topics: Lab Report Writing, Group Forming, Multisim Software and Multimeter Training, Resistive Circuits, Mesh analysis and node analysis, Superposition Theorem, Thevinin's and Norton's Theorem, Diode and Applications, Operational Amplifier and Application, Digital Logic Components and Verification of De Morgan's Theorem, Oscilloscope and Applications, Phase Relations in AC Circuits, Series Resonance.

EE202 Linear Circuit Analysis II

Credits and contact hours: 3, 3

Instructor: Dr. Satilmis Budak

Text book: Basic Engineering Circuit Analysis, John Wiley, Eleventh (11th) Edition, 2015

Course description: This is a continuation course to EE 201. It addresses analysis of ac circuits, power calculations, Laplace transforms and application to transient analysis of electric circuits. Response to non-periodic excitations using Fourier series is included. Concepts of frequency response, basic filter circuits are also considered.

Prerequisites: EE 201, EE 201L, MTH 125

Required course

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Student Outcome	Assessment Tool
Understand average and RMS values of sinusoidal waveforms, calculate power and power factor. Obtain ac waveforms using Matlab	a,e, k	Homework, Quiz, Exams, Computer projects
Understand v-i relations in phasor forms. Calculate equivalent impedance analytically and with Matlab	a,e, k	Homework, Quiz, Exams, Computer projects
Solve ac phasor circuits by mesh analysis and node analysis and by Matlab simulation	a,e, k	Homework, Quiz, Exams, Computer projects
Understand maximum power transfer, and application of network theorems	a,e	Homework, Quiz, Exams,
Understand active and reactive power concepts, analyze industrial loads and design for power factor improvement. Verify with Multisim modeling	a,e, k	Homework, Quiz, Exams, Computer projects
Learn the concepts of mutual inductance and magnetic coupling	a,e	Homework, Quiz, Exams
Analyze simple balanced 3-phase circuits involving Wye and Delta connections	a,e	Homework, Quiz, Exams
Obtain Laplace transforms of standard time functions and the concepts of poles and zeros. Obtain pole-zero plots with Matlab	a,e, k	Homework, Quiz, Exams, Computer projects

Calculate inverse Laplace transforms and solve differential equations with Laplace transforms and learn the applications of Matlab	a,e, k	Homework, Quiz, Exams, Computer projects
Understand the s-domain behavior of electrical circuit elements.	a,e	Homework, Quiz, Exams
Analyze transient behavior of electrical circuits using Laplace transforms	a,e	Homework, Quiz, Exams
Use Multisim to analyze the transient behavior of electrical circuits	a,e	Homework, Quiz, Exams
Understand resonance and network performance under variable frequency conditions, verify circuit resonance with Multisim	a,e, k	Homework, Quiz, Exams, Computer projects
Analyze non-sinusoidal waveforms using trigonometric Fourier series	a,e	Homework, Quiz, Exams
Learn to use Matlab to simulate Fourier series	k	Computer projects
Analyze electrical circuits for non-sinusoidal excitations	a,e	Homework, Quiz, Exams
Understand the basics of two-port network parameters	a, e	Homework, Quiz, Exams

Relation of course to Student Outcomes:

Student Outcomes	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(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	**X**
(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.	**X**

Topics: Computer average and RMS values of sinusoidal waveforms. Compute power and power factor. Obtain ac waveforms using Matlab. Understand v-i relations in phasor forms. Calculate equivalent impedance analytically and with Matlab. Solve ac phasor circuits by mesh analysis and node analysis and by Matlab simulation. Understand active and reactive power concepts, analyze industrial loads and design for power factor improvement. Verify circuit principles with Multisim modeling. Learn the concepts of mutual inductance and magnetic coupling, Analyze simple balanced 3-phase circuits involving Wye and Delta connections, Obtain Laplace transforms of standard time functions and the concepts of poles and zeros. Obtain pole-zero plots with Matlab, Calculate inverse Laplace transforms and solve differential equations with Laplace transforms and learn the applications of Matlab, Understand the s-domain behavior of electrical circuit elements. Analyze transient behavior of electrical circuits using Laplace transforms, Use Multisim to analyze the transient behavior of electrical circuits. Understand resonance and network performance under variable frequency conditions, verify circuit resonance with Multisim, Analyze non-sinusoidal waveforms using trigonometric Fourier series, Learn to use Matlab to simulate Fourier series, Analyze electrical circuits for non-sinusoidal excitations, Understand the basics of two-port network parameters.

EE 203 Analog Circuit Design and Analysis I

Credits and contact hours: 3, 3

Instructor: Professor Stoney Massey

Textbook: Microelectronics Circuit Analysis and Design (Fourth edition) McGraw Hill, 2010.

Coursed description: An analysis of nonlinear semiconductor devices: PN junction diodes, bipolar junction and field-effect transistors, biasing concepts, worst case analysis, and discrete amplifier circuit design and analysis.

Prerequisites: EE 201 and EE201L, MTH 125, Co-requisite: EE203L

Required course

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcomes	Student Outcome	Assessment Tool
Analyze the operation of diodes and transistors in electrical circuit networks.	a, e, k	Homework, Quiz, Exams
Analyze a small signal amplifier to determine the D.C. Q-point parameters and the small signal Hybrid π parameters.	a, e	Homework, Quiz, Exams
Analyze and determine when a transistor circuit is operating in the forward active, saturation, or cut-off region.	a, e	Homework, Quiz, Exams
Design a bias stable capacitor coupled small signal amplifier using either a bipolar junction transistor or a field effect transistor.	a, e, k	Homework, Quiz, Exams
Analyze and graph first order system transfer functions to determine the frequency response characteristics, sketch the Bode plot and find the 3 dB corner frequencies of transistor amplifier networks.	a, e, k	Homework, Quiz, Exams

Relation of course to Student Outcomes

Student Outcomes	
(a) an ability to apply knowledge of mathematics, science, and engineering.	X
(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.	X
(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.	X

Topics: Semiconductor materials and the PN junction diode, diode circuits, the bipolar junction transistor (BJT), basic BJT amplifiers, the field effect transistor, single-stage amplifiers at mid-frequencies, and single stage amplifiers at low and high frequencies

EE203L Analog Circuit Design and Analysis I Lab

Credits and contact hours: 1, 3

Instructor: Dr. Satilmis Budak

Reference book: Microelectronics: Circuit Analysis and Design, McGraw Hill, (4th Edition), 2010

Course description: This course is the companion lab to EE-203 and includes analysis, simulation and fabrication of analog electronic circuits including diode circuits, bipolar junction transistor amplifiers, operational amplifiers and circuits using operational amplifiers such as oscillators and filters.

Prerequisites: 201, 201L, MTH 125, Corequisite: EE 203

Required course

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Student Outcome	Assessment Tool
The PN Junction Diode, dc analysis, Q-point, ac small signal analysis	a, b, d, e, g, k	Pre-study, Multisim, Experiment, Lab Report
Bipolar Junction Transistors, Q point, dc analysis, bias stability	a, b, d, e, g, k	Pre-study, Multisim, Experiment, Lab Report
Operational Amplifiers	a, b, d, e, g, k	Pre-study, Multisim, Experiment, Lab Report
Single Stage Amplifiers, BJT Common Emitter Amplifier	a, b, d, e, g, k	Pre-study, Multisim, Experiment, Lab Report
Single Stage Amplifiers, BJT Common Collector Amplifier	a, b, d, e, g, k	Pre-study, Multisim, Experiment, Lab Report
Junction Gate FET dc analysis, Q point & biasing	a, b, d, e, g, k	Pre-study, Multisim, Experiment, Lab Report

Relation of course to Student Outcomes:

Student Outcomes	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**

(b) an ability to design and conduct experiments, as well as to analyze and interpret data	**X**
(c) an ability to design a system, component, or process to meet desired needs	
(d) an ability to function on multi-disciplinary teams	**X**
(e) an ability to identify, formulate, and solve engineering problems	**X**
(f) an understanding of professional and ethical responsibility	
(g) an ability to communicate effectively	**X**
(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.	**X**

Topics: Fundamental of experiments, forming groups, The PN Junction Diode, dc analysis, Q-point, The PN Junction Diode, ac small signal analysis, Operational Amplifiers, Bipolar Junction Transistors, Q point, dc analysis, bias stability (MULTISIM), Bipolar Junction Transistors, Q point, dc analysis, bias stability (EXPERIMENT), Single Stage Amplifiers, BJT Common Emitter Amplifier (MULTISIM), Single Stage Amplifiers, BJT Common Emitter Amplifier (EXPERIMENT), Single Stage Amplifiers, BJT Common Collector Amplifier (MULTISIM), Single Stage Amplifiers, BJT Common Collector Amplifier (EXPERIMENT), Junction Gate FET dc analysis, Q point & biasing (MULTISIM), Junction Gate FET dc analysis, Q point & biasing (EXPERIMENT).

EE 204 Digital Circuit Design and Analysis

Credits and contact hours: 3, 3

Instructor: Dr. Andrew Scott

Text book: Sandige and Sandige, Fundamentals of Digital and Computer Design with VHDL, Latest ed., McGraw Hill, New York, 2012. ISBN-13: 978-0-07-338069-8; ISBN-10: 0-07-338069-5

Course description: Analysis and design of those circuits where the nonlinearity of the active element is significant. Includes basic digital circuits, Boolean algebra, Karnaugh maps, Encoding, decoding, flip-flops, finite state machines and analog to digital conversion.

Prerequisites: EE 101, EE 201

Corequisites: n/a

Required course

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Program Outcome	Assessment Tool
Understand and interpret the differences between various data representations and number systems and transform between them. (e.g. 8/16/32 bit, signed/unsigned, integer/ character).	a	Homework, Quiz, Exams
Demonstrate an understanding of standard Boolean logic forms. (e.g. SOP, POS, NAND/NAND, NOR/NOR)	a	Homework, Quiz, Exams
Understand and design common arithmetic circuits (e.g. adder/subtractor/multiplier)	a, c	Homework, Quiz, Exams
Understand and design combinational circuits using decoders and multiplexers.	c, e	Homework, Quiz, Exams
Demonstrate an understanding of basic digital design and modeling techniques. (e.g. Truth Tables, K-MAPS, Boolean Algebra)	c, e	Homework, Quiz, Exams
Utilize a variety of feedback circuits to form bi-stable memory devices.	c, e	Homework, Quiz, Exams
Understand and design a variety of sequential circuits, and finite state machines (FSM).	c, e, k	Homework, Quiz, Exams, Computer Projects
Utilize VHDL to represent and create a variety of digital devices.	c, e, k	Computer Projects

Relation of course to Student Outcomes:

(a) an ability to apply knowledge of mathematics, science, and engineering	X
(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	X
(d) an ability to function on multi-disciplinary teams	
(e) an ability to identify, formulate, and solve engineering problems	X
(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.	X

Course Topics

1. Introduction
2. Number Systems
3. Arithmetic Operations
4. Decimal and Alphanumeric Codes
5. Binary Logic and Gates
6. Boolean Algebra
7. Standard Forms and Karnaugh Maps
8. NAND and NOR Logic
9. XOR/XNOR Logic
10. Combinational Logic Design
11. Latches and Flip-Flops
12. Finite State Machines
13. Sequential Circuit Design
14. Registers and Counters
15. VHDL/Verilog Hardware Definition Languages
16. Advanced Topics (as time permits)
17. Examinations

EE 301 Signals and Systems I

Credits and contact hours: 3, 3

Instructor: Dr. Shujun Yang

Text book: Roberts, M.J., Signals and Systems, McGraw Hill, 2nd Edition.

Catalog Description: Continuous time signals and systems, mathematical description of signals, description and analysis of systems, convolution integrals, Fourier Series in exponential and trigonometric formats, Fourier Transform and frequency response, Laplace Transform, impulse response, transfer functions, poles and zeros, system responses, introduction to discrete time systems.

Prerequisites: EE 202

Co-Requisite: MTH 238

Required course

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Student Outcome	Assessment Tool
Understand basic continuous time signals, singularit functions, transformations	a, k	Homework, Exams, Computer Projects
Plot functions and verify signal transformations using Matlab	k	Computer Projects
Understand the properties of continuous time systems, examine systems	a, e	Homework, Exams
Calculate the system response using convolution integrals, Develop Matlab codes	a, e, k	Homework, Exams, Computer Projects
Understand continuous time Fourier Series, Develop Matlab codes	a, e, k	Homework, Exams, Computer Projects
Calculate Fourier transforms of continuous time signals	a, e	Homework, Exams, Computer Projects
Determine the frequency response of linear systems, obtain Bode Plots	a, e, k	Homework, Exams, Computer Projects
Work with Laplace transforms, obtain direct and inverse transforms and pole zero configurations, develop Matlab solutions	a, e, k	Homework, Exams, Computer Projects
Analyze system performance using Laplace transforms	a, e	Homework, Exams, Computer Projects
Understand basics of discrete time signals and systems	a, e	Homework, Exams

Calculate discrete time system response with convolution sum	a, e	Homework, Exams

Course relation to student outcomes

Student Outcomes	
(a) an ability to apply knowledge of mathematics, science, and engineering	X
(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	X
(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.	X

Topics: Introduction, Mathematical description of continuous-time signals, Properties of continuous-time system, Fourier Series in exponential format, Fourier Series in Trigonometric format, Fourier Transform, Frequency Response, Laplace Transform, Pole-zero diagram and system response, Discrete-time signals.

EE 303 Electromagnetic Field Theory

Credits and contact hours: 3, 3

Instructor: Dr. Shujun Yang

Text book: William Hayt, Jr., John A. Buck, Engineering Electromagnetics, Graw Hill, Eighth Edition.

Catalog Description: A review of coordinate systems; vector analysis; study of electrostatics to include Coulomb's Law, Gauss's Law, electric field intensity, and flux density calculations, electric potential calculations; magnetostatics to include Biot-Savart law, Ampere's law, magnetic field intensity and flux density concepts; introduction to magnetic vector potential; time varying fields, Maxwell's equations; and transmission lines.

Prerequisites: EE 202 and MTH 238.

Required course

Course Learning Outcomes: Upon completion of the course, students will be able to

COURSE OUTCOMES WITH ABET CRITERIA

Course learning outcome	Student Outcome	Assessment Tool
Understand vector calculus and determine dot products an cross products, learn to use Matlab for vectors, and vecto products	a, k	Homework, Quiz tests, Exams Computer projects
Understand the different coordinate systems	a, e	Homework, Quiz tests, Exams
Calculate the forces and electric field intensity due to different charge systems.	a, e	Homework, Quiz tests , Exams,
Apply the divergence theorem and calculate the electric flux density	a, e	Homework, Quiz tests, Exams
Determine the electrostatic potentials and understand energy concepts	a, e	Homework, Quiz tests, Exams
Use Matlab to obtain equi-potential surfaces and stream lines	a, e, k	Computer projects
Understand boundary conditions and determine the fields in two dielectric problems	a, e	Homework, Quiz tests, Exams
Understand the various types of current sources	a, e	Homework, Quiz tests, Exams
Apply Biot-Savart law to determine the magnetic field intensity	a, e	Homework, Quiz tests, Exams
Understand Ampere's law to determine the magnetic field intensity	a, e	Homework, Quiz tests, Exams

Apply Stoke's theorem to calculate currents	a, e	Homework, Quiz tests, Exams
Determine the magnetic flux density, and magnetic flux	a, e	Homework, Quiz tests, Exams
Understand boundary conditions and determine the magnetic fields in two media problems	a, e	Homework, Quiz tests, Exams
Use Matlab for magnetic field simulations	a, e, k	Computer projects
Understand the concepts of coexistence of electric and magnetic fields	a, e	Homework, Quiz tests, Exams

Course relation to student outcomes

Student Outcomes	
(a) an ability to apply knowledge of mathematics, science, and engineering	X
(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	X
(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.	X

Topics: Introduction, Vector Analysis, Coulomb's Law and Electric Field Intensity, Electric Flux Density and Gauss's Law, Electric Energy and Potential, Conductors and Dielectrics, Capacitance, Steady Magnetic Field, Magnetic Forces and Materials, Inductance, Faraday's Law, Maxwell Equations.

EE 304 Numerical Methods and Digital Computation

Credits and contact hours: 3, 3

Instructor: Dr. Andrew Scott

Text book: Kaw, Autar. "Numerical Methods With Applications, Customized for AAMU." 2014 Edition, available online at http://www.lulu.com/shop/autar-kaw/numerical-methods-with-applications-customized-for-aamu/paperback/product-21319959.html

Course description: In this course numerical techniques are applied to the solution of scientific and engineering problems. Topics include software development techniques, solution of both linear and nonlinear equations, numerical integration and differentiation, interpolation and curve fitting, solution of differential equations, and optimization techniques. Emphasis is placed on developing programs in C++ language for execution in a UNIX environment

Prerequisites: EE 109/CS 109, MTH 238, Corequisites: n/a

Required course

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Program Outcome	Assessment Tool
Understand the role of Unix computing systems as development platform for modeling and simulation. (Optional as time permits)	j	Attendance on field trip to AL Supercomputer Ctr.
Utilize Unix system in a productive fashion and use network ssh and scp tools for interfacing desktop PCs with remote systems	j, k	Monitor login sessions.
Develop and document algorithms and data flow diagrams for solution of numerical engineering problems.	c, e	Quiz, Exams
Implement and demonstrate numerical techniques in C/C++ on a UNIX system.	a, c, k	Computer Projects
Obtain solutions of single and multi-variable non-linear equations	a, k	Homework, Quiz, Exams
Utilize vector and matrix based numerical techniques (e.g. inversion)	a, k	Homework, Quiz, Exams
Apply various numerical techniques for integration and differentiation.	a, k	
Understand role of power and Taylor series expansions.	a	Homework, Quiz, Exams
Create state-space representations of high order, multi-variable differential equations	a	Homework, Quiz, Exams

Apply Euler and R-K methods for solution of simultaneous D.E.s	a, k	Homework, Quiz, Exams

Relation of course to Student Outcomes:

(a) an ability to apply knowledge of mathematics, science, and engineering	X
(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	X
(d) an ability to function on multi-disciplinary teams	
(e) an ability to identify, formulate, and solve engineering problems	X
(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	X
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	X

Course Topics

1. Introduction
2. Basic UNIX Orientation
3. Unix File System and Code Development Tools
4. Software Design in C/C++
5. Algorithm Development
6. Solution of Non-Linear Equations
7. Interpolation and Curve Fitting
8. Numerical Differentiation and Integration
9. State-space Representation
10. Solution of Differential Equations
11. Power Series and Taylor Series
12. Boundary Value Problems (time permitting)
13. Optimization Techniques (time permitting).

EE 305 Semiconductor Engineering I

Credits and contact hours: 3, 3

Instructor: Dr. Mohammad A. Alim

Text Book: **Donald Neamen,** *An Introduction to Semiconductor Devices*, 1st or Latest Edition, McGraw-Hill, 2006, **ISBN 978-0-07-298756-0**

Reference: R. T. Howe and C. G. Sodini, *Microelectronics – An Integrated Approach* 1st or Latest Edition, Prentice-Hall, 1997

Course description: A study of the physics of semiconductor devices; properties of materials and devices used in electrical engineering; theory of operation of semiconductor devices to include semiconductor fundamentals; PN junction diodes; bipolar transistors; and field-effect devices.

Prerequisites: EE 203, EE 203L, PHY 214

Required course for General, Computer Engineering, and Microelectronics-VLSI Concentrations

Course Learning Outcomes: Upon completion of the course, students will be able to:

Course Learning Outcome	Program Outcome	Assessment Tool
1. Understand basic physical electronics	a, e, k	Homework, Exams
2. Understand the theories for the problems of semiconductor silicon	a, k	Homework, Exams
3. Understand donor, acceptor and simultaneous doping of semiconductor	a, e, k	Homework, Exams
4. Understand electrostatics, conductivity, and resistivity of semiconductor	a, e, k	Homework, Exams
5. Solve problems and make plots/graphs using standard programs: MATLAB, EXCEL	a, e, k	Homework, Exams
6. Design Diodes and p-n junctions for transistors	a, b,c, e, k	Homework, Exams
7. Write a term paper on a contemporary topic	g, j	Homework, Exams
8. Understand unipolar and bipolar devices	a, c, j	Homework, Exams

9. Comprehend basics of logic circuits using filed effect transistors	a, c, j, k	Homework, Exams
10. Understand overall integrated circuits and microelectronics	a, e	Homework, Exams

Relation of course to Student Outcomes:

Student Outcomes	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(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	**X**
(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	**X**
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	**X**

Topics Covered:

1. Microelectronics and IC Technology
2. Material Systems and their Properties
3. Conductor, Semiconductor, and Insulators
4. Single Crystal and Polycrystal semiconductors
5. Intrinsic/Extrinsic Properties and Doping Processes
6. Carrier Transport, Mobility, Drift and Diffusion Currents
7. Applied Electrostatics to the Junction Devices
8. *p-n* Diodes and Applications
9. *n-p-n* and *p-n-p* Transistors and Applications
10. MOS Structure and MOS Field-Effect Transistor

EE 306 Survey of Energy Systems

Credits and contact hours: 3, 3

Instructor: Dr. Stephen Egarievwe

Text book: Francis Vanek, Louis Albright and Largus Angenent. Energy Systems Engineering: Evaluation and Implementation, Third Edition , McGraw Hill, 2016.

Course description: This course reviews various sources of electric power including fossil fuel, renewable energy including solar, wind, wave, geothermal, and biomass and nuclear energy. Technologies for energy storage, transmission and distribution will also be included. Power plants, engines, radioactivity, and environmental impacts will be discussed. Cost of generation, distribution, energy consumption, and efficiency of various energy technologies are discussed.

Perquisites: EE 201, 202, PHY 214

Required course for Nuclear Power Concentration

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Student Outcome	Assessment Tool
Understand energy efficiency and conservation, and the importance of various energy sources	a, c, e, k	Homework, Quiz, Exams
Understand the economics of energy generation including unit cost of energy payback, period time value of money	a, c, e, k	Homework, Quiz, Exams
Become familiar with different nuclear power options for generation of power	a, c, e, k	Homework, Quiz, Exams
Become familiar with different renewable energy options for generating power	a, c, e, k	Homework, Quiz, Exams
Become familiar with specific power plant components that are important in different power plants	a, c, e, k	Homework, Quiz, Exams
Become familiar with energy storage technology and understand the fundamentals of energy storage, batteries, and fuel cells	a, c, e, k	Homework, Quiz, Exams

Relation of course to Student Outcomes:

Student Outcomes	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**

(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	**X**
(d) an ability to function on multi-disciplinary teams	
(e) an ability to identify, formulate, and solve engineering problems	**X**
(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.	**X**

Topics: Overview of Energy Systems and Units of Measure, System Tools for Energy Systems, Economics of Energy Generation, Climate Change and Environmental Impacts of Energy Production, Fossil Fuel Resources, Nuclear Energy Systems, Solar Resources and Photovoltaic Technologies, Wind Energy Systems, Bioenergy Resources and Systems, Energy Storage and Transportation.

EE 307 Fundamentals of Nuclear Engineering

Credits and contact hours: 3, 3

Instructor: Dr. Mohammad A. Alim

Text Book: **J. R. Lamarsh and A. J. Baratta,** *Introduction to Nuclear Engineering*; 3rd or Latest Edition, Prentice Hall (2001) **ISBN-13: 978-0201824988**; **ISBN-10: 0201824981**

References: (1) **I. Kaplan;** *Nuclear Physics*, **Any Edition or Latest** Edition, Addison Wesley Publishing or successor Publisher

(2) Any Nuclear Physics Book by any Author(s)

Course description: This course covers basic atomic and nuclear physics, fundamentals of radiation, knowledge of radioactive decay, binding energy, types of interactions, shielding, and radioisotopes, fission cross section, fission in a reactor, controlling fission chains, nuclear reactor, components of nuclear reactors, nuclear fuel cycles, radioactive waste storage and disposal, reactor accidents, safety, nonproliferation and national security, radiation effects, radiation detectors, etc.

Prerequisites: CHE 101, CHE 101L, PHY 214, Approval of the Advisor

Junior Standing in Electrical Engineering or Junior Standing in Mechanical Engineering;

Required course for Nuclear Power Concentration

Course Learning Outcomes: Upon completion of the course, students will be able to:

Course Learning Outcome	**Program Outcome**	**Assessment Tool**
9. Students will be able to apply knowledge of atomic structure, atomic weight, number densities, mass and energy, mass defect, and binding energy.	a, f, h, k	Homework, Exams
10. Students will be able to apply knowledge of excited states, radioactive decay, radioactivity calculations, nuclear reaction, and nuclear reactions	a, f, h, k	Homework, Exams
11. Students will be able to apply knowledge of charge Particle interactions and neutron interactions	a, f, h, k	Homework, Exams
12. Students will be able to apply knowledge of fundamentals of fission, fission chain reaction, neutron flux, and Fick's law of diffusion.	a, f, h, k	Homework, Exams
13. Students will be able to use the concept of biological and environmental effects of nuclear radiation.	a, f, h, k	Homework, Exams
14. Students will be able to apply knowledge of basic principles of nuclear radiation detection, nuclear waste management, and non-proliferation.	a, f, h, k	Homework, Exams

Relation of course to Student Outcomes:

Student Outcomes	
(a) an ability to apply knowledge of mathematics, science, and engineering	X
(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	X
(g) an ability to communicate effectively	
(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context	X
(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	X

Topics Covered:

Overview of Nuclear Engineering: atomic structure, atomic weight, number densities, mass and energy, mass defect, and binding energy

Excited states, radioactive decay, radioactivity, and nuclear reactions

Fundamentals of charge particle interactions, neutron interactions, fission, and fission chain reaction

Neutron diffusion, neutron flux, and Fick's law

Basics of nuclear reactor theory

Basics of biological and environmental effects of nuclear radiation.

Radiation protection and radiation shielding

Reactor safety issues

EE 308 Thermal System Engineering

Credits and contact hours: 3, 3

Instructor: Dr. Mohammad A. Alim

Text Book: **M. J. Moran, H. N. Shapiro, B. R. Munson, and D. P. DeWitt,** *Introduction to Thermal Systems Engineering: Thermodynamics, Fluid Mechanics, and Heat Transfer*, 1st or Latest Edition, John Wiley (2003), **ISBN 0-471-20490-0**

References: (1) **J. M. Smith, H. C. Van Ness, and M. M. Abbott;** *Introduction to Chemical*

Engineering Thermodynamics, **7th or Latest** Edition**,** McGraw-Hill **(**2005)**; ISBN: 0-07-310445-**

0 / 978-0-07-310445—4; **(2)** T. L. Bergman, A. S. Lavine, F. P. Incropera, and D. P. Dewitt;

Fundamentals of Heat and Mass Transfer, 7th or Latest Edition, John Wiley (2011); ISBN: 978-

0-470-50197-9**; (3)** F. M. White; *Fluid Mechanics*, 8th or Latest Edition, John Wiley (2015)

ISBN: 0-07-339827-6 / 978-0-07-339827-3,

Course description: This course reviews basic knowledge of thermodynamics, fluid mechanics, and heat transfer concentrating in nuclear power option in electrical engineering and computer science. Technologies associated with thermal behavior of a system possessing comprehensive knowledge of heating sources in nuclear power generation and uses of electricity from there. Overview of fluid mechanics and heat transfer in generating nuclear power will illuminate the students' background. The significance of growing demand of electrical power using nuclear sources will be emphasized. Thermal behavior and heat transport will be explored considering a nuclear power plant. Laws of thermodynamics will be introduced while discussing heat transport in a system as power plant, nuclear reactor, and energy storage.

Prerequisites: MTH 227, PHY 214; and Approval of the Advisor

Junior Standing in Electrical Engineering

Required course for Nuclear Power Concentration

Course Learning Outcomes: Upon completion of the course, students will be able to:

Course Learning Outcome	**Program Outcome**	**Assessment Tool**
15. Understanding the equilibrium temperature of a system, and solve heat energy and conservation problems including various energy sources	a, c, e, k	Homework, Exams
16. Identify specific thermal behavior and heat transport systems in the generation of power within the power plant	a, c, e, k	Homework, Exams
17. Apply the first Law of Thermodynamics to closed and Control	a, c, e, k	Homework,

volume systems, and Second Law of Thermodynamics including entropy concepts to analyze the thermal efficiencies of heat engines such as Carnot and Rankine cycles.		Exams
18. Perform dimensional analysis for problems in fluid mechanics	a, c, e, k	Homework, Exams
19. Become familiar with specific power plant components that Are important in different power plants	a, c, e, k	Homework, Exams
20. Solve issues with heat transfer modes and rate equations.	a, c, e, k	Homework, Exams

Relation of course to Student Outcomes:

Demonstrated Capabilities	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(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	**X**
(d) an ability to function on multi-disciplinary teams	
(e) an ability to identify, formulate, and solve engineering problems	**X**
(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	**X**

Topics Covered:

Overview of heat energy systems, units of measure, fundamentals of the system approach

Conservation of energy and various energy systems

Thermal behavior and heat transport systems in the generation of power within power plant

Heating systems in the nuclear power generation

Fluid systems and fluid mechanics

Heat transfer and rate equations

Heat conduction processes

EE 320 Computer Architecture

Credits and contact hours: 3, 3

Instructor: Dr. Andrew Scott

Text book: Sandige and Sandige, Fundamentals of Digital and Computer Design with VHDL, Latest ed., McGraw Hill, New York, 2012. ISBN-13: 978-0-07-338069-8; ISBN-10: 0-07-338069-5

Course description: Basic concepts used in computer hardware design and computer system architecture are studied. The computer is presented as a finite state machine. Basic computer functions such as address and data paths, instruction sets and memory cycles, components such as registers, arithmetic units, instruction decoders, and types of memories are discussed. A general purpose instruction set computer will be analyzed.

Prerequisites: EE 204

Corequisites: EE 320L

Required course

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Program Outcome	Assessment Tool
1. Understand and interpret the differences between various data representations and number systems and transform between them. (e.g. 8/16/32 bit, signed/unsigned, integer/float/character).	a	Homework, Quiz, Exams
2. Demonstrate an understanding of basic digital design and modeling techniques.	a	Homework, Quiz, Exams
3. Utilize a variety of standard combinational circuits to meet specific requirements.	c, e	Homework, Quiz, Exams
4. Understand and design a variety of sequential circuits, and finite state machines (FSM).	c, e, k	Homework, Quiz, Exams, Computer Projects
5. Understand the function of traditional von Neumann architecture, and instruction sets.	a, c, k	Homework, Quiz, Exams
6. Understand the role of memory systems and I/O.	c, k	Homework, Quiz, Exams, Computer Projects
7. Understand indirect, indexed and extended addressing modes, and their function in assembly instructions.	c, k	Homework, Quiz, Exams
8. Utilize assembly language instructions to	c, k	Homework, Quiz,

implement basic algorithms		Exams, Computer Projects
9. Utilize VHDL to represent and create a variety of digital devices.	b, c, k	Computer Projects

Relation of course to Student Outcomes:

(a) an ability to apply knowledge of mathematics, science, and engineering	X
(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	X
(d) an ability to function on multi-disciplinary teams	
(e) an ability to identify, formulate, and solve engineering problems	X
(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.	X

Course Topics

Introduction

Review of Combinational and Synchronous Circuits

Memory and Storage

Basic Computer Structures

Input-Output and Communication

Processor and System Structures

VHDL/Verilog Hardware Definition Languages

Advanced Topics (as time permits)

EE 320L Digital Systems Laboratory

Credits and contact hours: 1, 2

Instructor: Dr. Andrew Scott

Text book: Handouts, Required Equipment is Nexys3 project board featuring Xilinx Spartan FPGAs, by Digilent, Inc. www.digilentinc.com. Equipment can be purchased, or University owns some boards that can be used in Lab 272.

Course description: This laboratory course provides a hand-on approach to digital fundamentals through the use of Complex Programmable Logic Devices (CPLDs and FPGAs). A number of laboratory projects will be completed. Early experiments concentrate on basic logic devices, and then more complex combinatorial circuits follow, including adders, multiplexers, encoders, and decoders. Low level memory devices including latches and flip-flops, counters and registers are developed. The use of advanced logic device technology prepares students for work using an industry-standard design environment.

Prerequisites: N/A

Corequisites: EE 320

Required course

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Program Outcome	Assessment Tool
Understand basic TTL devices	a	Lab projects
Understand and create basic combinational circuits.	a, b	Lab projects
Understand basic Flip/Flop circuits	a	Lab projects
Understand and create basic sequential circuits.	a, b	Lab projects
Understand and apply HDL programming.	k	Lab projects
Develop digital circuitry for FPGA using industry software.	a, b, k	Lab projects

Relation of course to Student Outcomes:

(a) an ability to apply knowledge of mathematics, science, and engineering	X
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	X
(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.	X

Course Topics

Basic TTL – OR/AND/NOT…
Standard Forms and Karnaugh Maps
NAND and NOR Logic
Exclusive OR Gates
Combinational Logic Design
Latches and Flip-Flops
Sequential Circuit Design
Registers and Counters
VHDL Programming
FPGAs

EE 330 Microprocessors

Credits and contact hours: 3, 3

Instructor: Dr. Andrew Scott

Text book: Handouts, Valvano, Jonathan W.; “Embedded Microcomputer Systems: Real Time Interfacing” 3rd Edition, Cengage Learning, 2012. ISBN: 1-111-42625-2.

Course description: A study of number systems, binary arithmetic, basic structure and operation of microcomputer systems. The microprocessor will be discussed and studied in both machine code and assembly language levels. Students will write code in assembly language, interface external devices to the microcomputer system, and study bus protocols.

Prerequisites: EE 320, EE 320L

Corequisites: N/A

Required course

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Program Outcome	Assessment Tool
Understand and interpret the differences between various data types (e.g. 8/16/32 bit, signed/unsigned, integer/float/character).	a, b	Homework, Quiz, Exams
Understand the purpose of bit masks, and how to implement them in both OR and AND situations.	a	Homework, Quiz, Exams
Develop and document algorithms and data flow diagrams for implementation of embedded engineering applications.	c, e	Homework, Quiz, Exams
Understand and apply assembly instructions and C code to implement an algorithm.	c, e, k	Homework, Quiz, Exams, Computer Projects
Understand the role of indirect, indexed and extended addressing modes.	a, k	Homework, Quiz, Exams, Computer Projects
Understand utilization of I/O (e.g. ports, data direction and configuration registers)	c, k	Computer Projects
Utilize A-D converter subsystem in the Freescale architecture	b, c, k	Computer Projects
Understand and apply pulse width modulation (PWM)	b, c, k	Computer Projects
Understand and apply standard SCI interface to	b, c, k	Computer Projects

external devices.		
Interface with basic LCD display using low level functionality via SCI interface.	b, c, k	Computer Projects
Utilize timers and interrupts to synchronize events, and control.	b, c, k	Computer Projects

Relation of course to Student Outcomes:

(a) an ability to apply knowledge of mathematics, science, and engineering	X
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	X
(c) an ability to design a system, component, or process to meet desired needs	X
(d) an ability to function on multi-disciplinary teams	
(e) an ability to identify, formulate, and solve engineering problems	X
(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.	X

Course Topics

Introduction
Number Precision and Representation
Microcomputer Operations
Microcomputer Architecture
Assembly Programming
C Language Programming
I/O Programming
Bus Protocols and Device Interfacing
A/D Conversion
Interrupts
11. Additional Topics as Time Permits

EE333 Analog Circuit Design and Analysis II

Credits and contact hours: 3, 3

Instructor: Dr. Insu Kim

Text book: Donald A. Neamen, Microelectronics Circuit Analysis and Design (Fourth edition) McGraw Hill, 2010, ISBN: 978-0-07-338064-3

Course description: This course is a continuation of the material presented in EE 203 and includes concepts of advanced analog electronic circuit design and analysis with special emphasis on VLSI circuits.

Prerequisites: EE 203 and EE 203L.

Required course

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Student Outcome	Assessment Tool
Analyze the operation of ideal BJTs.	a, e	Homework, Quiz, Exams
Analyze BJT amplifiers.	a, e	Homework, Quiz, Exams
Analyze metal-oxide-semiconductor field-effect transistors (MOSFETs).	a, e	Homework, Quiz, Exams
Analyze MOSFET amplifiers.	a, e	Homework, Quiz, Exams
Analyze the operation of ideal op-amps using the ideal op-amp model.	a, e	Homework, Quiz, Exams
Analyze op-amps using the finite gain of the op-amp.	a, e, k	Homework, Quiz, Exams
Design op-amp circuits to perform specific functions.	a, e, k	Homework, Quiz, Exams
Analyze and derive the loop gain of ideal and practical op-amp circuits.	a, e, k	Homework, Quiz, Exams

Relation of course to Student Outcomes:
Accreditation Board for Engineering and Technology (ABET) Criteria: Course Outcomes On a Per Student Basis.

	Demonstrated Capabilities	
(a)	an ability to apply knowledge of mathematics, science, and engineering	X
(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	X
(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.	X

Topics:

Analysis and design of transistor circuits including BJT and MOSFET.

Analysis and design of op-amp circuits using the ideal model.

Analysis of op-amp circuits using realistic finite loop gain conditions.

EE 340L Energy Conversion Laboratory

Credits and contact hours: 1, 3

Instructor: Dr. Zhigang Xiao

Text book: Handouts

Course description: DC motor, speed control and measurement, DC generator, connection, and magnetization characteristics, load characteristics and efficiency measurement of DC generator, measurement of mechanical parameters of DC motor, RC and RL circuits, open-circuit and short-circuit test of transformer.

Prerequisites: EE 202, EE 203L

Required course for Nuclear Power Concentration

Selected elective course for General, Computer Engineering, and Microelectronics-VLSI Concentrations

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Student Outcome	Assessment Tool
DC motor, speed control and measurement	a, b, c, e, k	Lab Project
DC generator, connection, and magnetization characteristics	a, b, c, e, k	Lab Project
Load characteristics of DC generator	a, b, c, e, k	Lab Project
Efficiency measurement of DC generator	a, b, c, e, k	Lab Project
Measurement of mechanical parameters of DC motor	a, b, c, e, k	Lab Project
RC and RL circuits, phasor diagram, and power factor	a, b, c, e, k	Lab Project
Open-circuit and short-circuit test of transformer	a, b, c, e, k	Lab Project
Open-circuit and short-circuit test of 3-phase alternator	a, b, c, e, k	Lab Project

Relation of course to Student Outcomes:

Demonstrated Capabilities	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	**X**
(c) an ability to design a system, component, or process to meet desired needs	**X**

(d) an ability to function on multi-disciplinary teams	
(e) an ability to identify, formulate, and solve engineering problems	**X**
(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.	**X**

Topics: Speed control of dc motor, magnetization characteristics of dc generator, load characteristics of dc generator, mechanical parameters of dc motor, A.C. circuits, phasor diagrams, power and power factor, OC and SC tests on transformer, and OC and SC tests on 3-phase alternator

EE 350 VLSI Design and Testing

Credits and contact hours: 3, 3

Instructor: Dr. Zhigang Xiao

Text book: Introduction to VLSI Circuits and Systems, John Wiley and Sons, Inc.

Course description: Principles of structured VLSI circuit design with emphasis on CMOS; VLSI fabrication technique for MOS; circuit characterization and performance estimation using Multisim and Spice; design and testing at the architectural, and register transfer logic levels.

Prerequisites: EE 305

Required course for Microelectronics-VLSI Concentration

Selected elective course for General and Computer Engineering Concentration

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Student Outcome	Assessment Tool
Basic CMOS logic design	a, c,e,k	Homework, Quiz, Exams
Basic CMOS design and fabrication including analysis tools	a, c, e,k	Homework, Quiz, Exams
Topological (mask) design and how to use layout tools	a, c, e,k	Homework, Quiz, Exams, Project
Relationship between layout design and circuit performance, including analysis of all parasitic capacitances and resistances	a,c, e, k	Homework, Quiz, Exams, Project
CMOS circuit power consumption, design of digital logic including design tradeoffs related to power and performance	a, c, e, k	Homework, Quiz, Exams, Project

Relation of course to Student Outcomes:

(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(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	**X**
(d) an ability to function on multi-disciplinary teams	
(e) an ability to identify, formulate, and solve engineering problems	**X**
(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.	**X**

Topics: Logic design with MOSFETs, physical structure of CMOS ICs, elements of physical design, electrical characteristics of MOSFETs, electronic analysis of CMOS logic gates, designing high speed CMOS logic networks, and advanced techniques.

EE 360L Communication Laboratory

Credits and contact hours: 1, 3

Instructor: Dr. Zhigang Xiao

Text book: Handouts

Course description: Fundamental communication principles and knowledge software simulation and hardware experiments, AM and FM modulation concepts for information transmission and demodulation techniques for information extraction from signals, signal mixing and frequency conversion, pulse code modulation, digital modulation, linear frequency modulation, Nyquist sampling theory and low pass filtering, high pass filtering, and quantization noise.

Prerequisites: EE 301

Selected elective course for General, Computer Engineering, and Microelectronics-VLSI Concentrations

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Student Outcome	Assessment Tool
Apply spectral analysis on various periodic signals	a, b, c, e, k	Lab Project
Mix signals and analyze the behavior of the resultant signal	a, b, c, e, k	Lab Project
Perform signal processing using TIMS hardware	a, b, c, e, k	Lab Project
Simulate amplitude modulation (AM) demodulator	a, b, c, e, k	Lab Project
Analyze the frequency responses of tunable low pass filter using TIMS hardware	a, b, c, e, k	Lab Project
Compare TIMS Tunable Low Pass Filter with Butterworth	a, b, c, e, k	Lab Project

Relation of course to Student Outcomes:

Demonstrated Capabilities	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	**X**
(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.	**X**

Topics: Fourier series simulation, signal mixing and filtering, signal modulation, signal processing with TIMS hardware, modulation (AM) demodulator, frequency responses of tunable low pass filter, and comparison of TIMS tunable low pass filter with Butterworth,

EE 403 Feedback System Analysis and Design

Credits and contact hours: 3, 3

Instructor: Dr. Shujun Yang

Text book: Norman S. Nise, Control Systems Engineering, Wiley, 6th Edition

Course description: A study of open and closed loop systems; time domain analysis; transfer functions, poles and zeros; frequency response, Bode plots; root locus methods; system stability, Routh-Hurwitz criterion, Nyquist criterion; system compensation and design; state space methods, state equations, state transition matrix, and system response.

Prerequisites: EE 301

Required course

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Student Outcome	Assessment Tool
Obtain Laplace transforms, inverse transforms, solution of ordinary differential equations and develop Matlab codes	a, e, k	Homework, Exams, Computer Projects
Obtain transfer functions, and analyze the behavior of electromechanical components	a, e, k	Homework, Exams, Computer Projects
Simplify block diagrams, and signal flow graphs.	a, e	Homework, Exams
Develop Matlab codes for interconnected systems and use Simulink models	k	Computer Projects
Understand and analyze steady state behavior of feedback systems, and work with steady state error coefficients	a, e	Homework, Exams,
Analyze the transient behavior of prototype second order system, determine peak overshoot, natural frequency, damping ratio and their significance	a, e, k	Homework, Exams, Computer Projects
Determine the frequency response of linear systems, and obtain the Bode plots	a, e, k	Homework, Exams, Computer Projects
Understand the concept of system stability, pole locations and apply Routh-Hurwitz criterion	a, e, k	Homework, Exams, Computer Projects
Understand root loci concepts, obtain root locus plots of typical systems, understand the movement of the closed loop poles	a, e, k	Homework, Exams, Computer Projects
Develop basic state space models, and obtain state transition matrix	a, e	Homework, Exams,

Understand Nyquist Criterion, Sketch Nyquist Diagram	a, e	Homework, Exams,

Relation of course to Student Outcomes:

Student Outcomes	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(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	**X**
(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.	**X**

Topics: Introduction to this course, Laplace Transform, Electrical network Transfer Function, Time Response, State Space Presentation, Reduction of multiple subsystems, Routh Table, Root Locus, Nyquist Diagram, and Steady State Errors.

EE 404, Communication Theory

Credits and contact hours: 3, 3

Instructor: Dr. Raziq Yaqub

Text book: Digital and Analog Communication Systems (Eighth Edition), By Leon W. Couch, II, ISBN-13:978-0132915380

References:

Fundamentals of Communication Systems, John G. Proakis, and Masoud Salehi, ISBN-13: 978013147135

Principles of Electronic Communication Systems / Edition 3, Louis E. Frenzel, ISBN-10: 007317042

Course Description: A study of communication signals and systems; AM and FM methods; pulse code modulation; multiplexing, and digital communication

Prerequisites: EE 301

Required course for General, Computer Engineering, and Microelectronics-VLSI Concentrations.

Specific goals for the course

To make students understand the evolution of communication systems, fundamentals of analog communication, digital communication, probability theory and random processes. Also to make students capable of getting a successful career, getting a leadership role, and contributing to the economic development.

Specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.

The students will be able to explain Signals, Systems and Signals Analysis, applications of Fourier Transform in communication theory, Modulations Systems (Frequency, Amplitude, Angle Modulation, and Digital Modulation), Multiplexing, Components of Analog and Digital transmission systems. Probability Theory and Random Process, Noise, Information Theory and Coding.

Course Learning Outcomes: Upon completion of the course, students will be able to:

Course Learning Outcome	Student Outcome	Assessment Tool
Understand evolution of advanced Communication Systems, and driving force behind the evolution.	a, g, j, k	CRQ, Homework, Exams, Extra Credit Questions
Analyze Signals and Systems	a, e, k	CRQ, Homework, Exams, Extra Credit Questions
Apply Fourier Transform in communication theory and solve Fourier Transforms.	a, e, k	CRQ, Homework, Exams, Extra Credit Questions
Comprehend Analog Modulations Systems	e, g, k	CRQ, Homework, Exams,

(Frequency, Amplitude, Angle Modulation)		Extra Credit Questions
Understand Digital Modulations Systems (BPS, QPS, QAM)	a, e, g	CRQ, Homework, Exams, Extra Credit Questions
Apply Probability Theory and Random Process to communication systems	a, e, g, j, k	CRQ, Homework, Exams, Extra Credit Questions
Understand Noise, and apply Probability Theory to understand Noise	a, e, k	CRQ, Homework, Exams, Extra Credit Questions
Grasp reasons behind transition from Analog to Digital, and evaluate the pros and cons of both analog and digital systems	a, g, j, k	CRQ, Homework, Exams, Extra Credit Questions
Understand Digital Transmission Techniques	a, e, k	CRQ, Homework, Exams, Extra Credit Questions
Get to know Information Theory and Coding	a, e	CRQ, Homework, Exams, Extra Credit Questions

Brief list of topics to be covered

Evolution/Overview of advanced Communication Systems, Signals, Systems and Signals Analysis, Fourier Transform, Modulations Systems (Frequency, Amplitude, Angle Modulation), Probability Theory and Random Process, Noise, Transition from Analog to Digital, Digital Transmission Techniques, Information Theory and Coding

EE 405L Simulation Techniques Laboratory

Credits and contact hours: 1, 3

Instructor: Dr. Zhigang Xiao

Text book: Handouts

Course description: Hands-on experience in the use of computer software and simulation tools, design and simulation of BJT- and CMOS-based electronic circuits such as differential amplifier ring oscillators, analysis of effects of biasing on voltage gain, and analysis of closed-loop gain and slew rate of operational amplifier.

Prerequisites: EE 333

Required course for General, Computer Engineering, and Nuclear Power Concentrations

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Student Outcome	Assessment Tool
Perform DC sweep analysis for electronic circuits	a, b, c, e, k	Lab Project
Analyze effects of biasing on voltage gain of differential amplifiers	a, b, c, e, k	Lab Project
Design and simulate BJT-based differential amplifiers	a, b, c, e, k	Lab Project
Design and simulate CMOS-based wide-range operational amplifiers	a, b, c, e, k	Lab Project
Design and simulate CMOS-based two-stage operational amplifier	a, b, c, e, k	Lab Project
Analyze closed-loop gain and slew rate of operational amplifiers	a, b, c, e, k	Lab Project
Design and simulate CMOS ring oscillators	a, b, c, e, k	Lab Project

Relation of course to Student Outcomes:

Demonstrated Capabilities	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	**X**
(c) an ability to design a system, component, or process to meet desired needs	**X**
(d) an ability to function on multi-disciplinary teams	

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

Topics: Junction gate field effect transistor (JFET) circuit, DC sweep analysis for electronic circuits, design and simulation of BJT-based differential amplifier, effects of biasing on voltage gain of BJT-based differential amplifier, design and simulation of CMOS-based wide-range operational amplifier, effects of biasing currents on voltage gain of CMOS-based operational amplifier, design and simulation of CMOS-based two-stage operational amplifier, effects of biasing currents on voltage gain of two-stage CMOS operational amplifier, closed-loop gain and slew rate of two-stage CMOS operational amplifier, design and simulation of CMOS ring oscillators.

EE 410 Microwaves

Credits and contact hours: 3, 3

Instructor: Dr. Shujun Yang

Text book: Microwave Engineering, David Pozar, Wiley (2004).

Course description: Maxwell's Equations, General plane waves solutions, Energy and power concepts, Plane wave reflection at planar boundaries, Transmission line theory, Terminated lossless transmission line, Smith chart, Rectangular waveguides, Coaxial Line, Striplines and microstrips, microwave network analysis, Impedance matching and tuning, microwave power dividers and combiners.

Prerequisites: EE 303

Required course for the General Concentration

Selected elective course for Computer Engineering and Microelectronics-VLSI Concentrations

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Student Outcome	Assessment Tool
Apply vector calculus to solve EM problems	a, e, k	Homework and exams
Solve plane wave propagation problems in homogeneous space	a, e, k	Homework and exams
Solve EM reflection at conducting plane boundary	a, e, k	Homework and exams
Solve EM reflection and transmission at dielectric plane boundary	a, e, k	Homework and exams
Calculate critical angle for total reflection	a, e, k	Homework and exams
Compute characteristic impedance of transmission lines	a, e, k	Homework and exams
Calculate reflection coefficient and SWR for transmission lines	a, e, k	Homework and exams
Understand Smith Chart	a, e, k	Homework and exams
Use Smith Chart to solve transmission line problems	a, e, k	Homework and exams
Design and analyze microwave matching networks	a, e, k	Homework and exams
Understand and use Y, Z, S, and ABCD matrices	a, e, k	Homework and exams
Design and analyze microwave power dividers	a, e, k	Homework and exams

Relation of course to Student Outcomes:

Student Outcomes	

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

Topics: Introduction, Vector Analysis, Maxwell Equations, Boundary conditions, Plane Wave Equations, Energy and Power, Reflections and Transmission at Interface, A Circuit Model of Transmission Line, Field Analysis of Transmission Lines, Terminated Lossless Transmission Line, Smith Chart, Smith Chart Applications, Transmission Lines and Waveguides, Microwave Network Analysis, Microwave Impedance Matching Networks, Microwave Power Dividers.

EE 420, Power Systems-I

Credits and contact hours: 3, 3

Instructor: Dr. Raziq Yaqub

Text book: Power Systems, By Ned Mohan, ISBN No. 0-9715292-7-2

References

Power System Analysis and Design, 5th Edition, By J. Duncan Glover and Mulukutla S. Sarma, ISBN-13: 978-1111425777

Electrical Power Systems, By P.S.R. Murty and Butterworth-Heinemann, ISBN No. 9780081012451

Course Description: Interconnected Systems, Review of Basic Concepts, Single Phase and Three Phase AC Power, Transformers and PU System, Electrical Motors and Generators, Transmission Lines, Voltage Regulation and Stability in Power, Short Circuit Studies.

Prerequisites: EE 301

Required course for Nuclear Power Concentration

Selected elective for General, Computer Engineering, and Microelectronics-VLSI Concentrations.

Specific goals for the course

To make students understand the AC Power, Transformers, Electrical Machines, Transmission Lines, Voltage Regulation and Stability, Short Circuit Studies. Also to make students capable of getting a successful career, getting a leadership role, and contributing to the economic development.

Specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.

The students will be able to explain Power Systems including Interconnected Systems, AC Power, Single Phase and Three phase, Transformer Model, Single Phase, Three Phase, and PU System, Electrical Machines, Generators and Motors, Transmission Lines, Voltage Regulation and Stability in Power Systems, Short Circuit Studies.

Course Learning Outcomes: Upon completion of the course, students will be able to:

Course Learning Outcome	Student Outcome	Assessment Tool
Grasp the bigger picture of Power Systems	a, g, j, k	CRQ, Homework, Exams, Extra Credit Questions
Know the value of Interconnected Systems	a, e, k	CRQ, Homework, Exams, Extra Credit Questions
Critically review the Fundamental Concepts of Electrical Engineering applicable to high voltage system	a, e, k	CRQ, Homework, Exams, Extra Credit Questions

Understand the AC Power Single Phase, and learn how it is different from DC Power.	a, e, g, k	CRQ, Homework, Exams, Extra Credit Questions
Understand the 3-Phase AC Power, and learn how it is different from Single Phase AC Power.	a, e, g	CRQ, Homework, Exams, Extra Credit Questions
Evaluate Transformer Model and calculate transformer parameters in PU System	a, e, g, j, k	CRQ, Homework, Exams, Extra Credit Questions
Examine Single Phase, and Three Phase Transformer, and learn different types and applications of transformers.	a, e, k	CRQ, Homework, Exams, Extra Credit Questions
Understand the principal and laws governing the operation of Electrical Machines (Generators)	a, g, j, k	CRQ, Homework, Exams, Extra Credit Questions
Understand the principal and laws governing the operation of Electrical Machines (Motors)	a, e, k	CRQ, Homework, Exams, Extra Credit Questions
Grasp the knowledge about Transmission and Distribution Systems, and their types.	a, e, g, j	CRQ, Homework, Exams, Extra Credit Questions

Brief list of topics to be covered

Introduction to Power Systems, Interconnected Systems, Review of Fundamental Concepts, AC Power Single Phase, AC Power Three phase, Transformer Model and PU System, Transformer (Single Phase, and Three Phase), Electrical Machines (Generators), Electrical Machines Motors, Transmission and Distribution Systems

EE 421, Power Systems-II

Credits and contact hours: 3, 3

Instructor: Dr. Raziq Yaqub

Text book: Power Systems, By Ned Mohan, ISBN No. 0-9715292-7-2

References:

Power System Analysis and Design, 5th Edition, By J. Duncan Glover and Mulukutla S. Sarma, ISBN-13:978-1111425777.

Electrical Power Systems, By P.S.R. Murty and Butterworth-Heinemann, ISBN No. 9780081012451

Course Description: Electrical Energy (Including Renewable Energy) Generation, Transmission Lines and Underground Cables, Power Flow, Transformers in Power Systems, HVDC Transmission, Distribution Systems, Power Quality, 3-Phase Systems, Voltage Regulation and Stability, Transients and Dynamic Stability, Control of Interconnected Power Systems, Transmission Line Faults, Relays/Circuit Breakers, Advanced concepts in Power Systems leading to Smart Grid.

Prerequisites: EE 301, EE 420

Required course for Nuclear Power Concentration

Specific goals for the course

To give students the ability to identify, formulate and solve problems involving: Power Generation, Transmission, Distribution and Consumption, Advanced Concepts in Power Systems leading to future Smart Grid, AC, DC, Steady State AC, Transients, faults and Protection, Transmission Line Parameters and Load flow analysis. Also to make students capable of getting a successful career and a leadership role.

Specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.

The students will be able to explain Power Systems Including solving problems related to Power Generation, Transmission, Distribution and Consumption, Advanced Concepts in Power Systems leading to future Smart Grid, AC, DC, Steady State AC, Transients, faults and Protection, Transmission Line Parameters and Load flow analysis.

Course Learning Outcomes: Upon completion of the course, students will be able to:

Course Learning Outcome	**Student Outcome**	**Assessment Tool**
Critically review the drivers behind advancements in Power Systems, and understand the motivations behind the Smart Grid	a, g, j, k	CRQ, Homework, Exams, Extra Credit Questions
Understand Energy Sources (Including Conventional & Renewable Energy Resources)	a, e, j, k	CRQ, Homework, Exams, Extra Credit Questions

Grasp the concepts, and pros & cons of overhead Transmission Lines vs. Underground Cables	a, e, g, k	CRQ, Homework, Exams, Extra Credit Questions
Analyze Power Flow, Transient Stability, Over-Voltages, Surge Arrestors, and Insulation Coordination	a, e, g, k	CRQ, Homework, Exams, Extra Credit Questions
Study design parameters of a Transformers	a, e, j, g	CRQ, Homework, Exams, Extra Credit Questions
Distinguish Distribution System from Transmission Systems, study the types of distribution systems, and understand the advantages/disadvantages of each. Also evaluate the Economic Dispatch	a, e, g, j, k	CRQ, Homework, Exams, Extra Credit Questions
Analyze Three Phase Systems	a, e, k	CRQ, Homework, Exams, Extra Credit Questions
Examine High Voltage DC, and advancements in HVDC in recent years.	a, g, j, k	CRQ, Homework, Exams, Extra Credit Questions
Understand the importance of Voltage Stability, and study different means to achieve stability.	a, e, k	CRQ, Homework, Exams, Extra Credit Questions
Understand mathematically analyze, and calculate Faults, and the role played by Relays and Breakers in fault mitigation.	a, e, g, j	CRQ, Homework, Exams, Extra Credit Questions

Brief list of topics to be covered

Advanced concepts leading to Smart Grid, Renewable Energy Resources), Transmission Lines and Underground Cables, Power Flow, Transient Stability, Over-Voltages, Surge Arrestors, and Insulation Coordination, Transformers, Distribution Systems, Economic Dispatch, 3-Phase Systems, HVDC, Voltage Stability, Faults/Relays/Breakers

EE 422, Smart Metering Infrastructure and Cyber Security (SMI&CS)

Credits and contact hours: 3, 3

Instructor: Dr. Raziq Yaqub

Text book:

No. precise textbook available on this topic. Lecture Notes will be provided by the instructor based on books given below and under supplemental material.

The Advanced Smart Grid: Edge Power Driving Sustainability, by Andres Carvallo and John Cooper, ISBN No. 13: 978-1-60807-127-2

References

Smart Grid Security: An End-to-End View of Security in the New Electrical Grid, By Gilbert N. Sorebo Michael C. Echols, ISBN- ISBN-13: 978-1439855874

Couse Description: Intro to Smart Grids. Fundamentals of Cyber Security, Components of SMI, SMI and Security Aspects at Subscriber End, SMI and Security Aspects at Utility End. Security Aspects in Communication/Sensors Networks enabling SMI, and consumer privacy, SMI, Attack Detection and Recovery at Utility Network,

Prerequisites: EE 301, EE 420

Elective course

Specific goals for the course:

To give students the ability to understand Smart Metering Infrastructure (SMI), Cyber Security with respect to" (a) SMI, (b) Subscriber, (c) Utility, and (d) Communication Networks. Subscribers' Consumer Privacy. Also to make students capable of getting a successful career and getting a leadership role.

Specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.

To give students the ability to understand Smart Metering Infrastructure (SMI), Cyber Security in context with SMI, SMI and Security Aspects at Subscriber End, SMI and Security Aspects at Utility End, Security Aspects in Communication/Sensors Networks enabling SMI, SMI and Subscribers' Consumer Privacy and Protections Also SMI and Attack Detection and Recovery.

Course Learning Outcomes: Upon completion of the course, students will be able to:

Course Learning Outcome	**Student Outcome**	**Assessment Tool**
Understand Fundamentals of Smart Grids to set the stage	g, j, k	CRQ, Homework, Exams, Extra Credit Questions
Grasp Fundamentals of Cyber Security (Security Attacks, Threats, and the Model of Cyber Security/Protocols.	a, e, j, k	CRQ, Homework, Exams, Extra Credit Questions

Comprehend the basic concept and components of SMI, and Automatic Meter Reading (AMR)	e, g, k	CRQ, Homework, Exams, Extra Credit Questions
Envision SMI and Security Aspects at Subscriber End:	e, g, k	CRQ, Homework, Exams, Extra Credit Questions
Study SMI and Security Aspects at Utility End including SCADA.	a, e, j, g	CRQ, Homework, Exams, Extra Credit Questions
Learn Security Aspects in Communication/Sensors Networks enabling SMI.	a, e, g, j, k	CRQ, Homework, Exams, Extra Credit Questions
Examine SMI and Subscribers' Privacy Aspects to discuss consumer Privacy and Protections.	a, e, k	CRQ, Homework, Exams, Extra Credit Questions
Analyze SMI, Attack Detection and Recovery at Utility Network.	g, j, k	CRQ, Homework, Exams, Extra Credit Questions

Brief list of topics to be covered

Fundamentals of Smart Grids, Fundamentals of CS to introduce Security Attacks, Threats, and the Model of Cyber Security and Security Protocols for Smart Grid, The basic concept and components of SMI, and Automatic Meter Reading (AMR), SMI and Security Aspects at Subscriber End, SMI and Security Aspects at Utility End including SCADA, Security Aspects in Communication/Sensors Networks enabling SMI, SMI and Subscribers' Privacy Aspects to discuss consumer Privacy and Protections.

EE 425 High Performance Computing

Credits and contact hours: 3, 3

Instructor: Dr. Andrew Scott

Text book: Two electronic textbooks will be utilized for this course:

1. "Introduction to High Performance Scientific Computing", Eijkhout, Chow and van de Geijn. 1st ed. 2011. http://www.lulu.com/shop/victor-eijkhout/introduction-to-high-performance-scientific-computing/paperback/product-21738434.html#productDetails

2. "High Performance Computing", Severance, Connexions, Rice University, Houston, TX, 2009. http://cnx.org/content/col11136/1.2/

Course description: This course introduces students to the cutting edge of high performance computing, examining both parallel and distributed architectures and the networks that interconnect them. The course covers a number of topics, ranging from computing and network architecture, design of software applications, to hands-on supercomputing.

Prerequisites: Senior Standing or Consent of Instructor

Corequisites: N/A

Selected elective course for General, Computer Engineering, and Microelectronics-VLSI Concentrations

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Program Outcome	Assessment Tool
Understand the history and evolution of high performance computing hardware/software.	g	Classroom presentation
Demonstrate an understanding of various HPC architectures.	c	Projects, Exams
Understand the interconnected role of memory and network systems in shared and distributed systems.	c	Projects, Exams
Understand the role of algorithm choice and data dependencies for large scale problems.	a, c, k	Projects, Exams
Utilize OpenMP and MPI programming libraries to effect parallel software applications.	a, c, k	Projects
Gain experience in cutting edge HPC technologies such as GPU and FPGA co-processing.	a, c, k	Projects

Relation of course to Student Outcomes:

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

Course Topics

Introduction
History of High Performance Computing (HPC) Hardware
Parallel Computing Architecture
Distributed Computing Architecture
Network Topologies in HPC
Memory-Hierarchy Management
Developing Technologies (FPGAs, GPUs,…)
Parallel I/O
Languages and Compilers
Optimized Libraries
Message Passing and Threads
OpenMP
MPI
Applications
Programming Projects

EE 426, Next Generation Mobile Networks (NGMN), Applications, and Services

Credits and contact hours: 3, 3

Instructor: Dr. Raziq Yaqub

Text book: 5G Mobile and Wireless Communications Technology 1st Edition, by Afif Osseiran, ISBN-13: 978-1107130098

References:

From GSM to LTE-Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband, 3rd Edition, by Martin Sauter, ISBN-13: 978-1119346869

Course Description: Evolution of advanced Communication Systems from 1G to 5G, fundamentals of radio communications network including smart antennas, fundamental of IP based core network, and the applications of NGMN in different verticals such Smart Grid, IoT, Public Safety, Cloud and virtualization.

Prerequisites: EE 301, 404

Elective course

Specific goals for the course

To make students understand the evolution of communication systems, fundamentals of radio communications, fundamentals of IP based core network, and the applications of NGMN in different interdisciplinary fields such Smart Grid, IoT, Public Safety, Cloud and virtualization.

Specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.

The students will be able to explain the radio and core network aspects of 4G/LTE and 5G communication systems. They will also be able to understand the applications and services of NGMN in Internet of Things, Smart Grid, Public Safety Services, Cloud Services and Virtualization.

Course Learning Outcomes: Upon completion of the course, students will be able to:

Course Learning Outcome	Student Outcome	Assessment Tool
Deep dive into Radio Aspects of 4G/LTE and 5G Telecommunication Systems, including OFDMA and MIMO.	a, g, j, k	CRQ, Homework, Exams, Extra Credit Questions
Comprehend the Evolved Packet Core that is built on modern IP-based architecture.	e, g, k	CRQ, Homework, Exams, Extra Credit Questions
Envision applications and services offered by Mobile broadband.	a, e, k	CRQ, Homework, Exams, Extra Credit Questions
Introduce the concept of Internet of Things (IoT) including new products, services and applications	e, g, k	CRQ, Homework, Exams, Extra Credit Questions

Understand how NGMN can be applied in Smart Grid	a, e, g	CRQ, Homework, Exams, Extra Credit Questions
Understand how Public Safety Services can benefit from NGMN.	a, e, g, j, k	CRQ, Homework, Exams, Extra Credit Questions
Analyze the application of NGMN in Cloud Services.	a, e, k	CRQ, Homework, Exams, Extra Credit Questions
Analyze the application of NGMN in Virtualization	a, g, j, k	CRQ, Homework, Exams, Extra Credit Questions

Brief list of topics to be covered

Radio Aspects of 4G/LTE and 5G Telecommunication Systems, Evolved Packet Core based on modern IP-based architecture, Applications and services of mobile broadband, Applications of NGMN in Internet of Things (IoT), Applications of NGMN in Smart Grid, Applications of NGMN in Public Safety Services, Applications of NGMN in Cloud Services, Applications of NGMN in Virtualization

EE 431 Semiconductor Engineering II

Credits and contact hours: 3, 3

Instructor: Dr. Mohammad A. Alim

Text Book: R. S. Muller and T. I. Kamins, *Device Electronics for Integrated Electronics*, 3rd or Latest Edition, John Wiley (2003) , **ISBN 0-471-593-98-2;** also supported by necessary handout materials from time to time or as-necessary basis.

References: (1) D. Neamen, *An Introduction to Semicond. Devices*, 1st or Latest Edition, McGraw-Hill (2006), **ISBN 978-0-07-298756-0**; (2) R. T. Howe and C. G. Sodini, *Microelectronics – An Integrated Approach*, 1st or Latest Edition, Prentice-Hall (1997), **ISBN 0-13-588513-3**

Course description: Principles of device electronics, physics of bond models, Schottky barriers, bipolar and unipolar devices, conduction phenomena, role of defects and noise. Introduction to wide bandgap semiconductors, junction devices, and brief statistics of SRH generation-recombination.

Prerequisites: EE 305 (Offered Spring)

Required course for Microelectronics-VSLI Concentration

Selected elective course for General and Computer Engineering Concentrations

Course Learning Outcomes: Upon completion of the course, students will be able to:

Course Learning Outcome	Program Outcome	Assessment Tool
1. Understand basic physical electronics	a, e, k	Homework, Exams
2. Understand the theories for the problems of semiconductor silicon	a, k	Homework, Exams
Understand donor, acceptor and simultaneous doping of semiconductor	a, e, k	Homework, Exams
Understand electrostatics, conductivity, and resistivity of semiconductor	a, e, k	Homework, Exams
Solve problems and make plots/graphs using standard programs: MATLAB, EXCEL	a, e, k	Homework, Exams
6. Design Diodes and p-n junctions for transistors	a, b,c, e, k	Homework, Exams
7. Write a term paper on a contemporary topic	g, j	Homework, Exams

8. Understand unipolar and bipolar devices	a, c, j	Homework, Exams
9. Comprehend basics of logic circuits using filed effect transistors	a, c, j, k	Homework, Exams
Understand overall integrated circuits and microelectronics	a, e	Homework, Exams

Relation of course to Student Outcomes:

Demonstrated Capabilities	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(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	**X**
(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	**X**
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	**X**

Topics Covered:

Semiconductor Electronics

Silicon Technology

Conduction Processes and Relevant Mechanisms

Metal-Semiconductor Contacts and Schottky Barriers

The *p-n* junction: Generation/Recombination, Injection, SRH Effect, etc.

Transistor Properties

Theories of MOS System, Models of Various MOSFET and JFET

Hybrid Systems

EE 451 Integrated Circuit Fabrication

Credits and contact hours: 3, 3

Instructor: Dr. Zhigang Xiao

Text book: Fabrication Engineering at the Micro and Nanoscale, Forth Edition, 2013

Course description: Introduction to principles of monolithic IC fabrication including bipolar and MOS transistor processing, active and passive device and process design, simulation, cleanroom procedures, in-process and final test and evaluation techniques, yield, chip assembly and packaging.

Prerequisites: EE 305, and permission of instructor

Required course for Microelectronic-VLSI Concentration

Selected elective course for General and Computer Engineering Concentrations

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Program Outcome	Assessment Tool
Growth rate versus temperature for oxidation	a, e, k	Homework, Exams
Dopant concentration and profile in thermal diffusion	a ,e, k	Homework, Exams
Dopant concentration and profile in ion implantation	a, e, k	Homework, Exams
Mask design and fabrication	b, c, k	Homework, Exams
Photo lithography and photo resists	b, c, k	Homework, Exams
Plasma and dry etching	b, c, k	Homework, Exams
PVD, CVD, and epitaxial growth	b, c, k	Homework, Exams
Isolation, contact, metallization	b, c, k	Homework, Exams
MOSFET characterization	a, b, k	Homework, Exams
MOS process integration; bipolar process integration	a, b, c, k	Homework, Exams
Packaging and yield	a, c, e	Homework, Exams

Relation of course to Student Outcomes:

(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	**X**

(c) an ability to design a system, component, or process to meet desired needs	**X**
(d) an ability to function on multi-disciplinary teams	
(e) an ability to identify, formulate, and solve engineering problems	**X**
(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.	**X**

Topics: Thermal oxidation, thermal diffusion, ion implantation, optical lithography, plasma and dry etching, wet etching, thin film deposition, isolation, contact, metallization, MOS process, integration, packaging technology and yield.

EE 451L Integrated Circuit Fabrication Laboratory

Credits and contact hours: 1, 3

Instructor: Dr. Zhigang Xiao

Text book: Handouts

Course description: Hands-on experience in cleanroom-Based microfabrication, silicon wafer oxidation, UV lithograph, wet etching of silicon dioxide, thermal diffusion for source/drain doping, e-beam evaporation of aluminum thin films for metal contacts, characterization of fabricated devices.

Corequisite: EE 451

Required course for Microelectronics-VLSI Concentration

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Student Outcome	Assessment Tool
Perform wet and dry oxidation	a, b, c, e, k	Lab Project
Perform UV lithography	a, b, c, e, k	Lab Project
Perform wet etching of silicon dioxide	a, b, c, e, k	Lab Project
Perform e-beam evaporation of aluminum thin films	a, b, c, e, k	Lab Project
Test and characterize the fabricated MOSFETs	a, b, c, e, k	Lab Project
Analyze the measured IV curves	a, b, c, e, k	Lab Project

Relation of course to Student Outcomes:

Demonstrated Capabilities	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	**X**
(c) an ability to design a system, component, or process to meet desired needs	**X**
(d) an ability to function on multi-disciplinary teams	
(e) an ability to identify, formulate, and solve engineering problems	**X**
(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.	**X**

Topics: Initial silicon wafer oxidation, UV lithograph for source/drain definition, wet etching of silicon dioxide and thermal diffusion for source/drain doping, UV lithograph for gate definition, wet etching of silicon dioxide and dry oxidation for gate oxide, UV lithograph for contact definition, wet etching of silicon dioxide and e-beam evaporation of aluminum thin films for metal contacts, UV lithograph and aluminum etching for metallization, characterization of fabricated devices for sheet resistance and contact resistance of boron doping, characterization of fabricated diode and p-channel MOSFET for IV Curves

EE 452 Semiconductor Instrumentation

Credits and contact hours: 3, 3

Instructor: Dr. Mohammad A. Alim

Text Book: W. R. Runyan and T. J. Shaffner, *Semiconductor Measurement and Instrumentation*, 2nd or Latest Edition, McGraw-Hill, 1998, **ISBN 0-39-021736-0 and 978-0-39-021736-3;** also supported by necessary handout materials periodically or as-necessary basis.

References: (1) **(1)** D. K. Schroder, *Semiconductor Material and Device Characterization*, 3rd or Latest Edition, John Wiley, 2006, **ISBN 978-0-471-73906-7**; (2) R. T. Howe and C. G. Sodini, *Microelectronics – An Integrated Approach*, 1st or Latest Edition, Prentice-Hall (1997), **ISBN 0-13-588513-3**

Course description: Basic Principles of Semiconductor testing and evaluation. Various tools and techniques will be introduced for test and evaluation of semiconductor materials, devices and integrated circuits.

Prerequisites: EE 305

Elective course

Course Learning Outcomes: Upon completion of the course, students will be able to:

Course Learning Outcome	Program Outcome	Assessment Tool
Understand various instruments used in fabrication/processing and characterization	a, e, k	Homework, Exams
Understand the nature of tests evaluations of the devices	a, b,c, e, j, k	Homework, Exams
Understand various crystals and crystallography	a, b,c, e, k	Homework, Exams
Understand defect states and their role in conduction process	a, e, k	Homework, Exams
Understand metallization and alloys and diffusion laws	a, c, e, k	Homework, Exams
Perform data analysis for various tools/techniques using MATLAB, EXCEL	a, e, k	Homework, Exams
Role of vacuum evaporation in metallization and epitaxy	a, b,c, j, k	Homework, Exams

Relation of course to Student Outcomes:

Demonstrated Capabilities	

(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	**X**
(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	**X**
(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	**X**
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	**X**

Topics Covered:

A Perspective on Doping Processes and Related Instrumentation

Physics and Chemistry of Semiconductors

Crystal Structure of semiconductors and X-Ray Crystallography

Imperfections and Lattice Defects

Stoichiometric and Non-Stoichiometric Crystals and Polycrystals

Measurement and Characterization Tools/Techniques for Discrete and Integrated Systems

Resistivity and conductivity measurements – various probing techniques

Experimental Techniques of the Spectroscopic Approaches: Impedance/Admittance Spectroscopy, Lumped Parameter Approach, and Data Acquisition/Analyses, Deep Level Transient Spectroscopy (DLTS), Thermally Stimulated Current (TSC)

Diffusion Laws, Multi-Component Phase Equilibria, and alloys

Vacuum Evaporation, Epitaxy, Thin Films, and Metallization

Introduction to Reverse Engineering and Evaluation of Unknown Material/Semiconducting Systems

EE 460 Nuclear Reactor Engineering I

Credits and contact hours: 3, 3

Instructor: Dr. Stephen Egarievwe

Textbooks:

Nuclear Heat Transport by M. M. El-Wakil (Hardcover, Revised), American Nuclear Society, 1981.

Nuclear Reactor Analysis by J. J. Duderstadt and L. J. Hamilton, John Willey & Sons, 1976.

Course description: This course introduces students to nuclear power generation concepts and systems. Topics will include heat generation and removal from reactors, steady and unsteady-state conduction mechanisms in the reactor elements, single and two-phases, and liquid metal cooling core thermal design.

Pre-requisites: EE 307, 308

Required course for Nuclear Power Concentration

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Student Outcome	Assessment Tool
Understand the various nuclear reactor designs and the nuclear fuel cycle	a, e	Homework, Exams
Understand nuclear processes	a, e	Homework, Exams
Understand the thermodynamics of nuclear power plant and heat generation	a, e	Homework, Exams
Solve the steady neutron-transport/heat-conduction problems using the differential equation	a, e, k	Project, Exams
Work with the numerical methods	a, e, k	Project
Understand system characteristics of PWRs and BWRs	a, e, k	Project, Exams

Relation of course to Student Outcomes:

Student Outcomes	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(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	**X**
(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.	**X**

Topics: History, types of nuclear reactors, and fuel cycle; Review of Radioactive decay, nuclear interactions, and microscopic and macroscopic cross sections; Thermodynamics of nuclear power plant; Reactor heat generation and temperature distribution in fuel elements; Introduction to neutron transport; Numerical methods; System characteristics of PWRs and BWRs; One-dimensional steady and transient heat transfer; Introduction to conduction mechanisms in the reactor elements, single and two-phases, and liquid metal cooling core thermal design.

EE 461 Nuclear Reactor Engineering II

Credits and contact hours: 3, 3

Instructor: Dr. Stephen Egarievwe

Textbooks:

Nuclear Heat Transport by M. M. El-Wakil (Hardcover, Revised), American Nuclear Society, 1981.

Nuclear Reactor Analysis by J. J. Duderstadt and L. J. Hamilton, John Willey & Sons, 1976.

Course description: This course is the continuation of EE 460 (Nuclear Reactor Engineering I). It provides the BSEE students in the NP concentration with more advanced knowledge in reactor engineering and prepares them for careers in the nuclear power industry. Topics include heat generation and removal studies from reactors, reactor-specific issues, heat transfer calculations, heat flux calculations and core thermal design, major safety issues.

Pre-requisite: EE 460

Required course for Nuclear Power Concentration

Course Learning Outcomes: Upon completion of the course, students will be able to

Course Learning Outcome	Student Outcome	Assessment Tool
Estimate the stress induced in structural components from temperature gradients due to the heat conduction	a, e	Homework, Exams
Calculate the dimensionless quantities appropriate to heat transfer calculations in nuclear reactors	a, e	Homework, Exams
Calculate heat transfer coefficients using an appropriately selected correlation at forced or natural convection conditions	a, e	Homework, Exams
Perform mass, momentum and energy balances on different reactor components	a, e, k	Homework, Exams
Understand critical heat flux (CHF) and core thermal design	a, e, k	Homework, Exams
Understand major safety issues related to the light water reactors addition to the principal differences between "next generation" and current generation light water reactors.	e, k	Project, Exams

Relation of course to Student Outcomes:

Student Outcomes	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**

(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	**X**
(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.	**X**

Topics: Critical flow phenomenon; Heat transfer with change in phase; Critical heat flux; Two-phase flow fundamentals; Two-phase flow models; Calculation of two phase pressure drop; Critical heat flux and core thermal design; Pressure drop and buoyancy driven flow in BWRs; Next generations (Gen III) of PWRs and BWRs.

EE 470 Engineering Analysis and Design I

Credits and contact hours: 2, 2

Instructor: Dr. Mohammad A. Alim

Text Book: There is no Text Book as it is a capstone project. Reference books are recommended.

Reference 1: Charles B. Fleddermann, *Engineering Ethics*, Pearson – Prentice-Hall 2008

Reference 2: J. Campbell Martin, *The Successful Engineer: Personal and Professional Skills-A Sourcebook,* McGraw Hill, 1998

Reference 3: Lawrence J. Kamm, *Successful Engineering - A Guide to Achieving Your Career*

Goals, McGraw Hill, 1989

Course description: Students must demonstrate their complete engineering capabilities by participating in a capstone design project. This first course of the capstone project is provided to facilitate project selection, literature survey, and orientation, and introductory activities per mentor guidance.

Prerequisites: Senior standing and consent of the instructor/mentor/coordinator

Required course

Course Learning Outcomes: Upon completion of the course, students will be able to:

Course Learning Outcome	**Program Outcome**	**Assessment Tool**
Identify and understand the NSPE Code of Ethics	f, h	Written essays
Apply the NSPE Code to a variety of ethical dilemma situations	f, h	Written essays
Decompose a project into its component tasks, and develop a Gantt chart schedule with task dependencies and resource allocation.	e, k	Project task descriptions and schedule
Synthesize project progress into industry standard format, and deliver oral presentations to a technical audience.	a, b, d, g, k	Oral presentations, faculty evaluation
Work on a team with their peers, and take direction from a project supervisor (mentor).	d, g	Mentor evaluation
Research a problem and identify potential solution path(s)	a, d, j, k	Oral presentations, faculty evaluations
Analyze a problem, and create a mathematical and/or simulation model as appropriate for their project.	a, d, e, k	Oral presentations, faculty evaluations

Complete a preliminary engineering design with consideration of design and logistical constraints in a team effort.	b, c, d	Oral presentations, faculty evaluations
Organize project progress into standard technical report format.	d, g	Semester report

Relation of course to Student Outcomes:

Demonstrated Capabilities	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	**X**
(c) an ability to design a system, component, or process to meet desired needs	**X**
(d) an ability to function on multi-disciplinary teams	**X**
(e) an ability to identify, formulate, and solve engineering problems	**X**
(f) an understanding of professional and ethical responsibility	**X**
(g) an ability to communicate effectively	**X**
(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context	**X**
(i) a recognition of the need for, and an ability to engage in life-long learning	
(j) a knowledge of contemporary issues	**X**
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	**X**

Topics Covered:

Ethical Concerns and Situations

Project Management and Scheduling

Research Methods and Investigation Strategies

Project Design and Analytical Approaches

Oral Presentations

Report Writing

EE 471 Engineering Analysis and Design II

Credits and contact hours: 2, 2

Instructor: Dr. Mohammad A. Alim

Text Book: There is no Text Book as it is a capstone project. Reference books are recommended.

Reference 1: J. Campbell Martin, *The Successful Engineer: Personal and Professional Skills-A Sourcebook,* McGraw Hill, 1998

Reference 2: Lawrence J. Kamm, *Successful Engineering - A Guide to Achieving Your Career*

Goals, McGraw Hill, 1989

Course description: Students must demonstrate their complete engineering capabilities by participating in a capstone design project. This is a continuation of EE-470 and is provided to facilitate project completion of the capstone design project under the guidance of the mentor.

Prerequisites: EE 470

Required course

Course Learning Outcomes: Upon completion of the course, students will be able to:

Course Learning Outcome	Program Outcome	Assessment Tool
Track project progress by its component tasks, as developed a Gantt chart schedule, making adjustments as required.	e, k	Project task descriptions and schedule
Synthesize project progress into industry standard format, and deliver oral presentations to a technical audience.	a, b, d, g, k	Oral presentations, faculty evaluation
Work on a team with their peers, and take direction from a project supervisor (mentor).	d, g	Mentor evaluation
Complete a preliminary engineering design with consideration of design and logistical constraints in a team effort.	b, c, d	Oral presentations, faculty evaluations
Synthesize a prototype based on the preliminary design.	a, b, e, d, k	Oral presentations, faculty evaluations
Test project for design robustness as compared to project requirements	a, b, e, d, k	Oral presentations, faculty evaluations
Iteratively refine design to meet design constraints and project deliverable requirements.	a, b, c, d, e, k	Oral presentations, faculty evaluations Semester report

Prepare a poster presentation for a technical meeting.	g, j	Poster session participation
Organize project progress into standard technical report format.	d, g	Semester report

Relation of course to Student Outcomes:

Demonstrated Capabilities	
(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	**X**
(c) an ability to design a system, component, or process to meet desired needs	**X**
(d) an ability to function on multi-disciplinary teams	**X**
(e) an ability to identify, formulate, and solve engineering problems	**X**
(f) an understanding of professional and ethical responsibility	**X**
(g) an ability to communicate effectively	**X**
(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context	**X**
(i) a recognition of the need for, and an ability to engage in life-long learning	
(j) a knowledge of contemporary issues	**X**
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	**X**

Topics Covered:

Project Management and Scheduling

Project Design

Project Testing

Oral Presentations

Poster Presentation and STEM Competition

Final Report Writing

ME 481 Quality and Reliability Assurance

Credits and contact hours: 3, 3

Instructor: Dr. Michael Ayokanmbi

Textbook: Miller & Freund's Probability and Statistics for Engineers, R. A. Johnson, 9th Ed., Pearson, 2017.

Reference Books: Statistical Quality Control, 7th Ed., D. C. Montgomery, Wiley

Statistical Methods for Quality Improvement, Thomas P. Ryan, 3rd Edition, Wiley.

Introduction to Quality and Reliability Engineering, 2015 Edition. R. Jiang, Springer, 2015.

Quality Control, D. H. Besterfield, 6th Edition, Prentice Hall.

Reliability: Modeling, Prediction and Optimization, W. Blischke D. Murthy, Wiley.

Reliability & Maintainability Engineering, C. E. Ebeling, McGraw Hill.

Course Description: An introduction to probability and statistics. Quantitative techniques for establishing product specifications and process controls for quality assurance, ISO 9000; the role of reliability in manufacturing operations; and so forth, are covered.

Required course

Pre-requisites by Topics:

1. System of units.
2. Solution of ordinary differential equations.
3. Mathematical Solution of open-ended engineering problems.
4. Fundamental concepts of design and process realization

Topics:

Introduction to probability and statistics as applied to quality and reliability analysis

Quality Analysis and improvement. Data treatment – Visually Inspecting data to improve product quality; Description of Data – detecting grinding operation problem with frequency distribution; Quartiles and percentiles – comment on the relationship between quality at different plants.

Design for reliability and quality in product/process realization. Fundamentals concepts: Sample space and event, tree diagram; permutation and combination - determining the size of an experiment and selection of machines for an experiment; probability calculation - the probability of requiring repairs under warranty.

Reliability and mathematical methods. Fundamental concepts of applied probability. Introduction to conditional probability, special production rule of probability - the probability of falsely signaling a pollution problem, using the probability to compare the accuracy of two schemes, Bayes' theorems - applications for system reliability evaluation.

Introduction to fundamental concepts in statistical methods for reliability applications and quality control. Various statistical distributions, mean and variance, Chebyshev's theorem, Poisson processes – calculating the probabilities of imperfections, normal and exponential distribution, six-sigma.

Quality assurance. ISO 9000, the Malcolm Baldridge Award, certification procedures. Performance measures.

The statistical content of quality-improvement program. Experimental designs for quality, the Taguchi method. Quality control, control charts for measurements, control charts for attributes, tolerance limits.

Application to reliability and life testing. Failure-time distribution, the exponential model in life testing – obtaining a confidence interval for mean life, Weibull reliability function and Weibull failure-rate function.

Course Learning Outcomes: Upon the completion of the course, students will be able to

<table>
<tr><th>Course Learning Outcome</th><th>Program Outcome</th><th>Assessment Tool</th></tr>
<tr><td>Quality Analysis and improvement. Data treatment, Quartiles and percentiles</td><td>A, E</td><td rowspan="5">Home work
Quiz
Exams</td></tr>
<tr><td>Design for reliability and quality in product/process realization. Fundamentals concepts: Sample space and event, tree diagram; permutation and combination - determining the size of an experiment and selection of machines for an experiment; probability calculation - the probability of requiring repairs under warranty.</td><td>A, C, E</td></tr>
<tr><td>Reliability and mathematical methods. Fundamental concepts of applied probability. Conditional probability, special production rule of probability - the probability of falsely signaling a problem, using the probability to compare the accuracy of two schemes, Bayes' theorems - applications for system reliability evaluation. Various statistical distributions, mean and variance, Chebyshev's theorem, Poisson processes – calculating the probabilities of imperfections, normal and exponential distribution, six-sigma.</td><td>A,E</td></tr>
<tr><td>The statistical content of quality-improvement program</td><td>A,E</td></tr>
<tr><td>Application to reliability and life testing.</td><td>A,C, E</td></tr>
</table>

Relation of course to Program Outcomes:

(a) an ability to apply knowledge of mathematics, science, and engineering	**X**
(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	**X**
(d) an ability to function on multi-disciplinary teams	

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

CS 215 Data Structures

Credits and contact hours: 3, 3

Instructor: Dr. Venkata Atluri

Textbook: C++ Plus Data Structures, 5th edition by Nell Dale (ISBN 978-1-449-64675-2), Jones & Bartlett Learning.

Reference Books:

Algorithms, Data Structures and Problem Solving with C++, by Mark A. Weiss, Addison-Wesley Publishing, Inc.

Understanding Program Design and Data Structures with C++, by Kenneth A. Lambert and Thomas L. Naps, West Publishing Company.

Course Description: This course concentrates on the ways data can be organized and accessed. The idea of abstract data types is introduced and real data structures such as lists, linked lists, record, stacks, trees, and graphs are explained in terms of their basic structure and in the ways that they can be used in practical programming problems. Several programming assignments are required.

Prerequisites: CS 109 or EE 109

Required course for Computer Engineering Concentration

Course Learning Outcomes:

Learning the concepts of Software Engineering and Software Ethics .

Understanding the concepts of Data Design and Implementation, Logical/application/ implementation level of a data structure and abstract data type.

Understanding and implementing the concepts of Lists, Stacks, Queues, Priority Queues, Heaps. Graphs, and Trees and Sorting and Searching Algorithms.

Student Outcome: 1c, 5a, 6a

Topics:

Introduction to Data Structures

Object-oriented programming – classes & objects, inheritance, encapsulation

Software Engineering Principles and Ethics

Abstract Data Types

Lists

Array-based implementation

Pointer-based implementation

Queues

Priority Queues

Recursion

CS 384 Operating Systems

Credits and contact hours: 3, 3

Instructor: Prof. Willie Bossie

Textbook and Supplemental Material:

Operating System Concepts 9th ed. by Abraham Silberschatz, Peter B. Galvin, and Greg Gagne, John Wiley & Sons, Inc., 2013. ISBN 978-1-118-06333-0

Modern Operating Systems, 2nd ed. by A.S. Tanenbaum Prentice Hall. 2001. ISBN: 0-13-031358-0

Course Description: The use of the operating system and other software systems is the core content of this course. Topics include tasking and processes, scheduling, task coordination, device management, file systems, security, and networking.

Prerequisites: CS 381 or EE 320

Required course for Computer Engineering Concentration

Course Learning Outcomes:

To explain what operating systems are, what they do, and how they are designed and constructed.

Describe the process concept and concurrency, threads, synchronization, and CPU scheduling as the heart of modern operating systems.

Explain the management of main memory during the execution of a process and the many different memory-management schemes.

Understand how the file system, mass storage, and I/O are handled in a modern computer system, and professional and ethical responsibility for computer scientists.

An overview of virtual machines and their relationship to contemporary operating systems.

Provide an understanding of the core ideas of distributed computing. To understand the LINUX operating systems, what it does, and how it is designed and constructed.

Student Outcomes: Outcomes 1b, 4b, 6a, 7b

Topics:

Operating-System Structures

Processes

Threads

Process Synchronization

CPU Scheduling

Deadlocks

Main Memory

CHE 101 General Chemistry I

Credits and contact hours: 3, 3

Instructor: J. (Ade) Odutola, Ph.D.

Text book: CHEMISTRY & Chemical Reactivity by John C. Kotz, Paul M. Treichel, & John R. Townsend, (7^{th} Ed.), Thomson-Brooks/Cole (2009)

Course description: A study of the fundamental laws of matter that govern physical and chemical changes. Atomic and molecular theories, atomic structure, periodic functions, classification of the elements are addressed.

Prerequisites: None

Required course

Student Outcomes:

Students will develop an understanding of the fundamental concepts of matter (atoms, molecules, and ions).

Students will develop an understanding of the stoichiometry of chemical reactions.

Students will develop an understanding of the first law of thermodynamics and thermochemistry.

Students will develop an understanding of the principles of atomic structure.

Students will develop an understanding of the periodic trends of the elements.

Methods of Assessing Outcomes

Assessment will be achieved through homework assignments, semester, standard, and final exams.

CHE 101 L General Chemistry Lab I

Credits and contact hours: 1, 3

Instructor: J. (Ade) Odutola, Ph.D.

Text book: General Chemistry Laboratory Manual for Alabama A. & M. University, Kamala Bhat and Paul Okweye, (2^{nd} Ed.), Thomson Learning, Ohio, (2004). This is an "in-house" manual.

Course description: Laboratory to accompany CHE 101. Basic exercises in general chemistry, to include fundamental operations used in making scientific measurements; properties of gases, liquids and solids, chemical elements and compounds.

Prerequisites: None

Corequisite: CHE 101

Required course

Student Outcomes:

Students will cultivate the ability to use standard lab equipment properly, effectively and safely (in the laboratory)

Students will exhibit the ability to follow instructions, carry out experiments, collect, record, graph, chart, and interpret data from experimentation (including possible sources of error)

Students will develop the ability to apply knowledge in lectures (such as chemical and physical properties of substances, solutions properties, stoichiometry, etc.) to the laboratory exercises

Students will demonstrate the ability to communicate effectively the results of their lab work via written reports.

Methods of Assessing Outcomes

Assessment will be achieved through Lab reports, home-works, quizzes, midterm and final exams

PHY 213 General Physics with Calculus I

Credits and contact hours: 4, 5

Instructor: Dr. Mohan Aggarwal

Text book: Fundamentals of Physics, 10^{th} Edition by Halliday, Resnick & Walker, John Wiley & Sons Inc. (2014).

Course description: Phys. 213 is the first part of a two-semester calculus-based introductory physics course designed to review the fundamental concepts of physics for science and engineering majors. It addresses the subjects covering Newtonian Mechanics, waves, and Thermodynamics. It provides a solid foundation for the more advanced courses to follow.

Prerequisites: MTH 125

Required course

Student Learning Outcomes:

Upon successful completion this course, the student will have acquired the following knowledge and skill to:

1. Demonstrate a comprehension of physical reality by understanding how fundamental physical principles underlie the huge variety of natural phenomena and their interconnectedness.

2. Demonstrate a comprehension of technology by understanding how things work on a fundamental level.

3. Build critical thinking and quantitative skills by gaining insight into the thought processes of physical approximation and physical modeling, by practicing the appropriate application of mathematics to the description of physical reality.

4. Demonstrate basic experimental skills by the practice of setting up and conducting an experiment with due regards to minimizing measurement error and by the thoughtful discussion and interpretation of data.

5. Demonstrate basic communication skills by working in groups on a laboratory experiment.

Course Outcomes:

Convert the unit of a physical quantity from one system of units to another

Resolve vectors and to calculate the dot and cross product of two vectors

Determine the particle kinematics with constant acceleration

Calculate the trajectory of a projectile

Define inertia, mass, Newton s laws of motion, inertial and non-inertial frames of reference, frictional forces

Define work, energy, conservative and nonconservative forces, and the Work-energy theorem

Explain the principle of conservation of energy, linear and angular moments of inertia, and energy quantization

Calculate the center of mass of rigid bodies

Explore the collision of two bodies and the definition of elastic and inelastic collisions

Define the concept of rotational dynamics, rotational inertia, centers of mass and gravity

Apply the Newton's law of Universal Gravitation, Pascal's and Archimedes' principle.

State the relationship between the kinetic, potential and total energies for a simple harmonic oscillator

Understand various waves, wave parameters, energy and power of a wave, and the wave equation

Understand the zeroth law and first law of thermodynamics, thermal expansion and heat transformation. The primary goal of this course is to acquaint the students with basic conceptual foundation and vocabulary of physics. Upon completing this course the student should be able to:

PHY 214 General Physics with Calculus II

Credits and contact hours: 4, 5

Instructor: Dr. Rajpal Sirohi

Text book: Fundamental of Physic, 9th or 10th Edition by Halliday, Resnick & Walker, John Wiley & Sons Inc.

Course description: PHY 214 is the second part of a two-semester calculus-based introductory physics course designed to review the fundamental concepts of physics for science and engineering majors. This is the second part of a calculus - based physics course designed for sciences, engineering and technical majors. The goal is the same as for Physics 1. Topics to be covered will include electricity, magnetism, and light. The students will perform eight to ten experiments. The course provides a solid foundation for the more advanced courses in physics to follow.

Prerequisites: MTH 125, PHY 213

Required course

Course Learning Outcomes:

The primary goal of this course is to acquaint the students with basic concepts in electricity, magnetism and optics. It is designed to help students develop problem-solving skills. At the end of the course, each student should be able to demonstrate his/her understanding of electric and magnetic forces, fields, electrical potential, electrical energy, RCL circuits, Maxwell’s equations, wave optics, mirrors and lenses. Upon completing this course, the students should be able to:

Student Outcomes:

Define Coulomb's law and explore its properties

Explain electric field, electric force, electrical potential & electrical energy

Apply Gauss Law

Define capacitance and calculate it for capacitors in series and parallel combinations as well as the stored energy.

Understand the sources and forces due to magnetic fields

Explain Faraday's law of electromagnetic induction

Understand the physical meanings of Maxwell's equations and their applications

MTH 125 Calculus I

Credits and contact hours: 4, 4

Instructor: Dr. Fayequa Majid

Text book: Calculus, Larson and Edwards, 10th edition, 2013.

Course description: Limits; derivatives of algebraic, trigonometric, exponential, and logarithmic functions; applications of the derivative; differentials; maximum and minimum problems; curve sketching using calculus; and the definite integral and its applications to area. This is the first of three courses in the basic calculus sequence taken primarily by students in science, engineering and mathematics

Prerequisites: MTH 113, MTH 115 or satisfactory placement test scores

Required course

Student Learning Outcomes

To provide a careful study of calculus. Mastery of the concepts of calculus: functions, limits, continuity, differentiation, and integration.

To help the student acquire technical facility and an understanding of the uses and applications of calculus.

To help the student gain mathematical maturity.

MTH 126 Calculus II

Credits and contact hours: 4, 4

Instructor: Dr. Fayequa Majid

Text book: Calculus, Larson and Edwards, 10^{th} edition, 2013.

Course description: Area, volume, and arc length; techniques of integration; sequences and series; parametric and polar curves; three-dimensional coordinates, vectors, lines, and planes. This is the second of three courses in the basic calculus sequence taken primarily by students in science, engineering and mathematics.

Prerequisites: MTH 125 or satisfactory placement test scores.

Required course

Student Learning Outcomes

The students should be able to apply calculus to compute measure. They should have familiarity with the techniques of integration and series. They should have knowledge of parametric and polar curves. They should have introductory knowledge of vectors and the three-dimensional coordinate system.

The students will be able to think about mathematics both algebraically and geometrically.

The students will develop critical thinking and apply it to problem solving.

The students will gain familiarity with various forms of graphs.

MTH 227 Calculus III

Credits and contact hours: 4, 4

Instructor: Dr. Fayequa Majid

Text book: Calculus, Larson and Edwards, 10^{th} edition, 2013.

Course description: Vector-valued functions; functions of several variables, partial derivatives and their applications; quadric surfaces, multiple integration, and vector calculus, including line and surface integrals; curl and divergence, Green's Theorem, and Stoke's Theorem. This is the third of three courses in the basic calculus sequence.

Prerequisites: MTH 126 or MTH 146.

Required course

Student Learning Outcomes

This course is designed to provide students of science, mathematics, and engineering an understanding of multivariate calculus.

1. The use of the methods of vector analysis including differentiation and integration of vector functions, finding tangent and normal vectors for curves, and graphing quadric surfaces.

2. The theory of functions of several variables, including continuity, partial and directional derivatives, the differential, and the finding of extrema.

3. The theory and use of multiple integrals, with applications to problems' of area, volume, surface area, mass and moments.

4. The definitions, theory and application of line and surface integrals.

MTH 238 Applied Differential Equations

Credits and contact hours: 3, 3

Instructor: Dr. Fayequa Majid

Text book: A First Course in Differential Equations with Modeling Applications (10th Edition) by Dennis G. Zill.

Course description: An introduction to numerical methods, qualitative behavior of first order differential equations, techniques for solving separable and linear equations analytically, and applications to various models, including populations, motions and chemical mixtures. Techniques for solving higher order linear differential equations with constant coefficients, including the general theory and the methods of undetermined coefficients, reduction of order, and variation of parameters. Interpretation of the behavior of solutions, and applications to physical models with higher order governing equations. The Laplace transform as a tool for solving initial value problems with discontinuous inhomogeneous terms

Prerequisites: MTH 126 or MTH 146

Required course

Student Learning Outcomes:

Ability to solve first and second order Differential Equations, find exact solutions using method of variation, Know initial value problems, know application of differential equations, ability to assess the veracity of mathematical statements, have ideas to support mathematical methods, and apply mathematical logic to higher-order problem solving.

Apply mathematical logic to higher-order problem solving

Apply the concepts of mathematics

Apply mathematical theory

Know the ideas supporting mathematical methods

Assess the veracity of mathematical statements

Appendix B– FACULTY VITAE

Mohammad A. Alim

Education

Ph.D., Electrical Engineering and Computer Science, Marquette University1986.

M.S., Physics, Marquette University 1980.

M.Sc., Physics, University of Dacca, Bangladesh 1976.

B.Sc. (Honors), Physics, University of Dacca, Bangladesh 1975.

Academic experience

Alabama A & M University, Professor of EE, August 2006 – Present, full-time.

Alabama A & M University, Associate Professor of EE, 1998 – 2006, full-time.

Non-academic experience

Ohio Brass Company, R&D Manager, 1989 -1998, full-time.

Cooper Industries, Senior Research Scientist, 1986 – 1989, full-time.

Certifications or professional registrations

None.

Current membership in professional organizations

ASEE, MRS, and ESA.

Honors and awards

2003 AAMU Researcher of the Year Award.

Service activities

Faculty Senate

Departmental Promotion and Tenure Committee

University Promotion and Tenure Appeals Committee

Conference participation and presentation in MRS, ASEE, and ESA.

Served on NSF Review panel in 2013.

Publications

Books

ISBN # 1-119-184851 and ISBN # 978-1-119-18485-0, M. A. Alim; "Immittance Spectroscopy: Applications to Material Systems," Scrivener-Wiley Publishing, New York (2017).

Papers

S. Budak, Z. Xiao, J. Cole, D. Price, T. Davis, T. Strong, and M. A. Alim; "Thermoelectric and Optical Properties of Advanced Thermoelectric Devices from Ni/Bi_2Te_3/Ni and Ni/Sb_2Te_3/Ni Thin Films," *Journal of Vacuum Science Technology B*, **35(5)**, 051401 (2017).

M. A. Alim, S. Budak, and S. Bhattacharjee; "The AC (Alternating Current) Electrical Behavior of Multi-Layered Thermoelectric Devices," *Journal of Electronic Materials*, **45#11**, 5588-5599 (2016).

S. Budak, M. A. Alim, S. Bhattacharjee, C. Muntele; "Effects of Mev Si Ions and Thermal Annealing on Thermoelectric and Optical Properties of SiO_2/SiO_2+Ge Multi-Nanolayer Thin Films," C 23rd Conference on Application of Accelerators in Research and Industry (CAARI) 2014, *Physics Procedia*, **66**, 321 – 328 (2015).
S. Budak, M. A. Alim, S. Bhattacharjee, C. Muntele, "Effects of MeV Si Ions and Thermal Annealing on Thermoelectric and Optical Properties of SiO_2/SiO_2+Ge Multi-Nanolayer Thin Films," ***Physics Procedia*, 66**, 321-328 (2015).

S. Bhattacharjee and M. A. Alim; "Frequency Dependent Impedance and Admittance (Immittance) Data-Handling and Interpretation using Complex Plane Formalisms via Nonlinear Regression Analysis for Smart Electronic Materials and Devices: Overview and Case Studies," *Journal of Material Science: Material Electronics*, **26**, 4521–4540 (2015).

J. Y. Li, S. T. Li, P. F. Cheng, and M. A. Alim; "Advances in ZnO–Bi_2O_3 Based Varistors," *Journal of Material Science: Material Electronics*, **26**, 4782–4809 (2015).

S. Budak, E. Gulduren, B. Allen, C. Jordan, J. S. Lassiter, T. Colon, C. Muntele, M. A. Alim, S. Bhattacharjee, and R. B. Johnson; "Thermoelectric Generators from SiO_2/SiO_2+Ge Nanolayer Thin Films Modified by *MeV* Si Ions," *Solid State Electronics*, **103**, 131-139 (2015).

W. H. Khushefati, N. U. Ahmed, and M. A. Alim; "Review on the Potential Applications of Geofoam Material in Saudi Arabia for Highways and Building Construction," *Journal of King Abdul-Aziz University*: *Engineering Science*, **26#2**, 23-47 (2015).

M. A. Alim, S. Bhattacharjee, and J. Herring; "The Immittance Response of Escherichia Coli Bacteria," *Journal of Bacteriology and Mycology*, **1#2**, 6, on-line November 21 (2014) id 1008, <http://austinpublishinggroup.com/bacteriology/fulltext/bacteriology-v1-id1008.php>.

M. A. Alim, S. Bhattacharjee, S. Khanam, S. Runa, and N. Muna; "The Behavior of the ZnO-Bi_2O_3-Based Varistor Capacitance," *Journal of Active and Passive Electronic Devices*, **9#2**, 157-184 (2014).

H. Li, J. Li, W. Li, X. Zhao, G. Wang, and M. A. Alim; "Fractal Analysis of Side Channels for Breakdown Structures in XLPE Cable Insulation," *Journal of Materials Science: Materials in Electronics*, **24#5**, 1640-1643 (2013).

Professional development activities

Participated in several proposal review panels and submitted several proposals.

Satilmis Budak

Education

Degree	Discipline	Institution	Year
B.Sc.	Physics Engineering	Hacettepe University, Turkey	1997
M.S.	Physics	Fatih University, Turkey	1999
Ph.D.	Physics	Gebze Institute of Technology, Turkey	2003

Academic experience

Institution	Rank	Dates Held	FT/PT
Alabama A&M Uni.	Professor of EE	August 2015- Present	FT
Alabama A&M Uni.	Associate Professor	Aug 2012 – Aug 2015	FT
Alabama A&M Uni.	Assistant Professor	Aug 2007 – Aug 2012	FT
Alabama A&M Uni.	Adjunct Professor	Aug 2006 – Aug 2007	PT
Alabama A&M Uni.	Research Associate	Jul 2005 – Aug 2007	FT
University of Alabama	Post-doctorate Fellowship	Jan 2004 – Jun 2005	FT

Non-academic experience: None

Certifications or professional registrations: None

Membership in professional organizations

a. Member, Institute of the Electrical and Electronic Engineers (IEEE)
b. Member, Materials Research Society (MRS)
c. Member, International Thermoelectric Society (ITS)
d. Member, American Vacuum Society (AVS)

Honors and awards

a. Research Associate (Postdoc) Award, University of Alabama, January 1, 2004 to June 30, 2005.
b. Research Associate (Postdoc) Award, Alabama A&M University and Research Institute, July 1, 2005 to August 14, 2007.
c. Receiving the award of the year on research by College of the Engineering, Technology, and Physical Sciences, May 1, 2013.
d. Receiving the award of the year on excellence in scholarship and research by the Presidential Citation, May 3, 2013.

Service activities

a. Member, University Grievance Committee, 2010-2011.
b. Reviewer for DOD, DOE, NSF proposals.

c. Member, SMMIB-2013 International Program Committee,
d. Assistant to the Guest Editor of American Journal of Material Science (May 2015).
d. Member, University Academic Standards & Curriculum Committee, 2011- Present.
f. Member, Graduate School thesis committees, 2008- Present.
g. Member, Faculty Senate as an alternate senator, 2011- Present.
h. Serving as a reviewer for AAMU-STEM-2016, 2017, and 2018.
i. Serving as a reviewer for numerous peer-reviewed journals.

Publications and presentations from the past five years (Some selected)

a. Satilmis Budak, Zhigang Xiao, Jorden Cole, Dennis Price, Tyler Davis, Tiara Strong, Mohammad A. Alim, "Thermoelectric and Optical Properties of Advanced Thermoelectric Devices from Ni/Bi_2Te_3/Ni and Ni/Sb_2Te_3/Ni Thin Films", J. Vac. Sci. Technol. B 35(5), 051401-1 (1 to 6), (2017).
b. Satilmis Budak, Zhigang Xiao, Barry Johnson, Jordan Cole, Mebougna Drabo, Ashley Tramble, Chauncy Casselberry, "Highly-Efficient Advanced Thermoelectric Devices from Different Multilayer Thin Films", American Journal of Engineering and Applied Sciences, 9, Issue 2, 356-363 (2016).
c. S. Budak, S. Guner, C. Muntele, D. Ila, "Thermoelectric Generators form AgBiTe and AgSbTe Thin Films Modified by High Energy Beam", Journal of Electronic Materials 44, 1884-1889 (2015).
d. S. Budak, E. Gulduren, B. Allen, J. Cole, J. Lassiter, T. Colon, C. Muntele, M. A. Alim, S. Bhattacharjee, R. B. Johnson, "Thermoelectric Generators from SiO_2/SiO_2+Ge Nanolayers Modified by MeV Si Ions", Solid-State Electronics 103, 131–139 (2015).
e. S. Budak, S. Guner, R. A. Minamisawa, C. I. Muntele, D. Ila, "Thermoelectric Properties of Zn_4Sb_3/$CeFe_{(4-x)}Co_xSb_{12}$ Nano-layered Superlattices Modified by MeV Si ions Beam", Applied Surface Science, 310, 226-229 (2014).

Recent professional development activities

a. Book Review titled "Thermoelectrics and its Energy Harvesting, 2 Vol Set, 03/19/2012 for CRC publisher.
b. Book Review titled "Open Quantum Physics and Environmental Heat Conversion into Usable Energy" for Bentham Science Publishers, 08/06/2014.
c. **Submitted Proposal:** Title: "AAMU-CHESS Partnership for Research and Education in Materials"; The Proposal Number: 1828005; Funding Agency: NSF-PREM; Funding Amount: $4,200,000.00; Period: 9/1/2018-8/31/2024, (Submitted Date: 2/2/2018). Investigators: S. Egarievwe, S. Budak, C. Glenn, E. Fontes, J. Brock.
d. **Submitted Proposal:** Title: "MRI: Acquisition of an X-Ray Photoelectron Spectrometer for Advancing Multidisciplinary Research and Education in Quantum Mechanics, Nanotechnology, Biosensors, and Energy Storage"; The Proposal Number: 1828729; Funding Agency: NSF-MRI; Funding Amount: $628,558.00; Period: 9/1/2018-8/31/2019 (Submitted Date: 02/05/18). Investigators: S. Egarievwe, K. Bhat, M. Drabo, P. Guggilla, S. Budak.

Stephen U. Egarievwe

Education

B.Sc.	University of Ife (now OAU)	Engineering Physics / Nuclear Engineering	1986
M.S.	Vanderbilt University	Computer Science	2005
M.S.	The University of Tennessee	Nuclear Engineering	2015
M.Sc.	University of Nigeria	Solar Energy	1989
M.A.	Fisk University	Physics	1995
Ph.D.	Alabama A&M University	Applied Physics	1998

Academic experience

Alabama A&M University	Professor	2017-Present	Full Time
Alabama A&M University	Associate Professor	2009-2017	Full Time
Fisk University	Associate Professor	2005-2008	Full Time
Fisk University	Assistant Professor	2001-2005	Full Time

Non-academic experience

Brookhaven National Laboratory	Research Scientist	2008-2009	Full Time
Oak Ridge National Laboratory	Research	Summer 2006	Full Time
Stanford Linear Accelerator Center	Research	Summer 2004	Full Time
Oak Ridge National Laboratory	Research	Summer 2003	Full Time
Stanford Linear Accelerator Center	Research	Summer 2002	Full Time
NASA Center - Fisk University	Research Asst. Prof.	1999-2001	Full Time
NASA Center - Fisk University	Research Associate	1998-1999	Full Time

Certifications or professional registrations

ABET Institute for the Development of Excellence in Assessment Leadership (IDEAL)

Grant Writing Certification

Current membership in professional organizations

Member, IEEE – the Institute of Electrical and Electronics Engineers

Member, ACM – Association for Computing Machinery

Member, ASEE – American Society of Engineering Education

Member, APS – American Physical Society

Honors and awards

R&D 100 Award (1998) for top 100 scientific/engineering products in R&D

ABET-IDEAL Scholar (2012)

SLAC Scholar, Stanford Linear Accelerator Center, Stanford University (2002 & 2004)

NASA Certificate of Service for Distinguished Contributions, EA-MQR (2003)

ORNL Commitment to Excellence - Science, Technology & Minority Education (2007)

Service activities

Faculty Handbook Committee, Alabama A&M University

Advisory Committee Member, Stony Brook University / Brookhaven National Laboratory (BNL) "Career Path" diversity program, Upton, New York, USA.

Grants/Projects Reviews: National Science Foundation (NSF), U.S. Department of Homeland Security (DHS), U.S. Department of Energy (DOE), U.S. Nuclear Regulatory commission (NRC), National Aeronautics and Space Administration (NASA), Office of Naval Research (ONR), U.S. Defense threat Reduction Agency (DTRA).

Reviewer for Journals: 1) IEEE transactions in Nuclear Science, 2) Journal of Crystal Growth, 3) Journal of Electronic Materials, 4) Journal of Materials Sciences and Applications, 5) Journal of Materials Science & Engineering B, 6) Materials Chemistry and Physics, 7) Thin Solid Films, and 8) Scientific Reports.

Publication

S. U. Egarievwe, E. D. Lukosi, I. O. Okwechime, R. Gul, A. Hossain, and R. B. James. "Effects of Tellurium Oxide on Surface Current and Performance of CdZnTe Nuclear Radiation Detectors." 2017 IEEE NSS/MIC, Atlanta, USA.

S. U. Egarievwe, A. Hossain, I. O. Okwechime, A. A. Egarievwe, D. E. Jones, U. N. Roy, and R. B. James. "Effects of Chemical Treatments on CdZnTe X-Ray and Gamma-Ray Detectors." *IEEE Trans. on Nuclear Science*, vol. 63 no. 2, pp. 1091–1098, 2016.

S. U. Egarievwe, W. Chan, K.-H. Kim, U. N. Roy, V. Sams, A. Hossain, A. Kassu, R. B. James. "Carbon Coating and Defects in CdZnTe and CdMnTe Nuclear Detectors." *IEEE Transactions on Nuclear Science*, vol. 63 no. 1, pp. 236–245, 2016.

S. U. Egarievwe, J. B. Coble, and L. F. Miller. "Analysis of How Well Regression Models Predict Radiation Dose from the Fukushima Daiichi Nuclear Accident." *Int'l Journal of Applied Physics and Mathematics*, vol. 6 no. 4, pp. 150–164, 2016.

Professional Development Activities

2017 IEEE Nuclear Science Symposium and Medical Imaging Conf., Atlanta, GA, USA.

2016 IEEE Nuclear Science Symposium and Medical Imaging Conf., Strasbourg, France.

AAMU-CHESS Partnership for Research and Education grant proposal to NSF, 2018.

Active Learning Integrated Nuclear Education (ALINE) grant proposal to NSF, 2017

AAMU Nuclear Engineering Scholarship Program grant, U.S. NRC, 2016-2018.

Kaveh Heidary

Education

Ph.D. Electrical Engineering, Syracuse University, 1993

M. S. Electrical Engineering, Syracuse University, 1984

B. S. Electrical Engineering, Magna Cum Laude, Syracuse University, 1982

Academic Experience

Alabama A&M University, Professor of EE and Chair of EECS, 2011-present, full-time

Alabama A&M University, Professor and Chair EE, 2006-2011, full-time

Alabama A&M University, Associate Professor of EE, 1998-2006, full-time

West Virginia University, Assistant Professor of EE, 1988-1989, full-time

University of South Carolina, Assistant Professor of EE, 1987-1988, full-time

Non-Academic Experience

Matrix Technologies, Engineer and Project Manager, 1992-1996, full time

Certifications or professional registrations

None

Current membership in professional organizations

IEEE Senior Member

Honors and Award

2004 Faculty of Year Award, IEEE Huntsville Section

Service Activities

Technical Program Co-Chair, IEEE SoutheastCon 2019

Technical Program Co-Chair, IEEE SoutheastCon 2008

Technical Program Chair, IEEE International Radar Conference 2003

Academic Standards Committee, AAMU 2006-present

Selected Publications

Heidary, Kaveh "Enhanced Matched Filter Theory and Applications," Journal of The Franklin Institute (2018 under review).

Heidary, Kaveh and Johnson, R.B. "Knowing the unknowable unknowns: subpixel anomalous source detection in hyperspectral imagery," International Journal of Engineering Research & Science, Vol. 3, No. 2, pp 52-65 (2017).

Heidary, Kaveh, "Design of State Invariant Target Classifiers," Proceedings of the International Conference on Computer and Information Science and Technology, Ottawa, Ontario, Canada, May 11-12, (2015).

Heidary, Kaveh, “Fourier filter augmented with trainer histograms,” Applied Optics, Vol. 53, No. 28, pp 6464-6471 (2014).

Heidary, Kaveh "Distortion tolerant correlation filter design," Applied Optics, Vol. 52, No. 12, pp 2570-2576 (2013).

Heidary, Kaveh and H. J. Caulfield, "Presmooting effects in Artificial Color image segmentation," Computer Vision and Image Understanding, Vol. 117, pp 195-201 (2013).

Heidary, Kaveh and R. Barry Johnson, "Autonomous tracking of designated persons in crowded scenes," Proceedings of SPIE Vol. 8833308 pp 1-12 (2013).

Heidary, Kaveh, "Hyperspectral Compression using Specialized Spectral Sensitivity Function," 17th International Conference on Image Processing, Computer Vision, & Pattern Recognition (2013).

Heidary, Kaveh " Basic Synthetic Template: Effective Tool for Target Classification and Machine Vision," International Journal of Advanced Computer Science and Applications, Vol. 4, No. 10, pp 22-31 (2013).

Professional Development

ECP Workshop, Baltimore, MD, 2017

ABET Symposium, Baltimore, MD, 2016

Insu Kim

Education

Ph.D. Electrical and Computer Engineering, Georgia Institute of Technology, 2014

M.S. Electrical and Computer Engineering, Sungkyunkwan University, Korea, 2002.

B.S. Electrical and Computer Engineering, Sungkyunkwan University, Korea, 2000.

Academic Experience

Alabama A&M University, Assistant Professor of EE, 2015-2017, full-time.

Georgia Institute of Technology, Postdoctoral Research Associate ECE, 2014-2015, full-time.

Non-Academic Experience

Korean Electric Power Corporation, Seoul, Korea, electrical engineer, 2002-2008, full-time.

Certification: None

Membership

IEEE

Honors and Awards

None

Service Activities

Technical reviewer for various IEEE journals and conferences.

Publications and Presentations

Insu Kim, "A case study on the effect of storage systems on a distribution network enhanced by high-capacity photovoltaic systems," *Journal of Energy Storage*, Vol. 12, pp. 121-131, August 2017.

Insu Kim, "The Markov chain Monte Carlo and acceptance-rejection algorithms for synthesizing short-term variations in the generation output of the photovoltaic system," *IET Renewable Power Generation*, Vol. 11, No. 6, pp. 878-888, 10 May, 2017.

Insu Kim, "Optimal distributed generation allocation for reactive power control," *IET Generation, Transmission, and Distribution*, Vol. 11, pp. 1549-1556, 20 April, 2017.

Insu Kim, Jean-Ann James, and John Crittenden, "The case study of combined cooling heat and power and photovoltaic systems for building customers using HOMER software," *Electric Power Systems Research*, Vol. 143, pp. 490-502, February 2017.

C. Noh, Insu Kim, W. Jang, and C. Kim, "The recent trends in renewable energy resources for power generation in the republic of Korea," *Resources*, Vol. 4, pp. 751-764, 2015.

Insu Kim, "The recent trends of renewable energy resources for power generation in the United States", *IET Engineering and Technology Reference*, 2015.

Shuo Xu and Insu Kim, "PQ bus voltage control with integration of distributed generators," 2017 Grid of the Future, Cleveland, Ohio, USA, Oct. 22-25, 2017.

Insu Kim and R. G. Harley, "Transient-State Analysis of a Large Distribution Feeder with Photovoltaic Systems Either with or Not the Capability of Reactive Power Control," 2017 North American Power Symposium, Morgantown, WV, USA, Sept 17-19, 2017.

Insu Kim, M. Begovic, B. Vidakovic, P. Djuric, and V. Jeremic, "Impact of Short-Term Variations in the Generation Output of Geographically Dispersed PV Systems," Hawaii International Conference on System Sciences, Koloa, HI, USA, Jan. 4-7, 2017.

Kim and R. G. Harley, "A Study on Power-Flow and Short-Circuit Algorithms Capable of Analyzing the Effect of Load Current on Fault Current Using the Bus Impedance Matrix," 2016 Electrical Power and Energy Conference, Ottawa, Canada, October 12-14, 2016.

Kim and R. G. Harley, "The Transient Behavior of the Volt/Var Control of Photovoltaic Systems for Solar Irradiation Variations," 2016 Electrical Power and Energy Conference, Ottawa, Canada, October 12-14, 2016.

Insu Kim, "The Effect of Load Current on a Three-Phase Fault," 7th Conference on Innovative Smart Grid Technologies, Minneapolis, MN, USA, Sept. 6-9, 2016.

Miroslav Begovic, Insu Kim, and Mladen Kezunovic, "Impact of Stochastically Distributed Renewable PV Generation on Distribution Networks," 19th Power Systems Computation Conference, Genoa, Italy, June 20-24, 2016.

Insu Kim, "Impact of Electric Vehicles on Peak Load Reduction," IEEE Transportation Electrification Conference and Expo Asia-Pacific, Busan, Korea, June 1-4, 2016.

Insu Kim, Jessica Mack, and Jamel Morris, "A Study to Maximize the Energy Usage of Photovoltaic Systems on the Campus," AlaSim International 2016, Huntsville, Alabama, May 4-5, 2016, Senior Design Project Research.

Insu Kim and Ronald G. Harley, "A Study on the Effect of Distributed Generation on Short-Circuit Current," Power Systems Conference 2016, Clemson, South Carolina, March 8-11, 2016.

Recent Professional Developments

Developing protection coordination methods and analysis techniques based on the DEW power-flow analysis program, with the Korean Electric Power Corporation, Oct. 1, 2017-July 31, 2020 (Awarded).

Developing power-flow and short-circuit analysis algorithms, with the Korean Electric Power Corporation, $120,000, July 1, 2015-April 30, 2017 (Awarded).

Optimal combination of electrical and thermal technologies to increase energy output to the energy input ratio of a combined cooled, heating, and power (CCHP) system, National Science Foundation with the Georgia Institute of Technology, $52,000, July 1, 2016-August 31, 2018 (Awarded).

Andrew R. Scott

EDUCATION

Doctor of Philosophy, Computer Science/Engineering, Interdisciplinary Program, University of Missouri-Kansas City 1998.

Master of Science, Mechanical and Aerospace Engineering, University of Missouri-Columbia 1993.

Bachelor of Science, Mechanical Engineering, University of Missouri-Columbia 1991.

ACADEMIC EXPERIENCE

Alabama A&M University, Professor of EE, 2014 – Present, full-time.

Alabama A&M University, Associate Professor of EE, 2009 – 2014, full-time.

Alabama A&M University, Assistant Professor of EE, 2002 – 2009, full-time.

NON-ACADEMIC EXPERIENCE

Computer Sciences Corporation (CSC/Nichols Research), Computational Research Specialist, 2000-2002, full-time.

Engineering Modeling & Simulation, Engineer/Software Developer, Engineering consultant to government and industry, 1998-2000, full-time.

NASA Lewis Research Center (LeRC)/University of Missouri, alternated work as researcher on-campus, and at NASA Lewis Research Ctr. 1995-1998, full-time.

Gas Safety and Development Laboratory, Gas Service, a division of Western Resources, Kansas City, Missouri, engineer, headed investigations of failed physical components from the field, including fracture and fatigue analysis 1992-1994, full-time.

PROFESSIONAL REGISTRATIONS

EIT, Engineer-In-Training, 1991, State of Missouri, USA.

PROFESSIONAL ORGANIZATIONS

IEEE, Senior Member, Continuous since 2001

AIAA, Senior Member, Continuous since 1991

HONORS and AWARDS

IEEE, Outstanding Educator Award, IEEE Huntsville Section, April 2014.

AAMU – Faculty of the Year, Research Award, College of Engineering Technology and Physical Sciences, Alabama A&M University, May 2014.

SERVICE ACTIVITIES

University Academic Appeals Committee

Departmental Promotion and Tenure Committee

College Promotion and Tenure Committee

University Information and Technology Committee

University Promotion and Tenure Appeals Committee

Co-advisor, member on MS thesis committees for multiple CS grad students

Reviewer for IEEE – Transactions on Instrumentation & Measurement Journal. Review multiple article submissions annually, 2009 – Present.

RECENT PUBLICATIONS and PRESENTATIONS

Clark, Renee M.; Kaw, Autar; Lou, Yingyan; Scott, Andrew; and Besterfield-Sacre, Mary, "Evaluating Blended and Flipped Instruction in Numerical Methods at Multiple Engineering Schools," *International Journal for the Scholarship of Teaching & Learning,* v. 12, no. 1, art. 11 (2018).

Clark, R.M., Kaw, A., Lou, Y., Scott, A. and Besterfield-Sacre, M.E., 2017, June. Board# 69: Blended vs. Flipped Teaching: One Course-Three Engineering Schools. In *2017 ASEE Annual Conference & Exposition*.

A. Kaw, Y. Lou, A. Scott, R. Miller; "Building a Concept Inventory for Numerical Methods: A Chronology," Proceedings of ASEE Annual Conference and Exposition, New Orleans, LA, June 26-29, 2016.

R. Clark, A. Kaw, M. Besterfield-Sacre, A. Scott, "How Do You Like Your Course - Blended or Flipped? A Preliminary Comparison", Proceedings of ASEE Annual Conference and Exposition, Seattle, WA, June 14-17, 2015.

PROFESSIONAL DEVELOPMENT ACTIVITIES

<u>Recent Externally Funded Research Projects</u>

A. Scott PI. "Reconfigurable Computing for Multi-Sensor Tracking Applications," DoD Missile Defense Agency (MDA), Contract: HQ0147-14-C-6002, September 26, 2014 – March 25, 2018, $700K.

A. Kaw, PI (USF), A. Scott co-PI (AAMU), "Improving and Assessing Student Learning in an Inverted STEM Classroom Setting", NSF, sub-contract from USF, $72K to AAMU, $598K total, Aug. 2014 – Aug 2017. $72K.

K. Heidary PI, A. Scott co-PI on multi-University project, "Experimental Centric Based Engineering Curriculum for HBCUs", NSF, sub-contract from Howard, $220K to AAMU, $1.2M total, Aug 2014 – Aug 2017. $220K

K. Heidary, PI, A. Scott, co-PI, "Development, Implementation and Integration of Novel Algorithms for ISR Systems Applications," Army Research Office (ARO), Contract: W911NF-13-1-0136, May 1, 2013 – April 30, 2016. $483K

A. Scott PI. "Innovative Methods for Computational Algorithms Utilizing Reconfigurable Devices," DoD Missile Defense Agency (MDA), Contract: HQ0147-10-C-6004, September 1, 2010 – August 31, 2013. $780K

Zhigang Xiao

Education

Ph.D., Electrical Engineering, University of Cincinnati, June 2004.

M.S., Physics, East China Normal University, June 1992.

Diplomat, Physics, Pingxiang Educational Institute, June 1987

Academic Experience

Alabama A & M University, Professor, August 2013 – Present, full-time.

Alabama A & M University, Associate Professor, August 2010 – July 2013, full-time.

Alabama A & M University, Assistant Professor, January 2005 – July 2010, full-time.

Shanghai Institute of Building Materials and Tongji University, Assistant Professor, July 1992- July 1997, full-time.

Non-Academic Experience: None

Certifications or Professional Registrations: None

Current Membership in Professional Organizations

Member, IEEE - Institute of the Electrical and Electronic Engineers.

Member, AVS – American Vacuum Society.

Honors and Awards: None.

Service Activities

Serve in the EE faculty search committee.

Serve in the university tenure and promotion committee (2010-2012).

Serve in the College tenure and promotion committee (2013-present).

Serve in the College scholarship committee.

Serve in the Center for Functional Nanomaterials (CFN) Users' Executive Committee (UEC) at Brookhaven National Laboratory, NY (2010-present).

Serve in the NSF proposal review panels for the NSF NanoManufacturing Program, the NSF ECCS MRI Program, and the NSF EPMD Program.

Publications and Presentations

The fabrication of carbon nanotube electronic circuits with dielectrophoresis, Z. Xiao, J. Elike, A. Reynolds, R. Moten, and X. Zhao, Microelectronic Engineering, 164, 123-127 (2016).

On-chip sensing of thermoelectric thin film’s merit, Z. Xiao and X. Zhu, Sensors 15, 17232-17240 (2015).

Ion beam irradiation effect on thermoelectric properties of Bi_2Te_3 and Sb_2Te_3 thin films, G. Fu, L. Zuo, J. Lian, Y. Wang, J. Chen, J. Longtin, and Z. Xiao, Nuc. Instr. and Meth. B **358, 229-235 (2015).**

Electron-beam-evaporated thin films of hafnium dioxide for fabricating electronic devices, Z. Xiao and K. Kisslinger, J. Vac. Sci. Technol. B 33, 042001 (2015).

Miniature Supercapacitors based on Nanocomposite Thin Films, L. Jiang, M. Vangari, T. Pryor, Z. Xiao, and N. S. Korivi, Microelectronic Engineering, Vol. 111, 52-57 (2013).

Fabrication of high-performance carbon nanotube field-effect transistors (CNTFETs) and CNTFET-based electronic circuits with semiconductors as the source/drain contact materials, A. Tramble, P. Burns, S. Hayden, R. Moten, Z. Xiao, and F. Camino, IEEE 2014 20th International Conference on Ion Implantation Technology (IIT), Portland, OR; IEEE/Xplore, **DOI:** 10.1109/IIT.2014.6939994.

Fabrication of single-walled carbon nanotube-based electronic circuits, J. Elike and Z. Xiao, present in AVS 62nd International Symposium (2015) in San Jose, CA.

The nanoscale multilayered Bi_2Te_3/Sb_2Te_3 thin films thermoelectric devices, Z. Xiao and S. Budak, present in AVS 62nd International Symposium (2015) in San Jose, CA.

Comparison of hafnium oxide and zirconium oxide thin films for fabricating electronic devices, J. Spence, F. Cunningham, R. Moten, and Z. Xiao, present in AVS 62nd International Symposium (2015) in San Jose, CA.

List of the Most Recent Professional Development Activities

As PI (with A. Alim (Co-PI), S. Budak (Co-PI), K. Heidary (Co-PI) and Shujun Yang (Co-PI)), **Project Title: "MRI: Acquisition of an Advanced E-Beam Evaporation Thin Film Deposition System for Research in Micro and Nanofabrication,"** Award #: ECCS-1229312, Funding Agency: NSF, Total Award: \$212,375, Performance Period: 09/2012 – 09/2014.

As PI, Project Title: "Design, Synthesis, and Fabrication of Mixed-Signal Application Specific Integrated Circuits (ASICS) for the Application of Flight Electronics at NASA," Funding Agency: NASA; Total Award: \$300,000; Period: 10/01/2011 - 09/30/2014.

As PI (with S. Budak (Co-PI), K. Heidary (Co-PI), and S. Yang (Co-PI)), Project Title: "Acquisition of an Advanced Mask Aligner and a Spin Coater Unit for Research at Micro and Nanoscale for Energy Harvesting and Nanoelectronics at Alabama A&M University," Award #: W911NF-16-1-0554, Funding Agency: DOD/ARO, Total Award: \$334,003, Performance Period: 09/2016 – 08/2017.

As PI (with S. Budak (Co-PI), K. Heidary (Co-PI) and Shujun Yang (Co-PI), Project Title: Acquisition of an atomic layer deposition system for research at micro and nanoscale for energy harvesting and nanoelectronics at Alabama A&M University," Award #: W911NF-17-1-0474, Total Award: \$ 480,070, Funding Agency: DOD/ARO, Performance Period: 09/2017 – 08/2018.

As PI, Project Title: "Development of wafer-scale fabrication of carbon-based integrated electronic devices," Award #: CBET-1740687, Total Award: \$300,000, Funding Agency: NSF, Performance Period: 08/2017 – 07/2019.

As PI, Project Title: Fabrication of nanoscale integrated thermoelectric devices for highly-efficient energy conversion and cooling application; Award #: N00014-17-1-2635, Total Award: \$450,000, Funding Agency: DoD/ONR, Performance Period: 07/2017 – 06/2020.

Shujun Yang

Education

Ph. D, Electrical Engineering, Old Dominion University, Norfolk, Virginia, 2006.

M.S., Physical Electronics, Inst. of Electronics, Chinese Academy of Sciences, 1998.

B.S., Physical Electronics, Tsinghua University, 1991.

Academic Experience

Alabama A&M University, Assistant Professor of EE, 2011-Present, full-time.

Alabama A&M University, Adjunct Faculty of EE, 2009-2010, part-time.

No-academic experience

Continental AG, Electronic Engineer, worked on engine controller, 2008-2009, full-time.

Applied Materials, Process Engineer, developed etch process, 2006-2008, full-time.

Shireen Inc., RF Engineer, worked on amplifiers and converters, 2005-2006, full-time.

Certifications or professional registrations: none

Current membership in professional organizations

Member of IEEE, and Member of MTTS

Honors and awards: Best Teaching Award, May '16, from College of Engineering, AAMU.

Service activities: Technical reviewer for JEET.

AAMU EE program visiting scholar host faculty.

Publications and presentations from past five years

Shujun Yang, "Reduction of passband insertion loss for a dual band bandstop filter", IJMA, vol. 7, no. 2, pp. 16-18, 2018.

Shujun Yang, "A modified E-shaped defected ground structure", IJMA, vol. 6, no. 3, pp. 22-24, 2017.

S. Yang, "A Survey on Compact Modified Dumbbell-Shaped DGS Having Square Loops", IJAREEI, vol. 6, issue 2, 496-500, 2017.

Shujun Yang, "A Compact Dual-Band Microstrip Bandstop Filter Having a Spurline and Two Embedded Open Stubs", Journal of Electrical System and Information Technology, volume 3, issue 2, 2016, pp. 314-319.

Shujun Yang, "A Dual-Band Bandstop Filter Having Two Open Stubs and Two Equivalent T-Shaped Lines", International Journal of Electromagnetics and Applications, vol.5, no. 3, 314-319, 2015.

S. Budak, S. Yang, Z. Xiao, and R. B. Johnson, "Thermal Annealing Effects on the Thermoelectric and Optical Properties of SiO2/SiO2+Au Multilayer Thin Films", American Journal of Material Science 5(3A), pp. 31-35, 2015.

S Yang, "Simulation of A Bandstop Filter Derived from An Optimum Bandstop Filter", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Volume 4, Issue 7, pp. 6096-6099, July, 2015.

S Yang, "Simulation on Harmonic Suppressions of a Square Ring Resonator by Two Spurlines", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Volume 3, Issue 12, pp. 13478-13483, December, 2014.

S Yang, "Simulation of a Bandstop Filter Having Two Open Stubs and an Embedded Open Stub", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Volume 3, Issue 11, pp. 12801-12804, November, 2014.

S Yang, "Simulation of a Compact Dual-Band Microstrip Bandstop Filter", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Volume 3, Issue 10, pp. 12271-12274, October, 2014.

S Yang, "Simulation of a Bandstop Filter with Two Open Stubs and Asymmetrical Double Spurlines", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Volume 3, Issue 9, pp. 11679-11701, September, 2014.

Shujun Yang, "Simulation of Two Novel Defected Ground Structures on Sonnet Suite Software", Alasim 2017, Huntsville, AL, Oct. 2017.

Shujun Yang, "Simulation of a Microstrip Bandstop Filter Having an Equivalent T-Shaped Line", IEEE Southeast Conference, April 2016.

Shujun Yang, "Simulation of a Compact Dual-Band Microstrip Bandstop Filter Having Three Spurlines", IEEE Southeast Conference, April 2016.

Shujun Yang, "Simulation of Microstrip Bandstop Filters with Sonnet Suite Software", Alasim2015.

Shujun Yang, Jeremy Crutcher, Brandon Ellis, Demario Nesby, and Willie Mccaa, "Design and Simulation of a Parallel-Coupled Microstrip Bandpass Filter", IEEE Southeast Conference, Mach 2014.

Shujun Yang, Jeremy Crutcher, Brandon Ellis, Demario Nesby, and Willie Mccaa, "First Harmonic Suppression of a Square Ring Resonator by Two Embedded Stubs", IEEE Southeast Conference, Mach 2014.

Shujun Yang, Jeremy Crutcher, Brandon Ellis, Demario Nesby, and Willie Mccaa, "First Harmonic Suppression of a Bandpass Filter with an Optimum Bandstop Filter", IEEE Southeast Conference, Mach 2014.

Recent professional development activities

Co-PI, NSF MRI: Acquisition of an Advanced E-Beam Evaporation Thin Film Deposition System for Research in Micro and Nanofabrication, 2012-2013, $220k.

Co-PI, Experimental Centric Based Engineering Curriculum for HBCUs, NSF 2013-2016, $220k.

Co-PI, Acquisition of an Advanced Atomic Layer Deposition System, ARL, 2017-18, 480k.

PI, Low Cost Microwave Circuit Laboratory for Minority Universities, Submitted to NSF

Raziq Yaqub

Ph.D., Electrical Engineering, Keio University, 1998

Academic experience:

Alabama A&M University, Normal, AL 35762, Associate Professor, 2016-, full time.

University of Tennessee Chattanooga, TN, Associate Professor, 2010-2012, full time.

Stevens Institute of Technology, New Jersey, Rowan University, New Jersey, and The College of New Jersey, 2010-2016, Adjunct Professor.

Non-academic experience:

Toshiba America Research Inc. Piscataway, New Jersey, Research Director, Conducted research and managed research teams to invent new products and new features. Filed 35 patents (25 issued) that generated an estimated annual revenue stream of about $10M (2001-2009).

NIKSUN, Princeton, NJ, USA, Director/Head Technical Training Department, Started NIKUN Corporate Training Department from scratch to provide product trainings on “Cybersecurity”, and “Network Performance” products for external customers, partners, resellers and internal employees. (2013-2016)

Tecvox, Huntsville, Al, USA, Research Director (2018-) Supervise research, development and operational activities to invent and produce new products.

Certifications or professional registrations:

None

Current membership in professional organizations

Senior Member, IEEE

Honors and awards

Inventor of the year award, New Jersey Hall of Fame

Service activities (within and outside of the institution)

Vice Chair, SouthEastCon 2019.

Reviewer of several journals and conference papers

Reviewer of Masters and Ph.D. theses.

Out Reach Activities in local schools

Important Publications and presentations from the past five years

Raziq Yaqub, Kaveh Heidary, “System and Method of Detecting Individuals In a Target Geographic Location With A Disastrous Site Using Smart Antenna Borne Drone, US Patent application filed on June 6, 2017, published on December 7, 2017, Publication number: 20170350959”

Michael Adams, Renee Adams, Raziq Yaqub, Integrated mobile phone case and charger, US Patent No. 20170288452issued on 10/05/17

Raziq Yaqub, Kaveh Heidary "Mathematical Modeling of Energy Harvesting in Piezo Embedded Electric Vehicle Tires Together with Self-Health Assessment of Suspension System", accepted for publication in International Journal of Electric and Hybrid Vehicles. February 2018.

Raziq Yaqub, Kaveh Heidary, Ambreen Joyo, Nicholas Madamopoulos, "Green-initiative for Realizing Adaptive Traffic-lights by Exploiting Smart-antenna Technology (GREATEST)," ITSM-17-09-0094.R2, accepted for publication in the IEEE Intelligent Transportation Systems Magazine. Your manuscript will also be published in IEEE Xplore.

Raziq Yaqub, Kaveh Heidary, “Autonomous Wind Turbine Blades Cleaning System”, 5th IEEE International Conference on Smart Energy Grid Engineering, August 14-17, 2017 UOIT, Oshawa, Canada

Raziq Yaqub, James Burrell, Xavier Crutcher, Jairus Morrow, “Prototype Model of Potholes and Road roughness Detection and Reporting System” 5th IEEE International Conference on Smart Energy Grid Engineering, August 14-17, 2017 UOIT, Oshawa, Canada.

Raziq Yaqub, Ambreen Joyo, Nicholas Madamopoulos, Managing traffic-light-duration by exploiting smart antenna technology (MATSAT), 2015 IEEE 23rd International Symposium on Quality of Service (IWQoS), 15-16 June 2015

Ambreen Joyo, Raziq Yaqub, Nicholas Madamopoulos, "Managing traffic-light-duration by exploiting smart antenna technology (MATSAT) for coordinated multiple-intersections (CMI)", Emerging Technologies (ICET) 2015 International Conference on, pp. 1-7, 2015.

Muhammad Kamran1, Dr. Raziq Yaqub, Dr. Azzam ul Asar, Autonomously Battery Charging Tires For EVs Using Piezoelectric Phenomenon, International Conference on Modeling, Simulations and Visualization Methods MSV'17.

Raziq Yaqub, “Defending Unethical-unplugging of an EV (DUE)”, 5th International Conference on Electric Power and Energy Conversion Systems, Kitakyushu, Japan, April 23-25, 2018

Presentation

http://icosst.kics.edu.pk/2016/main/dr_raziq_yaqub

http://sdiwc.net/conferences/eeetem2017/keynote-speakers/

http://icacci-conference.org/2017/isi-speakers

http://ualr.edu/eitcolloquium/spring-2017-schedule/

https://www.nationalcybersummit.com/Newsroom/Past-Speakers

Briefly list the most recent professional development activities

Attended ABET Symposium 2017

Attended ABET Workshop 2018

Attended ABET Symposium 2018

Appendix C – Equipment

Table 18. Major Pieces of Equipment Used by the EE Program in Support of Instruction

Equipment list	Location	Utilization
1. Keysight DSO-X2002A oscilloscopes (4 units) 2. Keysight DSO1052B oscilloscopes (4 units) 3. Agilent 54621A oscilloscope (4 units) 4. Agilent 54622D oscilloscope (4 units) 5. Agilent U3401A multimeters (7 units) 6. Agilent U34461A multimeters (7 units) 7. HP/Agilent 34401A multimeters (5 units) 8. EZ DM-441B multimeters (2 units) 9. BK Precision 4011A signal generators (15 units) 10. EZ FG-7002C signal generator (1 unit) 11. EZ GP-4303TP power supplies (5 units) 12. NI ELVIS II virtual instruments (11 units) 13. K&H Products ETS-7000 breadboard (12 units) 14. Assortment of solders, scopes, multimeters, power supplies, signal generators, cables, etc.	Room 263	EE 201L, 203L & Senior design as needed
1. Agilent N5230A Microwave Network Analyzer (1 unit) 2. Instek GSP-730 Microwave Spectrum Analyzer (1 unit) 3. Signal Hound VSG25A Microwave Signal Generator (1 unit)	Room 205	Senior design as needed
1. 12-HP i5 ProDesk. 2. 12 – Lenovo X2 PCs. 3. Associated system mock-up hardware; Freescale project boards with multiple MCU devices HCS12 and HCS08 with variety of sensors.	Room 270	EE 320L, 330, and senior design as needed
1. Steed diffusion furnace system; state-of-the-art custom computer controlled system with five tubes; the temperatures can vary up to 1200 ºC. 2. Karl Suss MA 6 mask aligner; 3-inch wafer and four-inch mask alignment and UV exposure. 3. Tempress dicing saw; diamond cuter for silicon wafers. 4. Rudolph ellipsometer; thickness measurements for dielectric transparent thin films. 5. Nikon and Olympus microscopes; optical imaging up to 1000 x. 6. MRK Image Analysis and Dimensional Measurement System; optical image capture and analysis; imaging up to 1000 x. 7. CEE Photoresist Coater; spinning up to 5000 rpm. 8. Blue M softbake and hardbake oven; heating temperatures up to 1000 ºC. 9. MMR Hall and Seebeck measurement system; resistivity and Seebeck coefficient measurements. 10. Semiconductor parameter analyzer; electrical	Room 135	EE 451, 451L, research, and senior design as needed

measurements for IV curves; Model: B2900A. 11. Lesker PVD 75 sputtering deposition system; 2-inch targets, RF/DC sources. 12. Lesker PVD 75 e-beam evaporation system; thermal evaporation and e-beam evaporation, manual/auto operation. 13. Ted Pella XP Precision Sectioning Saw; cutting of the substrates in the desired dimensions. 14. Lesker ALD Deposition System; Atomic Layer Deposition System (Arriving in June, 2018)		
1. EMONA-TIMS telecommunications modeling system, TIMS-301 system unit including the fixed modules (6 units) 2. EMONA-TIMS telecommunications modeling system, basic module set (6 units) 3. EMONA-TIMS telecommunications modeling system, advanced module set (3 units)	Room 274	EE 360L and senior design as needed
1. Electrolab Generator Trainers sets including DC compound and synchronous machine (6 units) 2. Assortment of high power resistive loads, selector switches, power meters, ammeters, voltmeters, etc.	Room 279	EE 340L and senior design as needed
1. JEOL Model JSM-6610LV scanning electron microscope with energy-dispersive X-ray spectroscopy (EDS) and nanometer pattern generation system (NPGS) for e-beam lithography, Oxford Energy Dispersive Spectroscopy (EDS). 2. Nabity nanometer pattern generation system (NPGS). 3. Hall Effect system supported by Van der Pauw resistivity measurement system. 4. Semiconductor parametric analyzers for C-V (capacitance-voltage) measurements, and ac small-signal electrical characterization impedance and gain phase analyzers. 5. Hitachi S-530 scanning electron microscope (SEM) equipped with Oxford Instruments Model 6566 Energy Dispersive Spectrometer. 6. Thermotron F-4-CHA Thermal/Altitude chamber and a Faxitron 805 materials x-ray unit. 7. LC Ferroelectric Test System equipped with a Photonic Sensor. 8. Assortment of standard electronic test equipment including signal generators, power supplies, oscilloscopes, spectrum analyzers, meters and probing equipment, etc.	Room 268 AB and 280	EE 431, 452, research, and senior design as needed
1. Various FPGA development systems for training and low density logic implementation, as well as a high performance FPGA platforms, including a NI BEE3 equipped with high capacity Xilinx FPGA devices, and an IBM Power9 CAPI system with Altera Stratix device. 2. Several workstations equipped with the latest 64 bit multi-core processors with the latest versions of engineering simulation and analysis software packages. 3. 256-band VNIR Surface Optics hyperspectral camera.	Room 278	Research and senior design as needed

4. Surface Optics SOC716 VNIR sixteen–band high-speed hyperspectral imaging system. 5. Laser scanner, turntable dual-axis scanning MEMS mirrors.		
1. Signal sources, scopes, meters, solders, breadboards, connectors, cables, etc.	Room 268	Senior Design
1. Keithley 6487 Picoammeter and Voltage Source, Keithley 169 Multimeter, and Auto Range Digital Multimeter, for characterization of electrical properties of semiconductor nuclear radiation detectors station. 2. REXON Scintillation Detector (Type NAI), ORTEC High Voltage Power Supply (Model 556), ORTEC Preamplifier (Model 575A), ORTEC Amplifier (Model 113), ORTEC Multichannel Analyzer (MCA), ORTEC NIM Bin Power Supply (Model 4001A), GW-INSTEC Oscilloscope with Digital Storage and Visual Persistence (Model GDS-3354), and Spectrum Techniques sealed radioactive materials Model RSS 8 Gamma Source Set (Isotopes: ^{133}Ba, ^{14}C, ^{109}Cd, ^{60}Co, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{55}Fe, ^{125}I, ^{129}I, ^{54}Mn, ^{22}Na, ^{210}Pb, ^{210}Po, ^{90}Sr, ^{204}Tl and ^{65}Zn) for measurement of detector responses to high energy radiations (X-rays and gamma-rays) and identification of special nuclear materials station. 3. Three-Zone Furnace (Model 1000C-1.5-4-4-4), Edwards Diaphragm Vacuum Pump XDD1 with T-Station 75, Thermocouples, and Nicety DT 804 Digital Multimeter for Post-growth semiconductor annealing. 4. Air Science Ductless Fume Hood, Fisher Scientific Heater and Stirrer, Fisher Scientific Timer, polishing pads, and reagent chemicals for nuclear detectors device fabrication and chemical treatment. 5. Infrared transmission microscopy station, equipped with AmScope Optical/Infrared Microscope, MD900E Digital Camera, and Newport Research Corporation optical table.	Room 265	Nuclear lab for research and senior design as needed
1. 30 – HP i5 ProDesk desktop computers.	Room 272	EE simulation lab, EE 405L
1. Thirty desktop computers and two printers. New computers and printers to be installed in summer 2018. Work is in progress.	Room 271	EE open computer lab
1. SGI altix 450 system with 167 processors 2. Dense Memory Cluster 1800 CPU cores, 10 TB memory	Alabama Supercomputer	Remote Access

Appendix D – Institutional Summary

Programs are requested to provide the following information.

Institution

Name and address of the institution

Alabama Agricultural and Mechanical University

4900 Meridian Street

Normal, AL 35762

Name and title of the chief executive officer of the institution

Dr. Andrew Hugine, Jr.

President, Alabama A&M University

Name and title of the person submitting the self-study report.

Dr. Chance M. Glenn, Sr., Dean

College of Engineering, Technology and Physical Sciences

Name the organizations by which the institution is now accredited and the dates of the initial and most recent accreditation evaluations.

Southern Association of Colleges and Schools Commission on Colleges (SACS)

Initial Accreditation: 1963

Most Recent Accreditation Evaluation: 2014

Type of Control

Public Institution

Public non-profit state supported education institution governed under the laws of the State of Alabama

Educational Unit

The Bachelor of Science in Electrical Engineering (BSEE) program is located within the Department of Electrical Engineering and Computer Science (EECS), which is one of three academic departments within the College of Engineering, Technology and Physical Sciences (CETPS). The CETPS is one of four colleges at the University.

The Chairperson of the Department of Electrical Engineering and Computer Science, Dr. Kaveh Heidary, is directly responsible for administration of the BSEE program. The Chairperson reports directly to the Dean of CETPS, Dr. Chance M. Glenn, Sr. The Dean reports directly to the Provost and Vice-President for Academic Affairs, Dr. Daniel K. Wims. The Provost reports directly to the President of Alabama Agricultural and Mechanical University, Dr. Andrew Hugine, Jr. The President reports to the Board of Trustees of Alabama A&M University.

An organizational chart depicting these relationships is shown in Figure 16.

Academic Support Units

The Dean of the College of Engineering, Technology and Physical Sciences (CETPS) is Dr. Change M. Glenn, Sr. The CETPS comprises three academic departments including two Engineering departments, and Department of Physics, Chemistry and Mathematics. The department chairpersons are:

- Department of Electrical Engineering and Computer Science – Dr. Kaveh Heidary
- Department of Mechanical & Civil Engineering and Construction Management – Dr. Mohamed Seif
- Department of Physics, Chemistry and Mathematics – Dr. Mohan Aggarwal

Non-academic Support Units

List the names and titles of the individuals responsible for each of the units that provide non-academic support to the program being evaluated, e.g., library, computing facilities, placement, tutoring, etc.

- Library:

J. F. Drake Memorial Learning Resources Center (Drake LRC)

Dr. Annie M. Payton, Director

- Computing Facilities:

Information Technology Services Department

Dr. Kylie Nash, Interim Chief Information Officer (CIO)

- Placement:

Career Development Services (CDS)

Ms. Yvette S. Clayton, Director

- Tutoring:

Tutorial Assistance Network (TAN)

Ms. Linda Skeete McClellan, MS, Program Specialist

- Registrar

Office of the Registrar

Ms. Brenda K. Williams, Registrar

- Freshman Academy

Dr. Pamela H. Thompson, Interim Executive Director

- Office of Retention and Persistence (ORP)

Ms. Mindi Thompson, Lead Academic Advisor

- High Performance Computing:

Alabama Supercomputer Center (ASC)

Mr. David Ivey, Program Manager

- Admissions:

AAMU Office of Admissions

Mr. Dwayne Green, Interim Director

- Title III: Aid for Institutional Development Programs

Title III Strengthening Grants Program

Dr. Andrea Cunningham, Director

- CETL

Centers for Excellence in Teaching and Learning

Dr. Pamela Arrington, Director

- Credit Unit

One semester credit normally represents one class hour or three laboratory hours per week. One academic year normally represents at least 28 weeks of classes, exclusive of final examinations.

Tables

Table 19 details program enrollment and degree data for the BSEE program. Table 20 provides information on the personnel staffing data for the BSEE program.

Table 19. Program Enrollment and Degree Data

Bachelor of Science in Electrical Engineering

	Academic Year		Enrollment Year					Total Undergrad	Total Grad	Degrees Awarded			
			1st	2nd	3rd	4th	5th			Associates	Bachelors	Masters	Doctorates
Current Year	2017-2018	FT	74	43	37	48	-	202	0	0	27	0	0
		PT	0	0	0	0	-	0	0				
1	2016-2017	FT	79	39	33	46	-	197	0	0	19	0	0
		PT	0	0	0	0	-	0	0				
2	2015-2016	FT	81	48	33	27	-	189	0	0	27	0	0
		PT	0	0	0	0	-	0	0				
3	2014-2015	FT	77	50	18	42	-	187	0	0	21	0	0
		PT	0	0	0	0	-	0	0				
4	2013-2014	FT	76	26	21	43	-	166	0	0	27	0	0
		PT	0	0	0	0	-	0	0				

Give official fall term enrollment figures (head count) for the current and preceding four academic years and undergraduate and graduate degrees conferred during each of those years. The "current" year means the academic year preceding the fall visit.

FT--full time

PT--part time

Table 20. Personnel

Bachelor of Science in Electrical Engineering

Year[1]: _FALL 2017_____

	HEAD COUNT		FTE[2]
	FT	PT	
Administrative[2]	1	0	0.5
Faculty (tenure-track)[3]	7	0	6.5
Other Faculty (excluding student Assistants)	2	2	2.4
Student Teaching Assistants[4]	0	0	0
Student Research Assistants	0	0	0
Technicians/Specialists	1	0	0.3
Office/Clerical Employees	1	0	0.5
Others[5]	0	0	0

Report data for the program being evaluated.

1. Data on this table should be for the fall term immediately preceding the visit. Updated tables for the fall term when the ABET team is visiting are to be prepared and presented to the team when they arrive.
2. Persons holding joint administrative/faculty positions or other combined assignments should be allocated to each category according to the fraction of the appointment assigned to that category.
3. For faculty members, 1 FTE equals what your institution defines as a full-time load
4. For student teaching assistants, 1 FTE equals 20 hours per week of work (or service). For undergraduate and graduate students, 1 FTE equals 15 semester credit-hours (or 24 quarter credit-hours) per term of institutional course work, meaning all courses — science, humanities and social sciences, etc.
5. Specify any other category considered appropriate, or leave blank.

Signature Attesting to Compliance

By signing below, I attest to the following:

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

____

Dean's Name (As indicated on the RFE)

______________________ ________________________

Signature **Date**

Appendix E – EE Survey Instruments

Alabama A&M University

Electrical Engineering Alumni Survey Form

Email the completed survey to: kaveh.heidary@aamu.edu

Part I. Personal Profile:

Name: ___________________________ Year/Semester of Graduation ____________

Address: ___________________________ City: _________________ State: ______Zip: _____

Telephone: (H)_____________(W)_____________ Email: ___________________________

1) Did you have a job offer before graduation? Yes __ No __

2) Did the number of job offers you received allow you to be selective in both jobs and job location Yes__ No__

3) Were you satisfied with your starting salary? Yes __ No __

4) Have you experienced salary growth and promotion in position and/or responsibility? Yes __ No __

5) Are you classified as a professional within your company? Yes __ No __

6) Do you feel that you are competitive with other young professionals hired by your company? Yes__ No__

7) Have you taken/passed the FE/EIT exam? Yes __ No __

8) Have you any further education or training since graduation? Yes __ No __

9) Do you feel that you obtained a quality education at the University? Yes __ No __

10) How well did your education prepare you for professional practice?

Well __ Adequately __ Not Well __

Part II. Personal Opinions

1) The following course(s) should be added or strengthened to make graduates more competitive.

2) The following laboratory course(s) should be added or strengthened to make graduates more competitive.

3) The transition from school to work would have been easier if the following were added to the curriculum.

Part III. Your undergraduate experience

Please rate your undergraduate experience	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I have the technical skills required for my job assignments.					
I have the ability to use the techniques and tools necessary for successful professional practice.					
I have the ability to communicate effectively both verbally and in writing.					
I have the ability to function on multi-disciplinary teams.					
I have an understanding of professional and ethical responsibility in professional practice.					
I have a recognition of the need for, and an ability to engage in lifelong learning.					
I am competitive with other young professionals hired by my company.					
I would recommend Alabama A&M University to my family and friends.					

Part IV. The School of Engineering and Technology plans to publish an annual Newsletter. If you would like to share your personal information and opinions with your fellow graduates and provide your input to the undergraduate students of the School of Engineering and Technology please list your accomplishments and other information you consider important below or on a separate sheet.

Signature:______________________________ Date: ________________

Alabama A&M University (AAMU)
Employer Survey Form
For
Electrical Engineering Program Alumni

Email the completed survey to: kaveh.heidary@aamu.edu

Is the AAMU graduate classified as an engineer or professional employee? Yes __ No __

How well did the employee's education prepare him/her for professional practice? ______

____

____

____

Employee Performance

Using the following criteria, please rate your employees.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
AAMU graduates have the technical skills required for their job assignments.					
AAMU graduates have the ability to communicate effectively both verbally and in writing.					
AAMU graduates have the ability to function on multi-disciplinary teams.					
AAMU graduates have an understanding of professional and ethical responsibility in professional practice.					
AAMU graduates have a recognition of the need for, and an ability to engage in lifelong learning.					
AAMU graduates are competitive with other young professionals hired by my company.					
I would recommend that my company hire more graduates from Alabama A&M University, School of Engineering and Technology.					

Comments: (Please add your perceptions about the employee's career preparation strengths and weaknesses.)

Alabama A&M University

Electrical Engineering Program

Graduating Senior Survey

Perceptions and Assessment of Education	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The advice given me by the engineering faculty advisors was accurate and of high quality					
The computing and simulation tools I needed to get my work done were readily available in my department.					
Engineering faculty members encouraged students to study in group environments.					
Lab courses were beneficial in helping to understand concepts taught in the lectures					
Courses taken in my department required that I analyze and interpret data.					
I was taught to design a system, component or process to meet a specific need.					
I was taught to function on multi-disciplinary teams.					
Ethical social and global economic and environmental issues in engineering were discussed in my undergraduate courses.					
My assignments required that I apply math, science and technology principles.					
My engineering assignments required that I solve realistic problems with multiple constraints.					
Oral and written communication skills were required in my courses.					
I made use of library and internet resources in solving problems.					
My instructors encouraged me to further my education beyond the undergraduate level.					
I plan to take the Fundamentals of Engineering examination.					
I plan to enhance my education by attending workshops and enrolling in graduate school.					
Engineering professors, department chairpersons and the Dean's office were helpful in obtaining intern and					

co-op positions and other technical employment.					
Overall, I feel that I have obtained a quality education here at the University.					
I would recommend AAMU to my family and friends.					

Post Graduate Employment	**Yes**	**No**
I have a post-graduation job offer.		
The number of job offers I received allowed me to be both job and location selective.		
I am satisfied with the salary offered.		

Post Semester - Course Survey

To be completed by Instructor

Year_______ Semester_____

Course Name____________ Course Number____________ Section #______________

Please answer the following questions relative to the course identified above.

1) Number of students originally registered for this class/section. ____
2) Number of students withdrawing from this class/section. ____
3) Number of students earning grade of "C" or better. ____
4) Estimate number of students purchasing course text. ____
5) Estimate number of students, on average, who were in class within 5 minutes of class start. ____
6) Estimate average percentage of students attending class regularly. ____

7) Which Educational Objectives (Educational Outcomes?) listed in the Course syllabus were not covered during this semester?

8) Why were these objectives (outcomes?) not covered?

9) Propose actions required to correct learning shortcomings experienced this semester.

10) Propose changes to educational objectives (outcomes?), teaching methods, textbooks, lab experiments, etc. for this course.

Electrical Engineering

Senior Design Team Partner Assessment Survey

2017-2018

Please use this form to rate the performance of your senior design team partners. Rate each of your partners (A, B, C, etc.) for each category. Your assessment is completely anonymous and will remain confidential and will not have any effect on grades.

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
My partner has effective communication skills	Partner A					
	Partner B					
	Partner C					
	Partner D					
My partner displayed good teamwork spirit	Partner A					
	Partner B					
	Partner C					
	Partner D					
My partner displayed professional and ethical responsibility	Partner A					
	Partner B					
	Partner C					
	Partner D					
My partner displayed a commitment to lifelong learning	Partner A					
	Partner B					
	Partner C					
	Partner D					

Appendix F – EE Graduating Senior Survey Results

The Graduating Senior Survey is utilized as an indirect measurement instrument for assessment of Student Outcomes. The Graduating Senior Survey Forms are distributed to all prospective BSEE graduates at the end of each semester in December and April.

The survey form (Appendix E) consists of twenty-one questions, of which fifteen are related to Student Outcomes. The possible answers to the first eighteen questions range from strongly agree to strongly disagree, and the last three questions have binary answers. The responses to questions number one through fifteen are utilized to measure the extent of attainment of Student Outcomes. Questions sixteen through twenty-one pertain to the respondents' general perception toward the program and university and their employment prospects. The numerical values assigned to each response range from 4 for strongly agree, to 0 for strongly disagree, which are subsequently rescaled to 0 - 100 range. Each one of the survey questions 1-15 is related to one or more of the a-k Student Outcomes.

The raw data associated with the aggregated responses to each survey question are tabulated for each academic year and are given below in Tables 22 - 27. The number listed in each block indicates the number of respondents who assigned the corresponding response to the respective question. Each list represents the combined responses of December and May graduates of the corresponding academic year. The number of respondents is listed at the top of each list. It is noted that the sum of numbers along each row is equal to or less than the number of respondents.

Table 21 lists the correspondence between survey questions on one hand and the Student Outcomes on the other hand.

Table 21. Relationships between survey questions and Student Outcomes

Student Outcomes	a	b	c	d	e	f	g	h	i	j	k
Question Number	9,10	4,5	6,8,10	3,7	6,10	8	11	8	13,14,15	1,2,12	2,4

Figure 17 plots the average scores for Student Outcomes a-k for six evaluation cycles obtained from the Graduating Senior Survey results. The abscissa represents Student Outcomes and the ordinate represents average score. Each one of the six-bar groups pertains to the average scores of the corresponding Student Outcome for six evaluation cycles which are color coded. The horizontal line represents the desired target score of seventy-five. It is seen that the target score is consistently met by all of the Student Outcomes as measured by the Graduating Senior Survey.

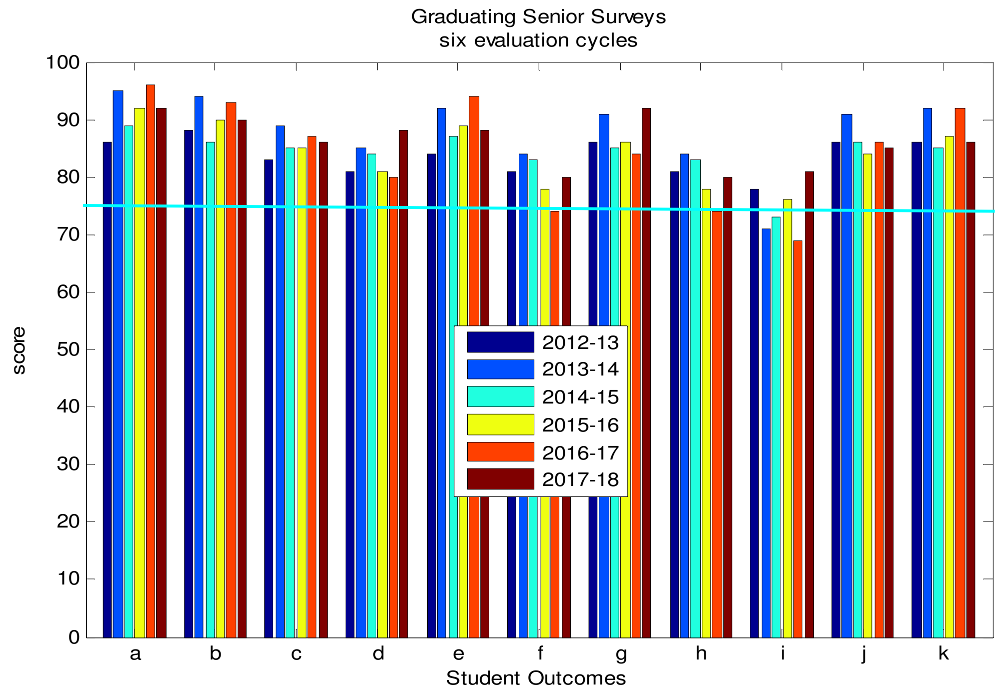

Figure 17. Student Outcomes scores for six assessment cycles

Table 22. Graduating Senior Survey results for academic year 2012-2013

Number of Respondents = 28

Question	scores				
	100	75	50	25	0
	Number of responses				
1	18	6	4	0	0
2	14	9	5	0	0
3	13	11	4	0	0
4	15	12	1	0	0
5	16	11	1	0	0
6	16	11	1	0	0
7	10	13	5	0	0
8	11	15	1	1	0
9	17	11	1	0	0
10	12	13	1	2	0

11	16	10	1	1	0
12	17	9	1	1	0
13	15	11	1	1	0
14	9	8	6	4	1
15	12	15	1	0	0
16	9	13	5	0	1
17	11	15	1	1	0
18	10	14	4	0	0

Question	Yes	No
19	22	6
20	17	11
21	20	8

Table 23. Graduating Senior Survey results for academic year 2013-2014

Number of Respondents = 20

Question	scores				
	100	75	50	25	0
	Number of responses				
1	15	4	1	0	0
2	14	5	1	0	0
3	13	2	5	0	0
4	15	4	1	0	0
5	16	4	0	0	0
6	14	5	1	0	0
7	12	4	4	0	0
8	12	5	2	1	0
9	17	3	0	0	0

10	14	6	0	0	0
11	15	3	2	0	0
12	13	6	1	0	0
13	8	6	2	3	1
14	7	4	8	0	1
15	11	3	4	1	1
16	12	4	4	0	0
17	13	6	1	0	0
18	13	5	2	0	0

Question	Yes	No
19	11	9
20	9	11
21	9	11

Table 24. Graduating Senior Survey results for academic year 2014-2015

Number of Respondents = 31

Question #	scores				
	100	75	50	25	0
	Number of responses				
1	17	13	1	0	0
2	14	15	2	0	0
3	15	11	5	0	0
4	15	14	2	0	0
5	17	12	2	0	0
6	14	17	0	0	0
7	15	14	2	0	0
8	14	15	1	1	0

9	20	10	1	0	0
10	16	14	1	0	0
11	16	13	1	1	0
12	16	14	0	1	0
13	14	15	0	1	1
14	10	10	2	6	3
15	11	15	4	1	0
16	17	12	1	1	0
17	16	14	0	1	0
18	16	15	0	0	0

Question	Yes	No
19	14	17
20	10	21
21	11	19

Table 25. Graduating Senior Survey results for academic year 2015-2016

Number of Respondents = 23

Question #	scores				
	100	75	50	25	0
	Number of responses				
1	12	10	1	0	0
2	11	11	1	0	0
3	12	9	2	0	0
4	12	10	1	0	0
5	16	7	0	0	0
6	12	11	0	0	0
7	6	12	5	0	0

8	7	12	4	0	0
9	17	6	0	0	0
10	14	9	0	0	0
11	12	9	2	0	0
12	8	10	5	0	0
13	9	14	0	0	0
14	6	8	3	4	2
15	11	8	4	0	0
16	5	13	3	2	0
17	9	12	2	0	0
18	10	13	0	0	0

Question	Yes	No
19	15	8
20	13	10
21	13	10

Table 26. Graduating Senior Survey results for academic year 2016-2017

Number of Respondents = 19

Question	scores				
	100	75	50	25	0
	Number of responses				
1	18	1	0	0	0
2	14	4	1	0	0
3	12	3	4	0	0
4	14	4	1	0	0
5	14	5	0	0	0
6	15	4	0	0	0

7	5	8	6	0	0
8	4	10	5	0	0
9	18	1	0	0	0
10	14	5	0	0	0
11	8	10	1	0	0
12	4	6	9	0	0
13	6	11	2	0	0
14	3	1	9	4	2
15	9	7	3	0	0
16	6	10	3	0	0
17	14	5	0	0	0
18	13	4	1	1	0

Question	Yes	No
19	16	3
20	12	7
21	13	6

Table 27. Graduating Senior Survey results for academic year 2017-2018

Number of Respondents = 19

Question	scores				
	100	75	50	25	0
	Number of responses				
1	12	7	0	0	0
2	11	3	5	0	0
3	11	8	0	0	0
4	12	6	1	0	0
5	12	7	0	0	0

6	11	6	2	0	0
7	11	5	3	0	0
8	10	6	1	1	0
9	15	4	0	0	0
10	13	5	0	1	0
11	13	6	0	0	0
12	11	3	4	0	0
13	12	5	1	0	0
14	9	3	4	3	0
15	10	4	6	0	0
16	5	7	4	3	0
17	11	7	1	0	0
18	11	6	2	0	0

Question	Yes	No
19	15	4
20	13	4
21	14	4

Appendix G – Student Outcomes Assessment Based on Senior Design Team Partner Assessment Survey

The Senior Design Team Partner Assessment Survey is utilized, in addition to the course outcomes assessment scores of Appendix-H, as a supplementary direct measurement instrument for the assessment of certain Student Outcomes.

The survey forms are distributed to students in EE 471, Engineering Design and Analysis II, at the end of spring semester. Each student is asked to evaluate all other student team members on his/her senior design team. The evaluations pertain to the assessment of team members' performance during the two semester sequence the students spend working on their capstone senior design projects in EE 470 and EE 471. Each student evaluates all her senior design teammates.

As seen from the survey instrument in Appendix E, the Senior Design Team Partner Assessment Survey consists of four assessment questions. The five possible responses to each question range from strongly agree to strongly disagree. The numerical values assigned to each response range from 4 for strongly agree to 0 for strongly disagree. Each one of the survey questions is related to one Student Outcome. The survey questions one-through-four correspond to Student Outcomes g, d, f, and i, respectively.

The numerical score assigned to each one of four Student Outcomes measured by this assessment instrument is determined by computing the weighted average of each of the outcomes and subsequently rescaling to range of zero to one-hundred. The raw data associated with the aggregated responses to each survey question are tabulated for each academic year and are given in Tables 28 – 33 below. The tables list the Senior Design Team Partner Assessment Survey results for six evaluation cycles covering academic years 2012-2013 through 2017-2018. The number listed in each block indicates the number of respondents who assigned the corresponding response to the respective question.

Figure 18 plots the scores for Student Outcomes d, f, g, and i for six evaluation cycles. The abscissa represents Student Outcomes and the ordinate represents average score. Each one of the six-bar groups pertains to the average scores of the corresponding outcome for six color coded evaluation cycles. The horizontal line represents the desired target score of seventy-five. It is seen that the target score is consistently met by all of the four measured outcomes.

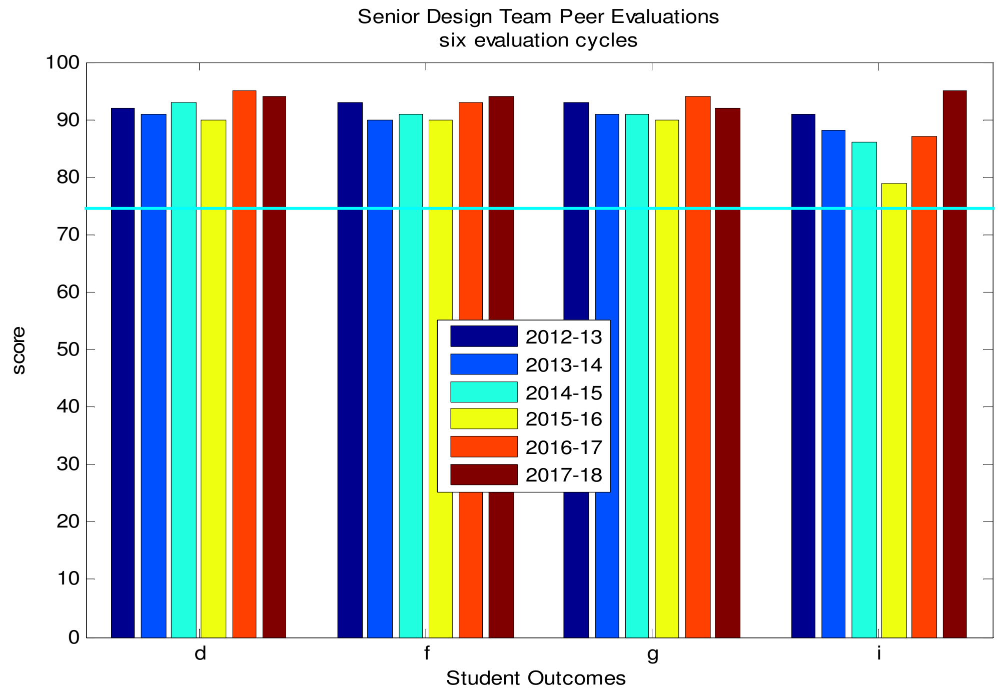

Figure 18. Student Outcomes scores for six assessment cycles

Table 28. Senior Design Team Partner Assessment results for academic year 2012-2013

Total Number of Respondents = 23

Question	scores				
	100	75	50	25	0
	number of responses				
1	48	9	4	0	0
2	47	9	5	0	0
3	48	9	4	0	0
4	44	14	4	0	0

Table 29. Senior Design Team Partner Assessment results for academic year 2013-2014

Total Number of Respondents = 18

Question	scores				
	100	75	50	25	0

	number of responses				
1	28	12	1	0	0
2	28	12	1	0	0
3	26	14	1	0	0
4	23	17	1	0	0

Table 30. Senior Design Team Partner Assessment results for academic year 2014-2015

Total Number of Respondents =23

Question	scores				
	100	75	50	25	0
	Number of responses				
1	35	14	2	0	0
2	39	11	2	0	0
3	35	14	2	0	0
4	29	17	6	0	0

Table 31. Senior Design Team Partner Assessment results for academic year 2015-2016

Total Number of Respondents =18

Question	scores				
	100	75	50	25	0
	Number of responses				
1	22	12	1	0	0
2	22	12	1	0	0
3	22	12	1	0	0
4	12	15	7	0	0

Table 32. Senior Design Team Partner Assessment results for academic year 2016-2017

Total Number of Respondents =16

Question	scores				
	100	75	50	25	0
	Number of responses				
1	26	6	1	0	0
2	27	6	0	0	0
3	24	7	1	0	0
4	15	13	1	0	0

Table 33. Senior Design Team Partner Assessment results for academic year 2017-2018

Total Number of Respondents =28

Question	scores				
	100	75	50	25	0
	Number of responses				
1	71	6	4	4	0
2	74	5	5	0	1
3	72	9	4	0	1
4	81	0	0	2	3

Appendix H – Student Outcomes Assessment Based on BSEE Courses Outcomes Assessment Scores

The EE Program is engaged in a continuous assessment process for determining the extent of attainment of Student Outcomes. Student Outcomes are measured and documented using various direct and indirect measurement tools. Direct measurement instruments used for determination of the extent of attainment of student outcomes include course rubrics and course outcomes spreadsheets that are utilized by the instructors for all the EE classes taught each semester. The outcomes spreadsheet for each class provides detailed information about the degree of attainment of each one of the outcomes that are addressed by that course. The attainment of each outcome associated with the course is recorded and tracked dynamically throughout the semester, for each student and the entire class. Student outcomes are aggregated across all courses in order to obtain a direct and quantitative measure of the degree of attainment of each student outcome. The Senior Design Team Partner Assessment Survey Form is also utilized as a direct measurement instrument for assessment of certain Student Outcomes. Indirect measurement instruments used for measuring the degree of attainment of student outcomes include various survey tools including Student Course Evaluation Form, Graduating Senior Survey Form, and Alumni Survey Form.

Each plot below in Figure 19 through Figure 55 shows the score distributions of all the Student Outcomes addressed by the respective course averaged over multiple sections and several semesters. Horizontal and vertical axes represent, respectively, Student Outcomes and number of students as a percentage of the sample population. Maximum score is one-hundred and the score range is partitioned into seven segments, which are color coded. The bar heights represent the percentage of students that attained the respective score range (color) on the particular Outcome. The course number, data collection time period, the number of sections, and the number of students for each data set are listed at the top of each plot.

The evaluation of course level outcomes assessment results guides the process of course content and delivery modifications. The EE program utilizes the periodic evaluations of course level outcomes assessment results across the entire curriculum as one of the indicators for assessing the extent of attainment of student outcomes. The evaluation of student outcomes assessment results is utilized in the continuous improvement process.

The plot of Figure 56 shows the Student Outcomes measurement results based on SO assessments averaged across eighteen BSEE core courses and laboratories (Table 5) during six measurement cycles from 2012-2013 through 2017-2018 academic years. Each year, the SO measurement results in all eighteen core courses and laboratories were aggregated by combining the results for each outcome across all the courses. For each academic year, for each course one score is assigned to each of the SOs addressed by that course. This is done by computing the weighted average of the midpoints of the seven score bands in Figure 19, namely, 15, 44.5, …, 84.5, 95, where the weight factors are the proportion of students whose scores fall in the respective bands. Therefore, the score range is from fifteen to ninety-five. In the plot of Figure 56, for each SO the computed scores across all courses addressing the outcome are averaged to obtain the score for that outcome during the particular academic year. In Figure 56, the abscissa represents the Student Outcomes and the ordinate is the computed score of the SO averaged across all the eighteen BSEE core courses. The target score is seventy-five denoted by the horizontal line. The Figure 56 plot shows SO evaluation results for six evaluation cycles, where each color band represents a particular academic year. The course level SO measurement results show that several SO scores fall below the targeted level. Inclusion of SO measurement results based on other direct and indirect assessment tools, however, indicate that virtually all SO scores meet or exceed the targeted level.

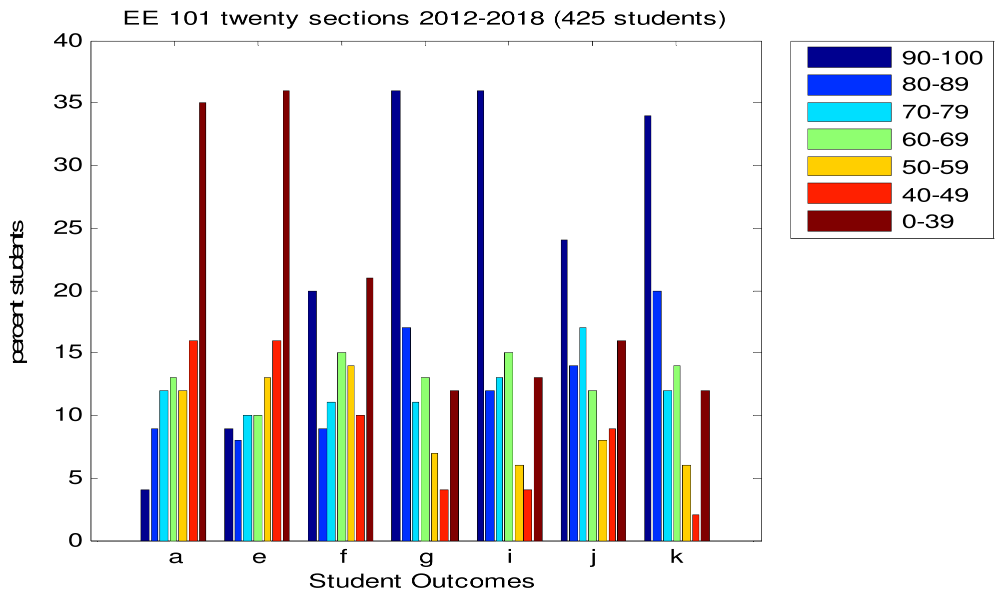

Figure 19. Course Outcomes EE 101

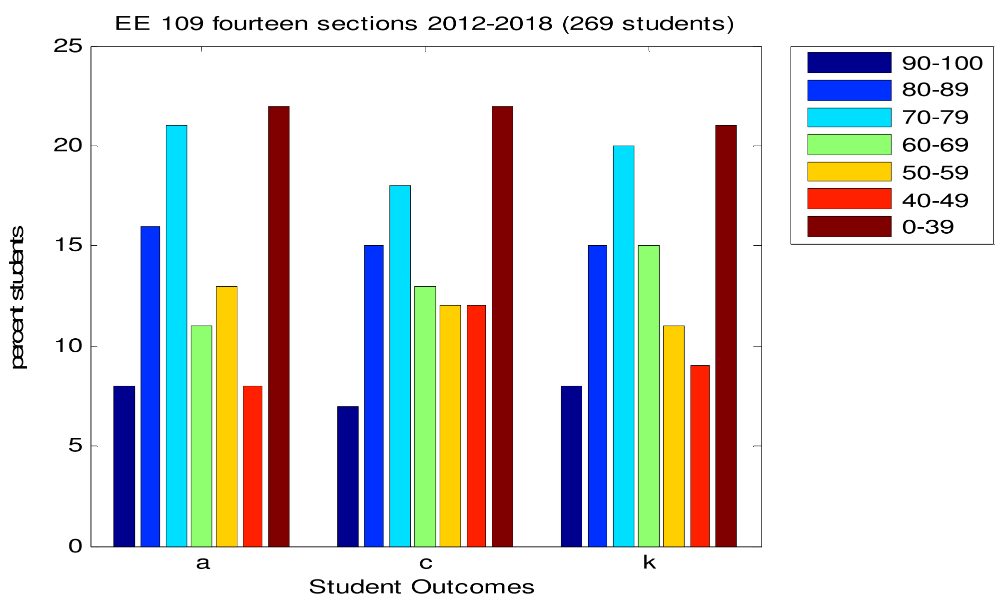

Figure 20. Course Outcomes EE 109

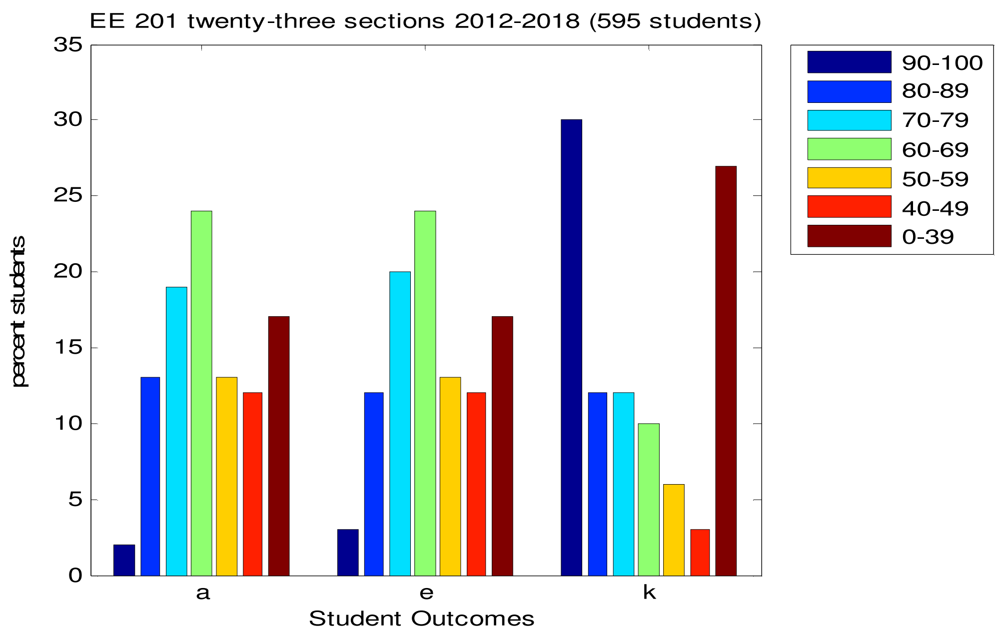

Figure 21. Course Outcomes EE 201

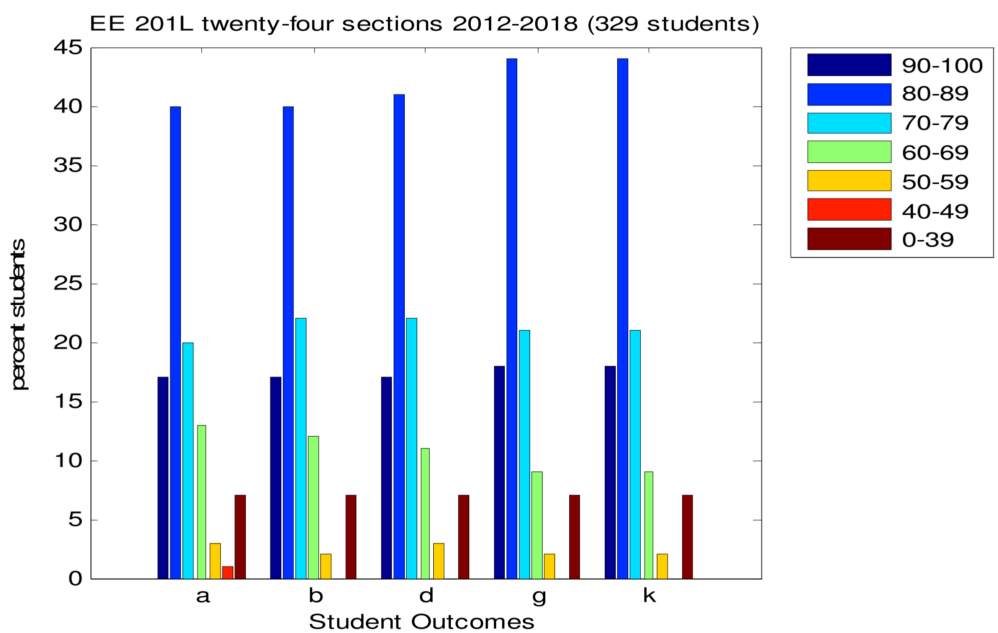

Figure 22. Course Outcomes EE 201L

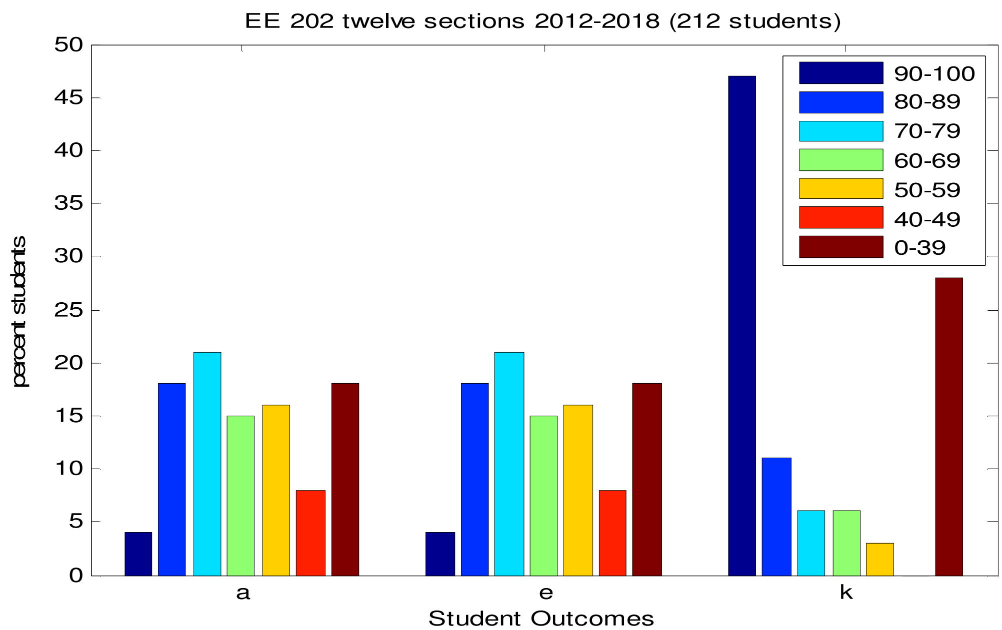

Figure 23. Course Outcomes EE 202

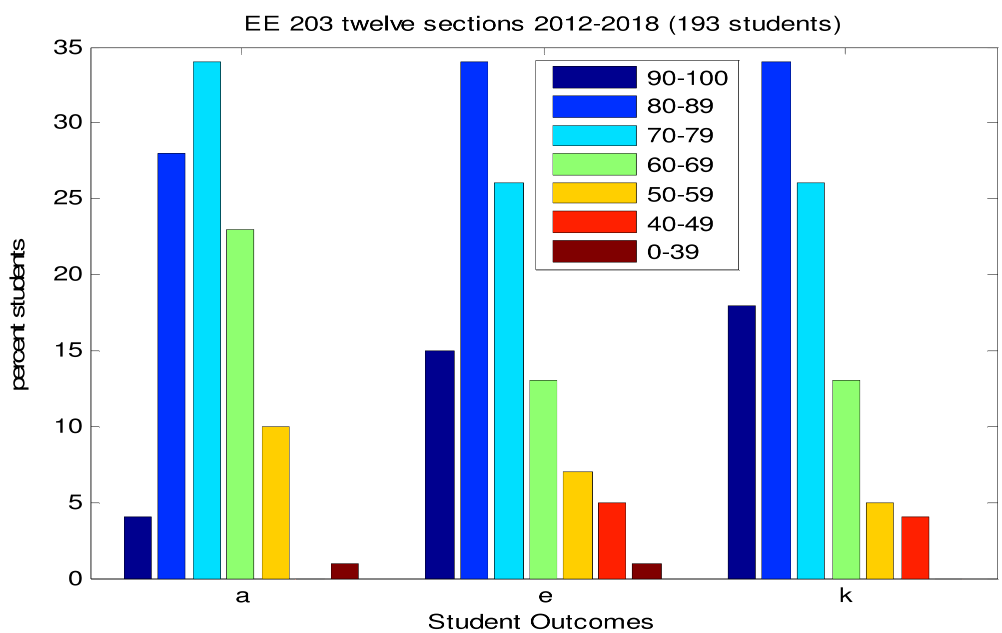

Figure 24. Course Outcomes EE 203

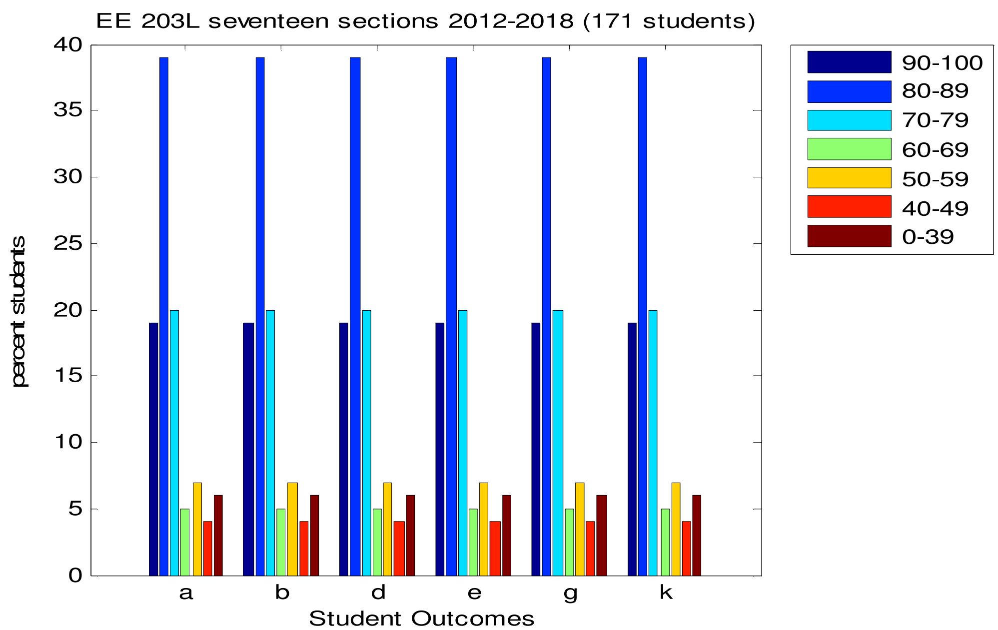

Figure 25. Course Outcomes EE 203L

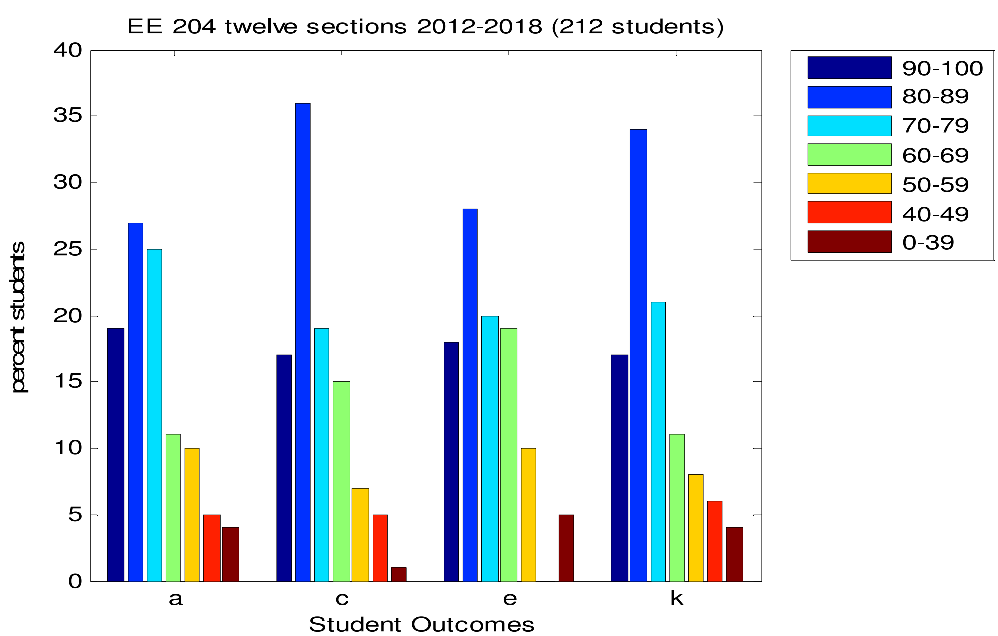

Figure 26. Course Outcomes EE 204

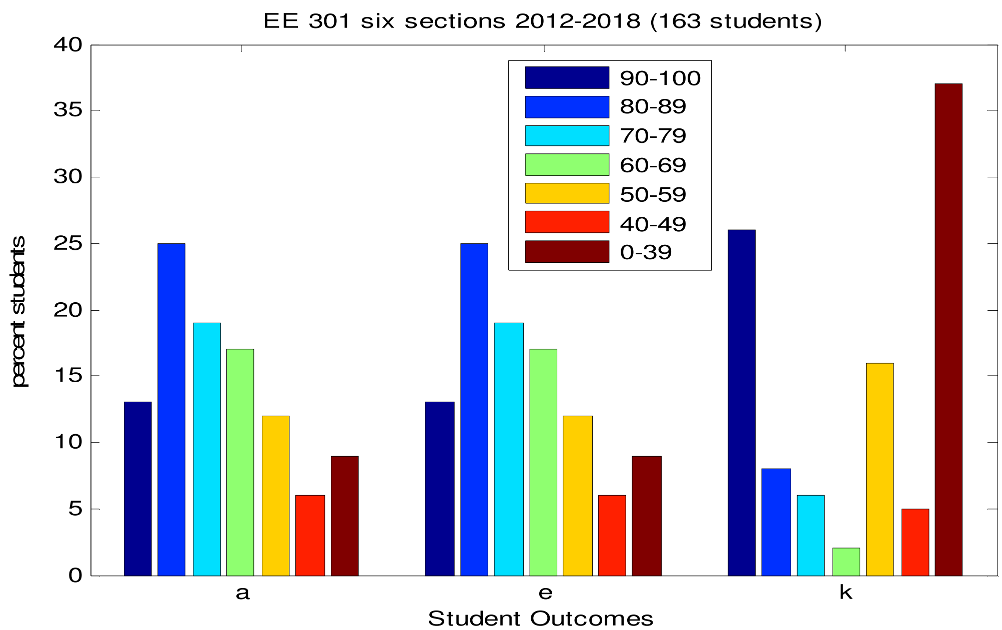

Figure 27. Course Outcomes EE 301

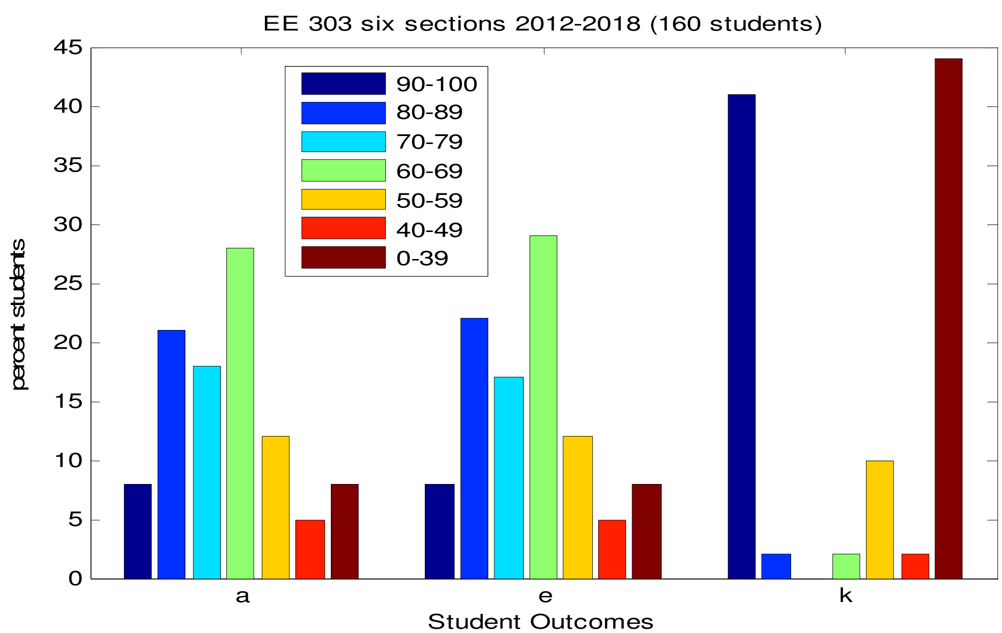

Figure 28. Course Outcomes EE 303

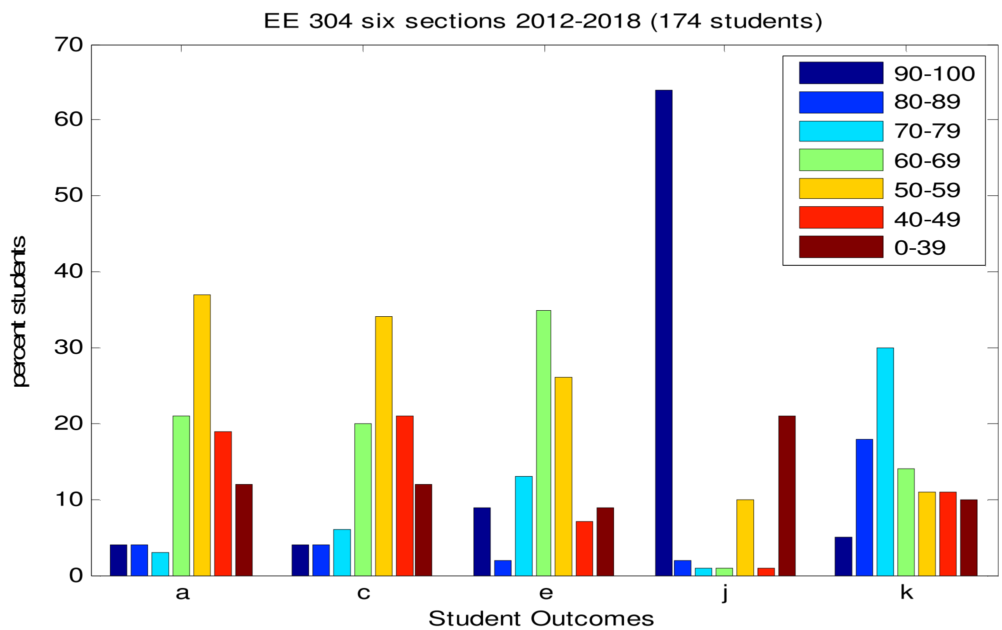

Figure 29. Course Outcomes EE 304

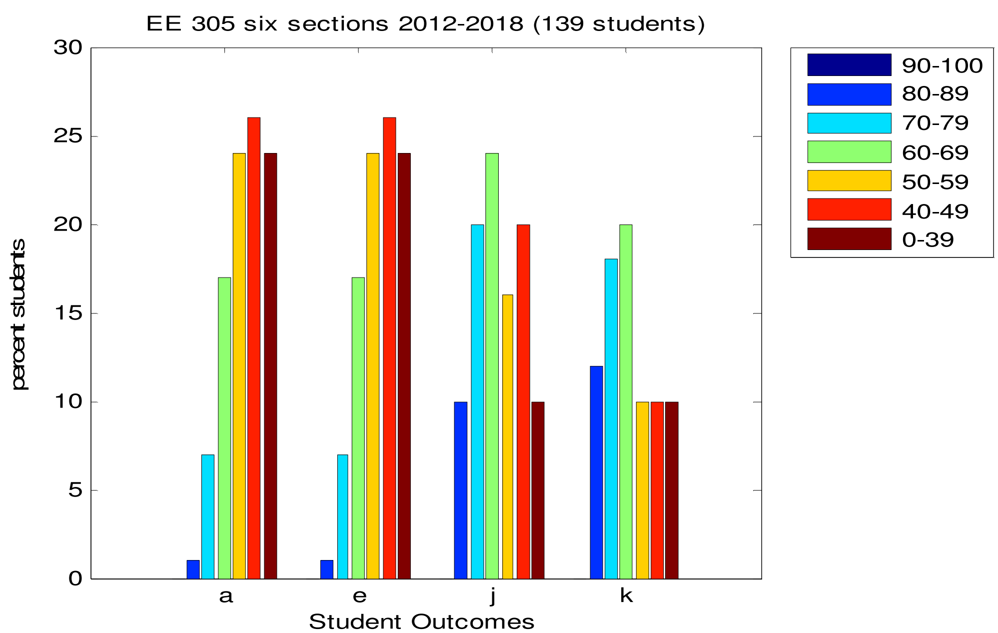

Figure 30. Course Outcomes EE 305

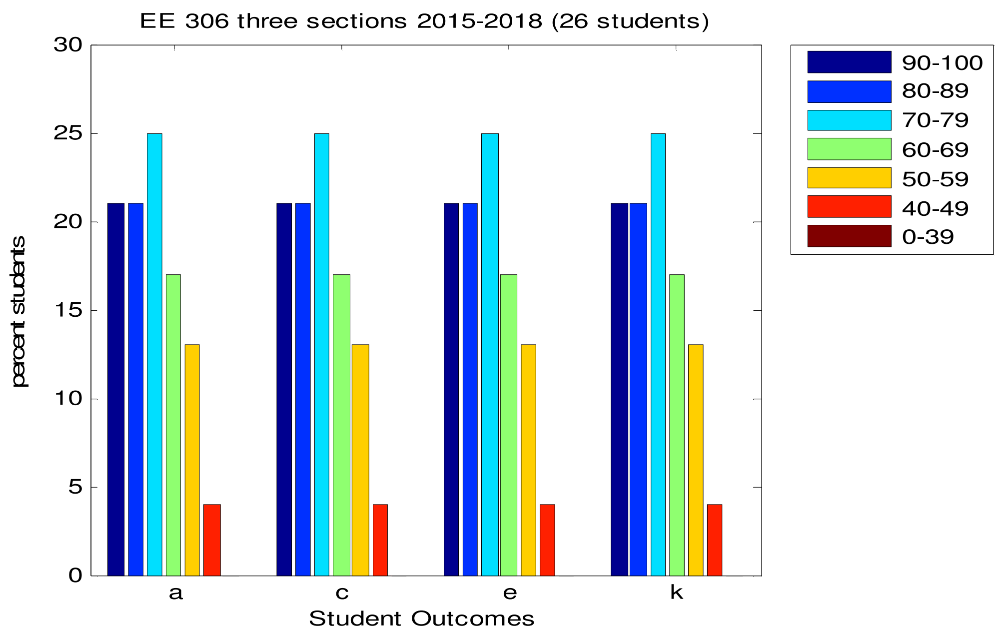

Figure 31. Course Outcomes EE 306

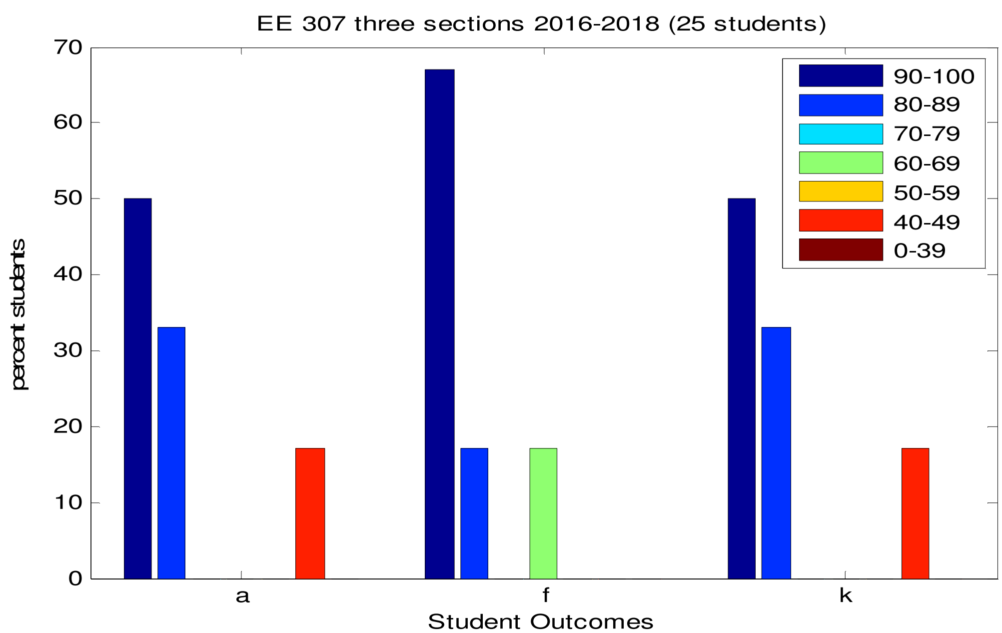

Figure 32. Course Outcomes EE 307

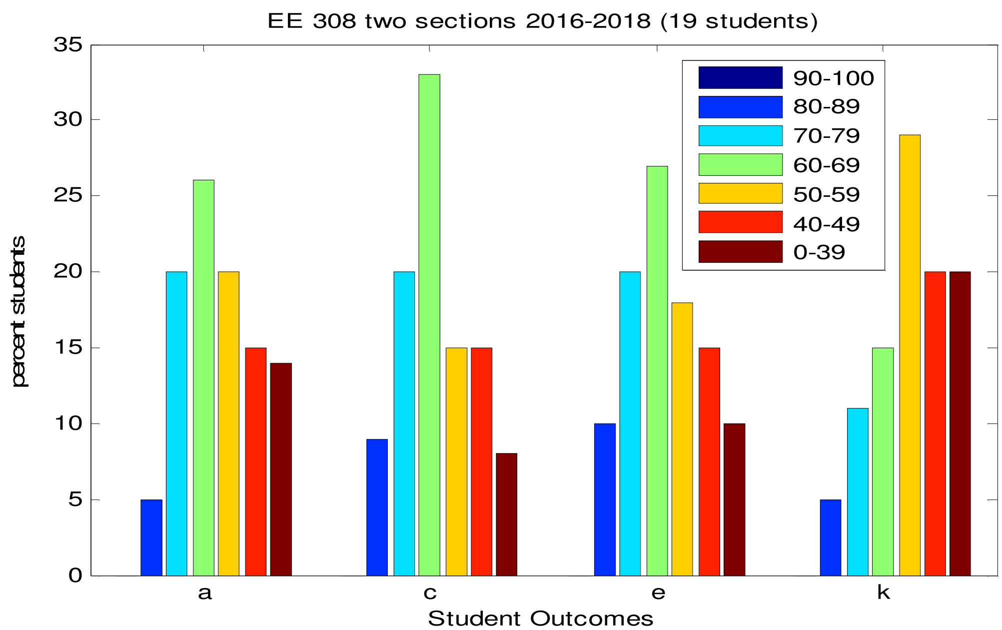

Figure 33. Course Outcomes EE 308

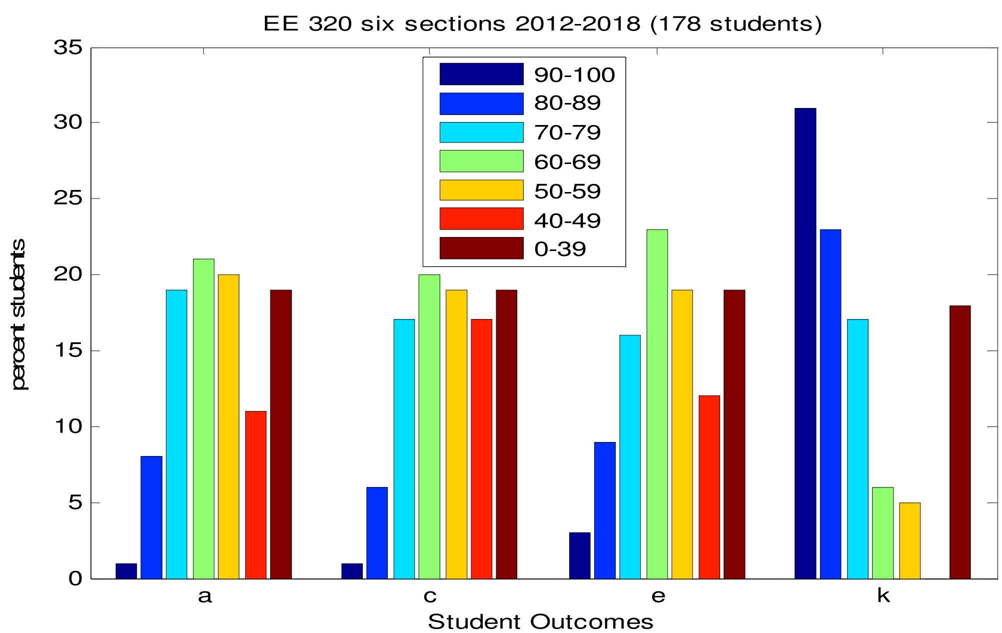

Figure 34. Course Outcomes EE 320

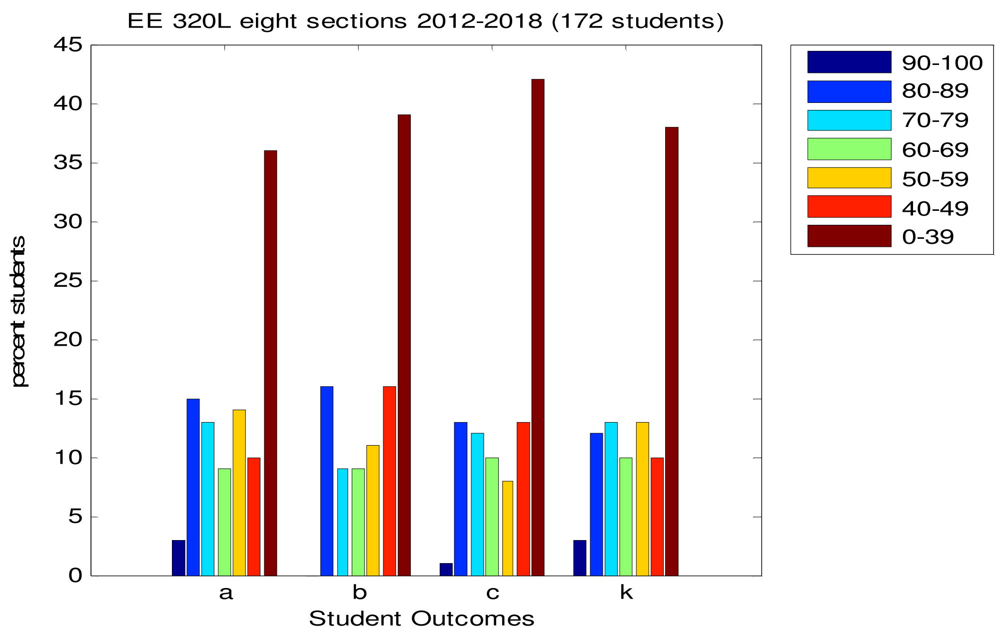

Figure 35. Course Outcomes EE 320L

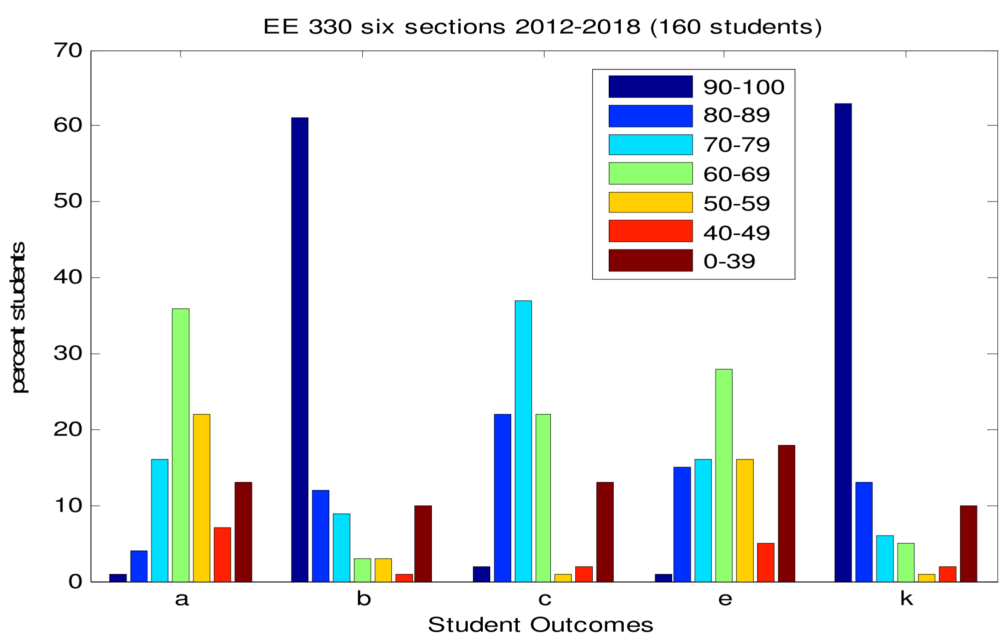

Figure 36. Course Outcomes EE 330

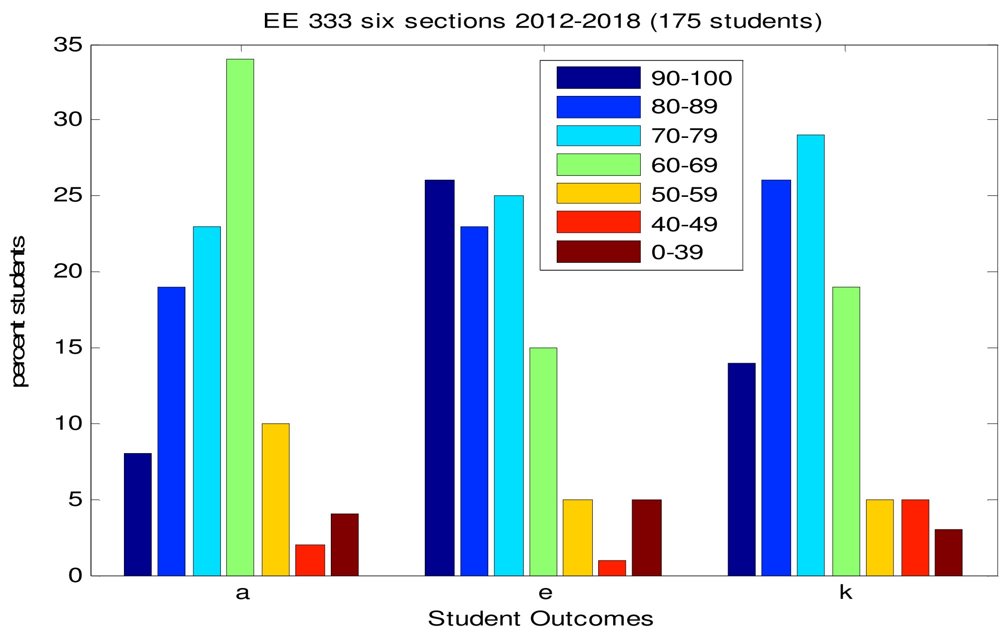

Figure 37. Course Outcomes EE 333

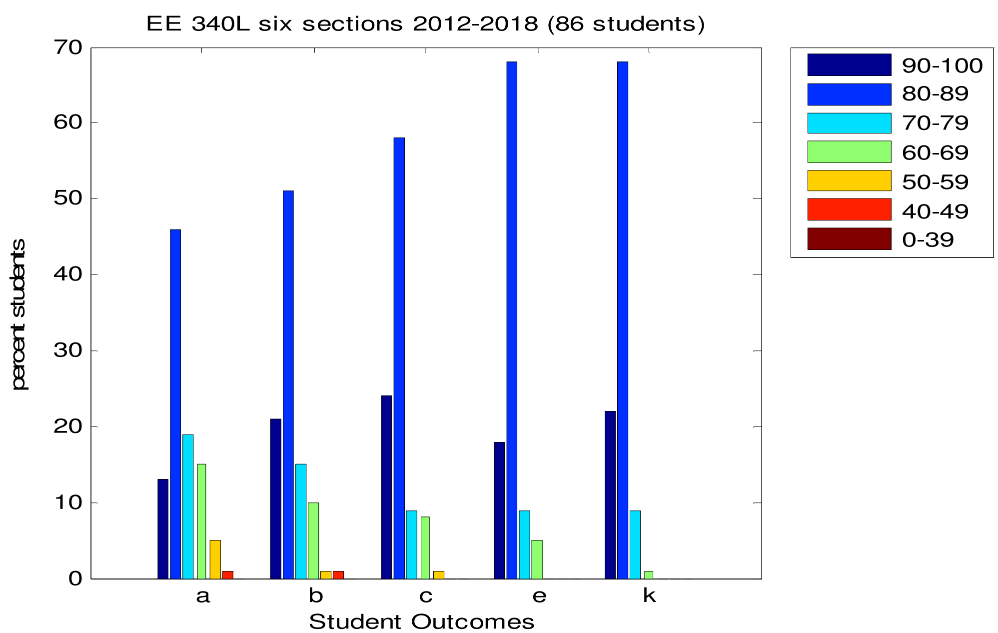

Figure 38. Course Outcomes EE 340L

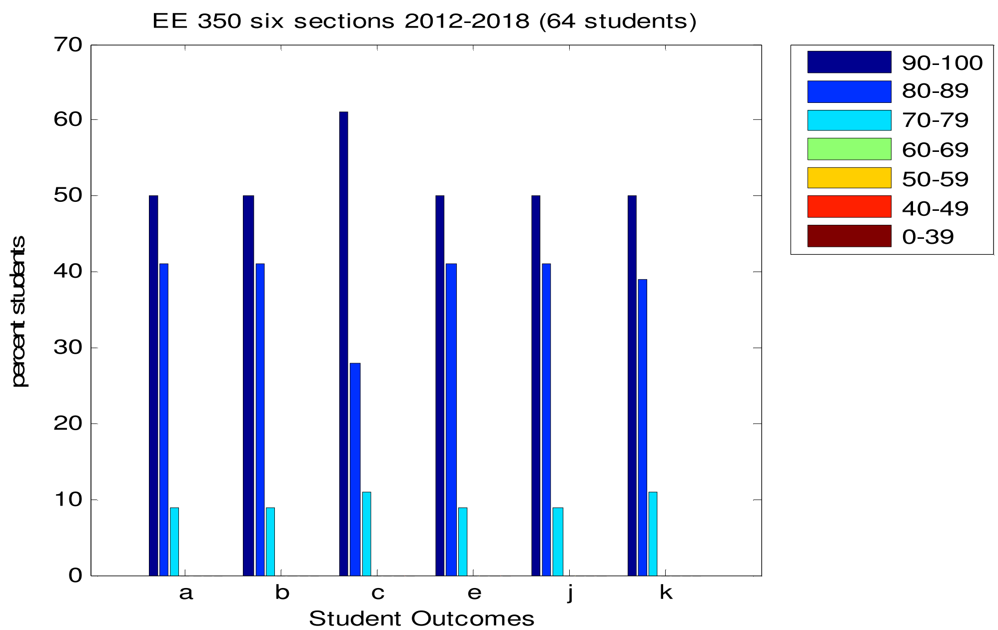

Figure 39. Course Outcomes EE 350

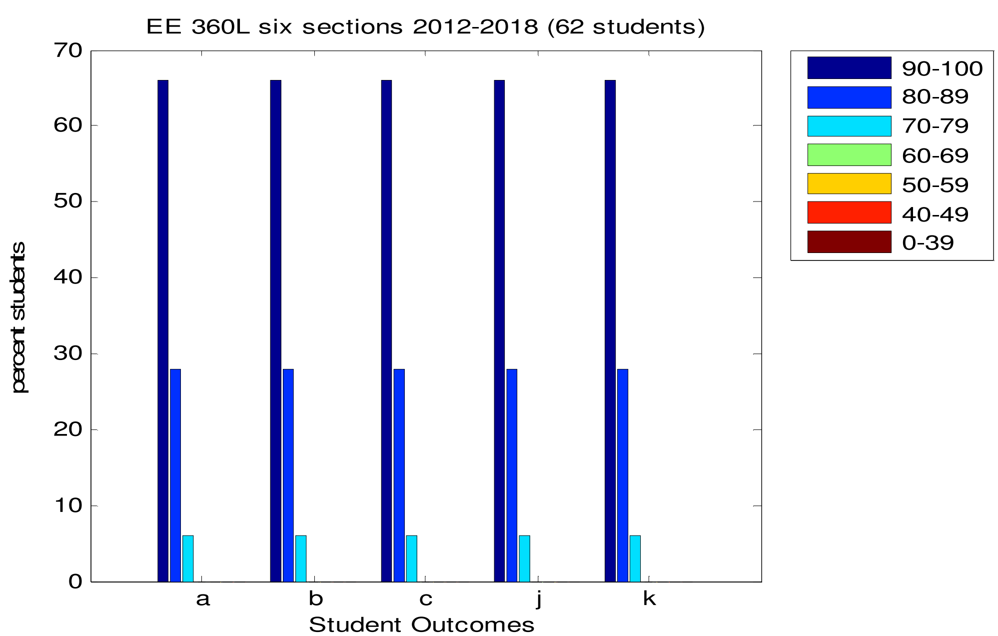

Figure 40. Course Outcomes EE 360L

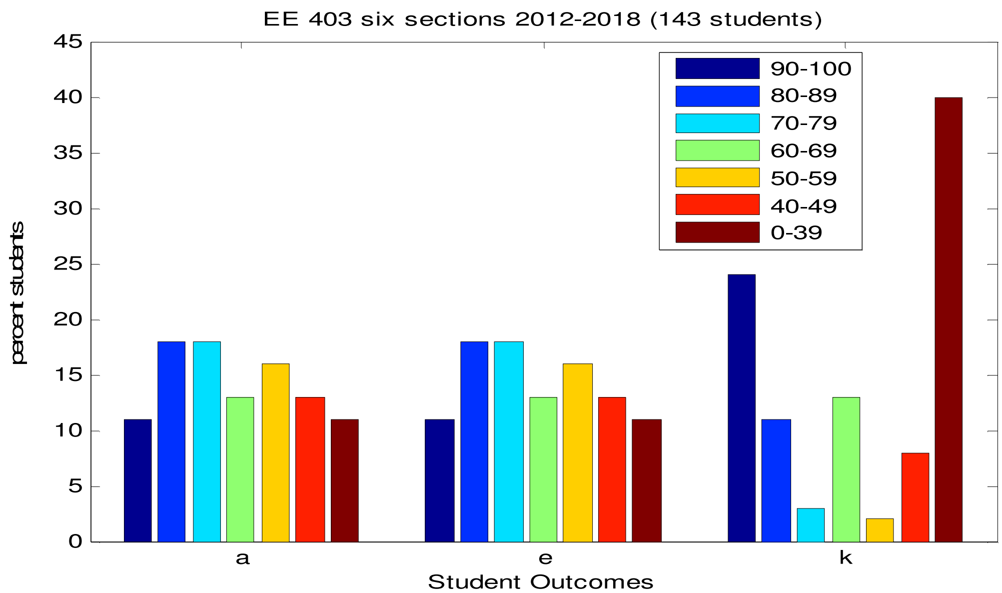

Figure 41. Course Outcomes EE 403

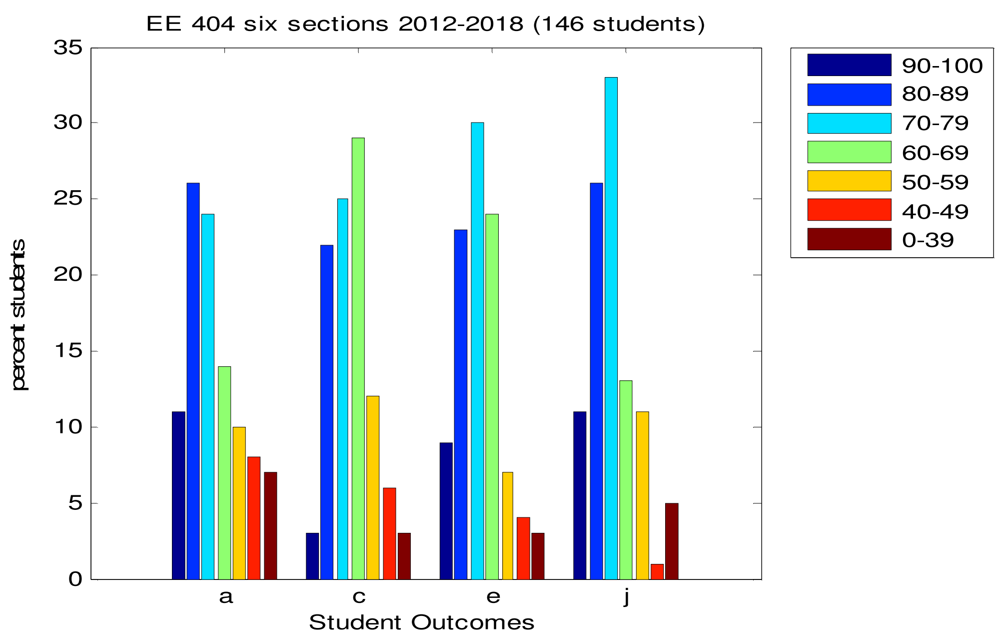

Figure 42. Course Outcomes EE 404

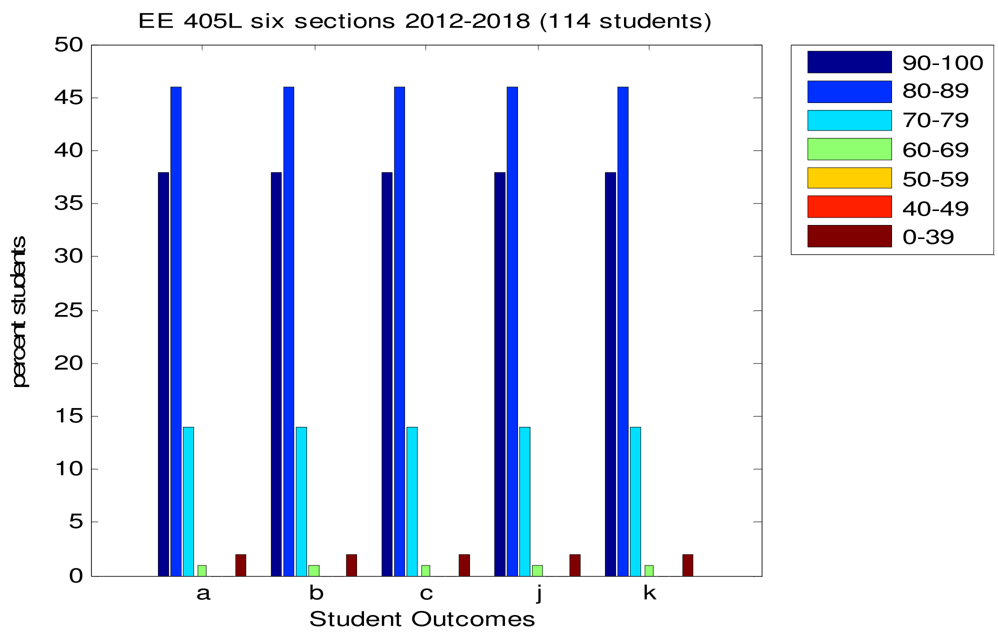

Figure 43. Course Outcomes EE 405L

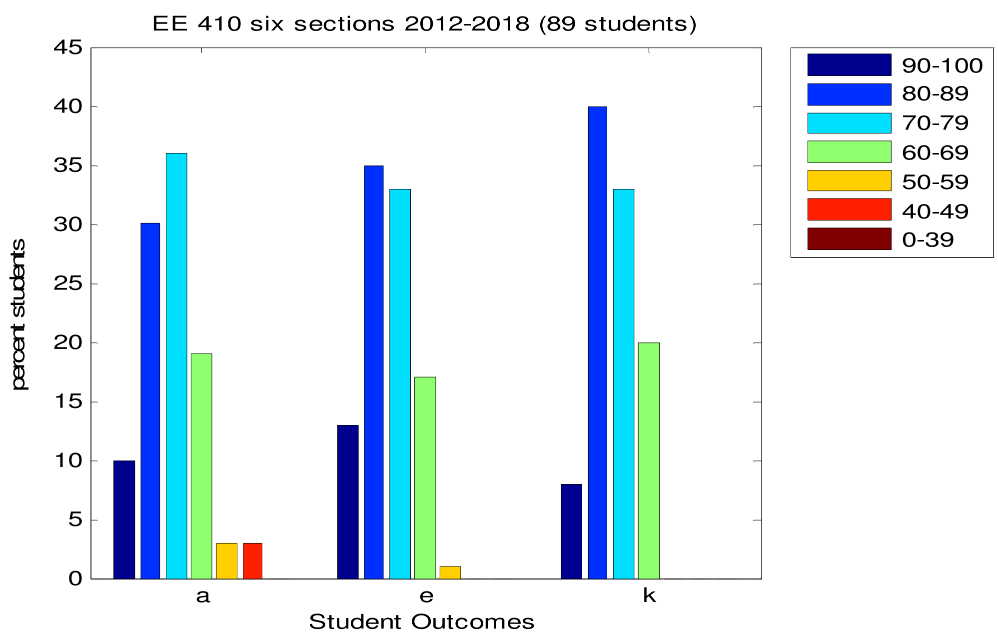

Figure 44. Course Outcomes EE 410

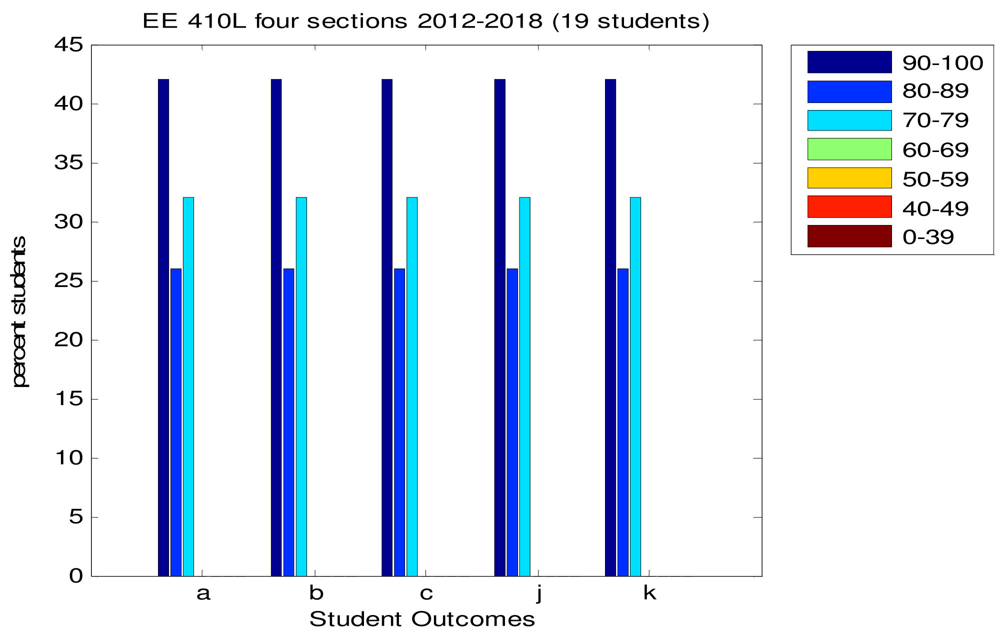

Figure 45. Course Outcomes EE 410L

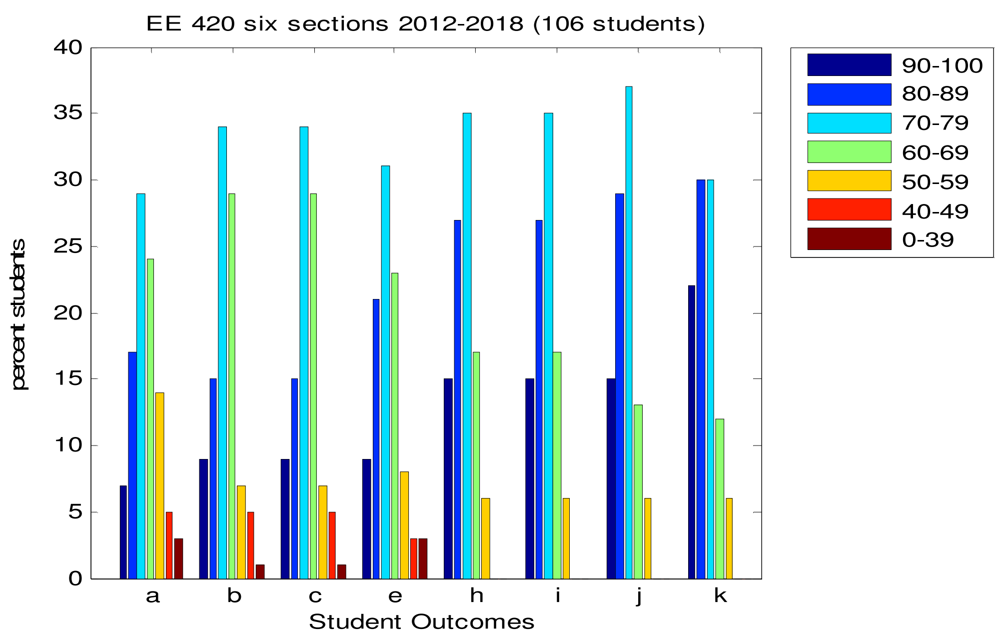

Figure 46. Course Outcomes EE 420

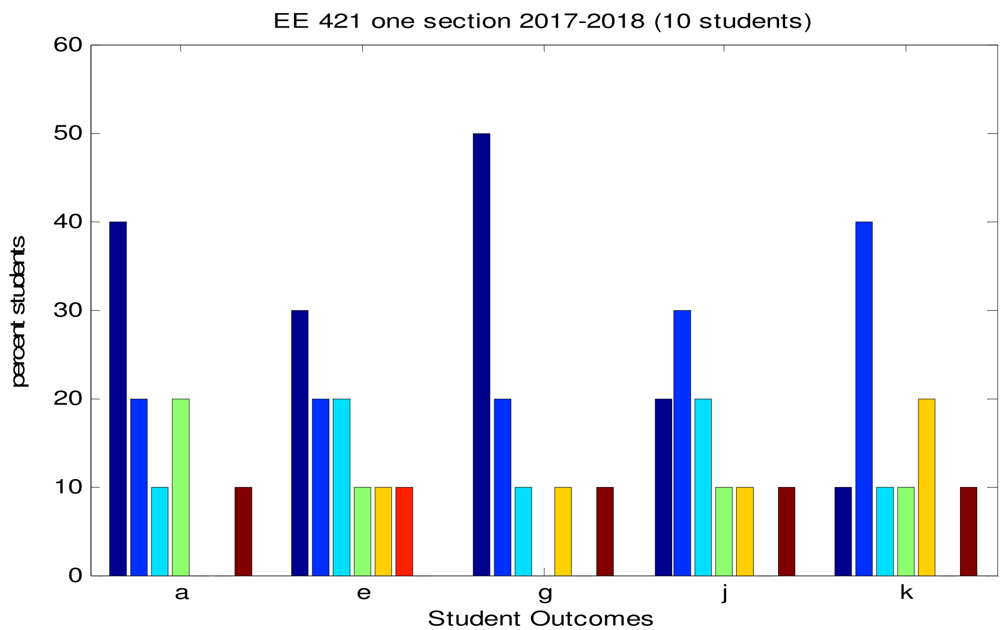

Figure 47. Course Outcomes EE 421

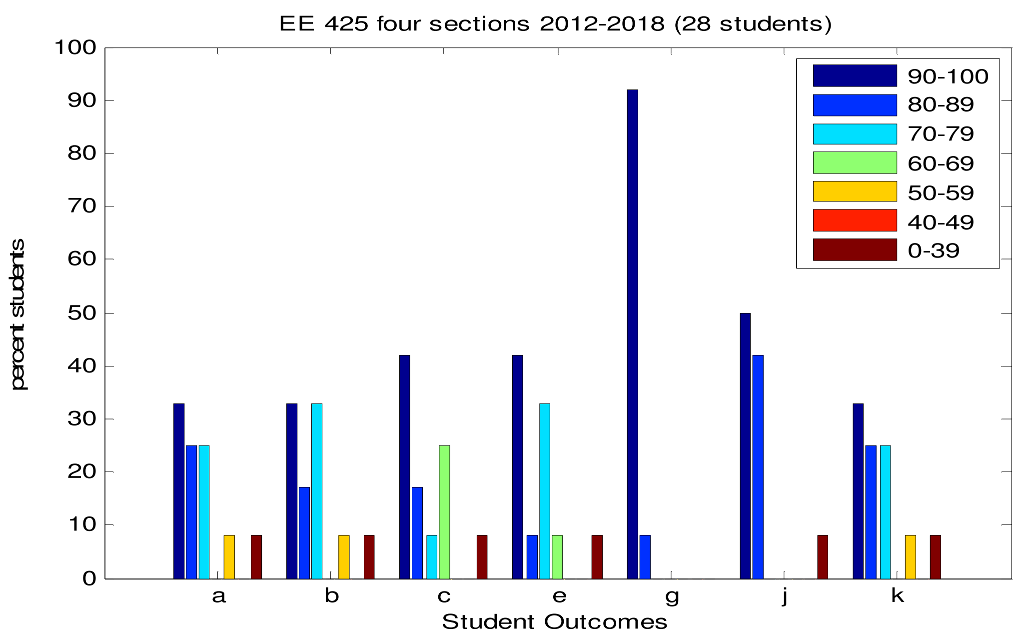

Figure 48. Course Outcomes EE 425

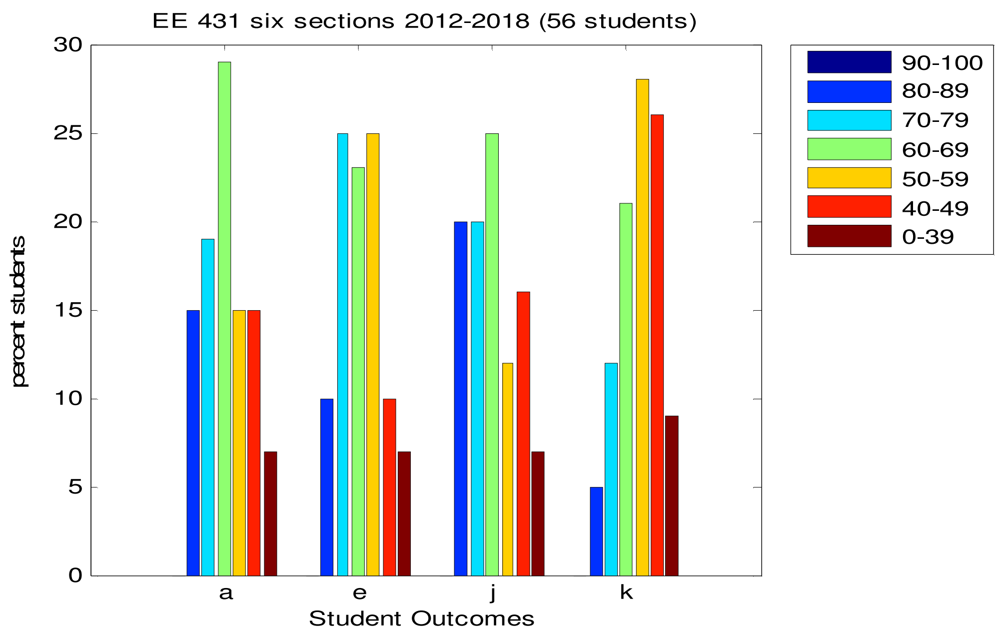

Figure 49. Course Outcomes EE 431

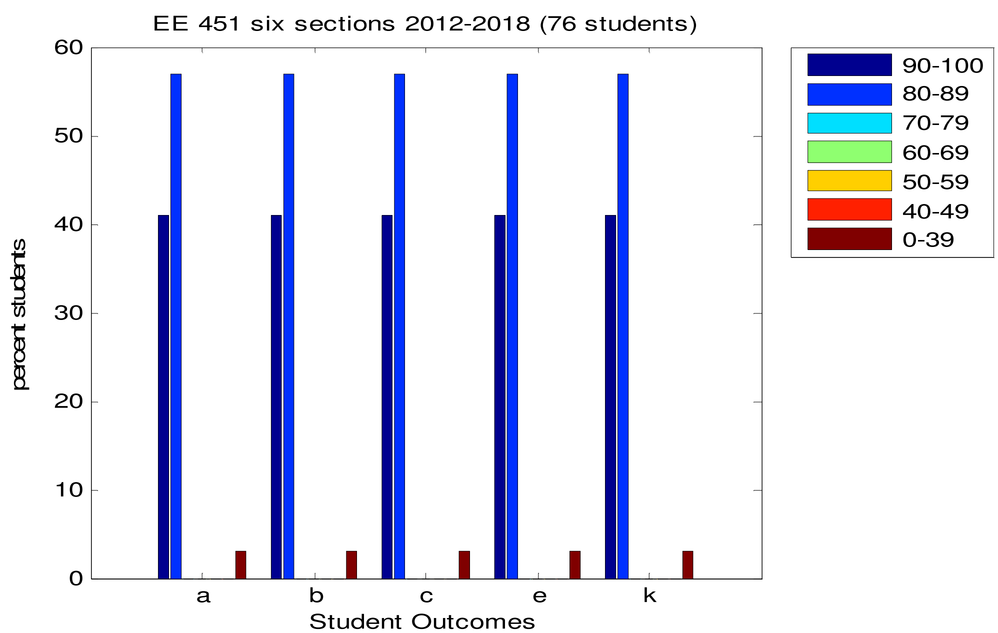

Figure 50. Course Outcomes EE 451

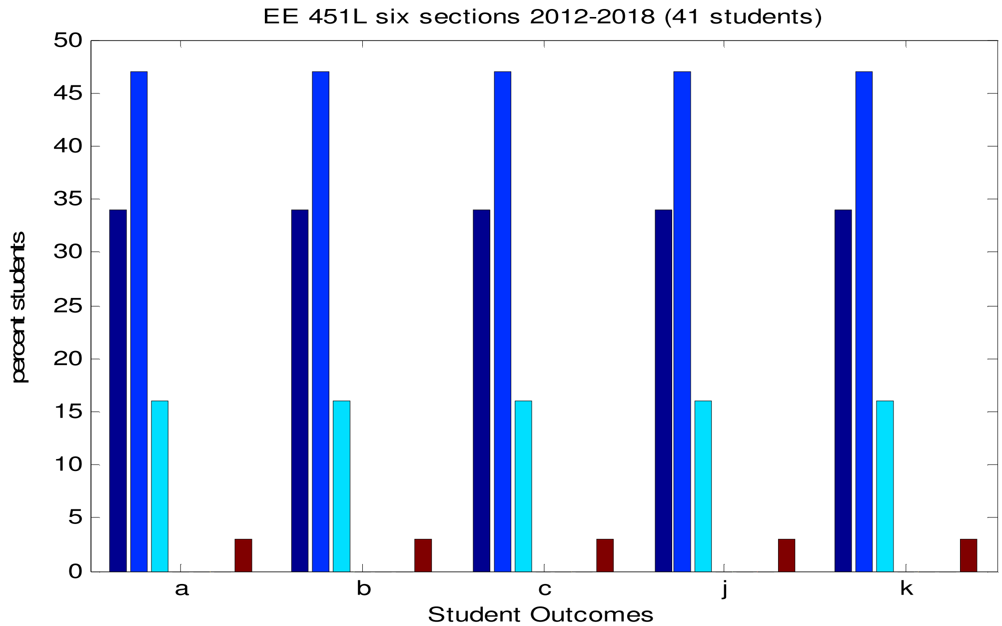

Figure 51. Course Outcomes EE 451L

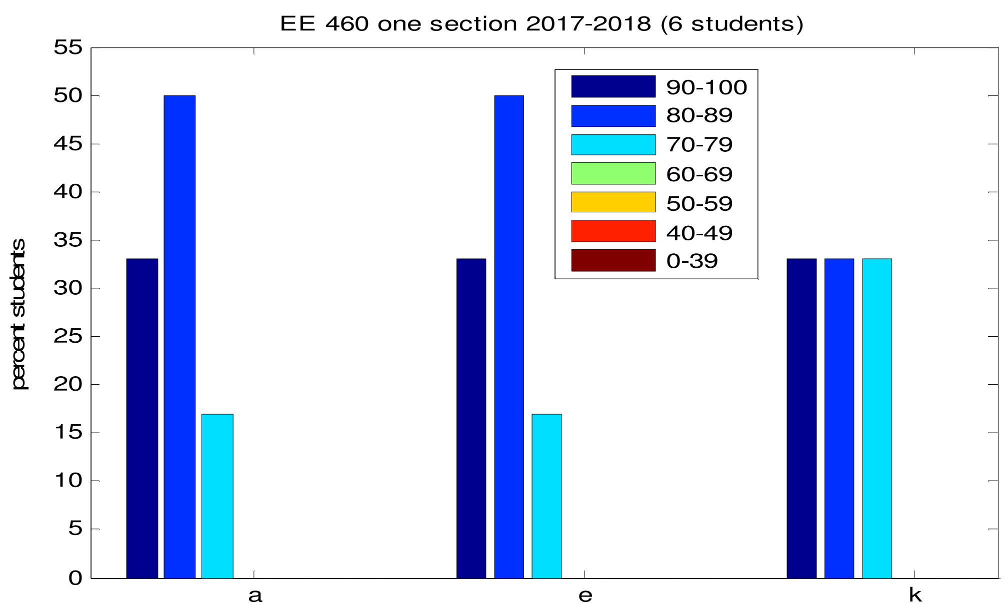

Figure 52. Course Outcomes EE 460

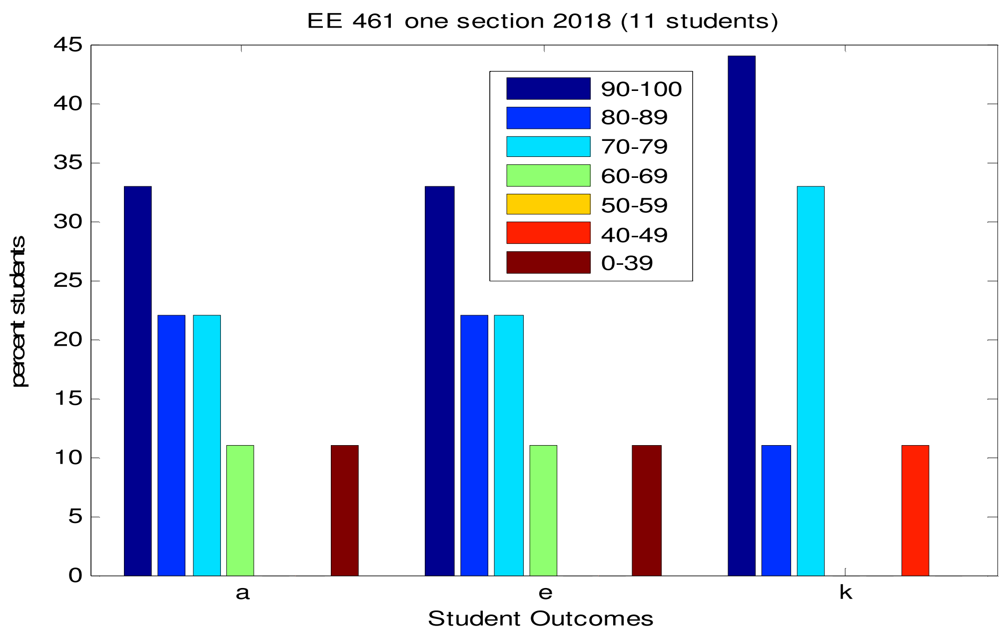

Figure 53. Course Outcomes EE 461

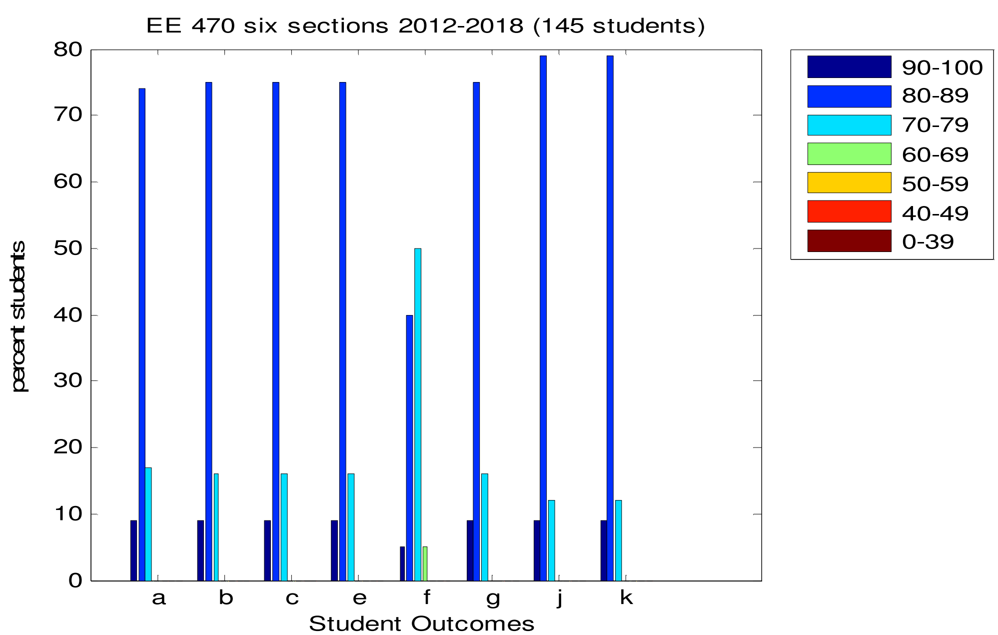

Figure 54. Course Outcomes EE 470

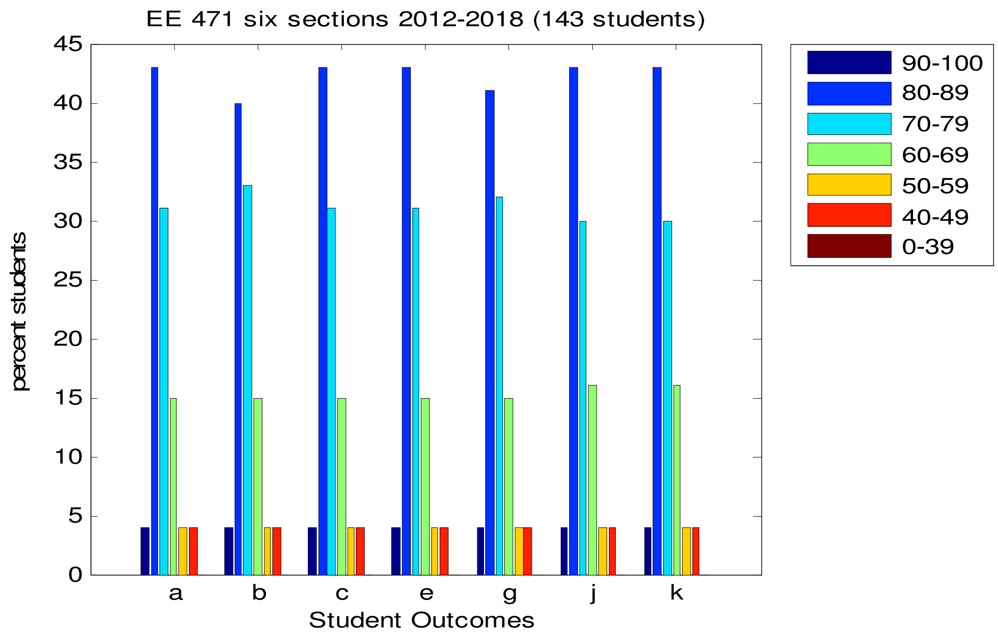

Figure 55. Course Outcomes EE 471

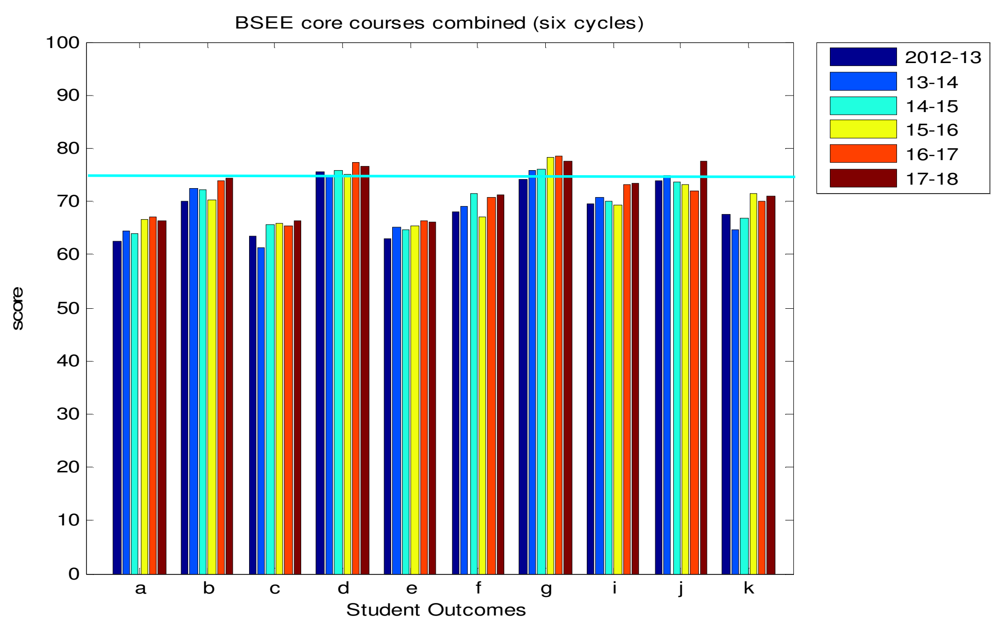

Figure 56. Six annual evaluation cycles of Student Outcomes measurement results based on eighteen BSEE core courses and laboratories.

Appendix I – Course Level Outcomes Measurement Instruments

As discussed above in CRITERION 4. CONTINUOUS IMPROVEMENT, Student Outcomes, Figure 3 provides further details of how Course Outcomes are utilized to measure SOs and provide feedback into the continuous improvement process.

The Course Outcomes (Course Learning Outcomes) are directly mapped to the relevant SOs supported by the course, and the mode(s) of measurement that applies to the outcome. As courses are conducted throughout the academic year, students' performance on the Course Outcomes is quantitatively assessed by the instructor. In addition to mapping SOs to the Course Outcomes, instructors must take that concept to another level, and map SOs to each assignment given in the course. Then, the numeric results obtained for each assignment via traditional grading, are assessed on each outcome (a)-(k) that has been associated with that particular assignment by the instructor.

For each course, all of the Course Outcomes are directly mapped to the relevant SOs supported by the course, and the mode(s) of measurement that applies to the outcome. An example Course Outcomes mapping matrix is shown in Figure 57. Each course syllabus contains this mapping matrix with outcomes specific to that course. Syllabi for all the courses in the BSEE program are shown in Appendix A. Note that each expressed Course Outcome is associated with one or more Program/Student Outcomes (SOs), and a brief description of the assessment tool(s) used to measure students' success at attaining the outcome.

Course Learning Outcome	Program Outcome	Assessment Tool
1. Understand and interpret the differences between various data representations and number systems and transform between them. (e.g. 8/16/32 bit, signed/unsigned, integer/ character).	a	Homework, Quiz, Exams
2. Demonstrate an understanding of standard Boolean logic forms. (e.g. SOP, POS, NAND/NAND, NOR/NOR)	a	Homework, Quiz, Exams
3. Understand and design common arithmetic circuits (e.g. adder/subtractor/multiplier)	a, c	Homework, Quiz, Exams
4. Understand and design combinational circuits using decoders and multiplexers.	c, e	Homework, Quiz, Exams
5. Demonstrate an understanding of basic digital design and modeling techniques. (e.g. Truth Tables, K-MAPS, Boolean Algebra)	c, e	Homework, Quiz, Exams
6. Utilize a variety of feedback circuits to form bi-stable memory devices.	c, e	Homework, Quiz, Exams
7. Understand and design a variety of sequential circuits, and finite state machines (FSM).	c, e, k	Homework, Quiz, Exams, Computer Projects
8. Utilize VHDL to represent and create a variety of digital devices.	c, e, k	Computer Projects

Figure 57. Example Course Learning Outcomes to SO Mapping

As part of the instruction of the course, the instructor also assigns SO mappings to each assignment in the course, from the SOs pre-determined for the course, as shown in Figure 58. The example course as a whole contributes to outcomes (a), (c), (e) and (k). However, Quiz #2 (Q2) is adjudged by the instructor to contribute only to outcomes (a) and (c), therefore no weight is given to outcomes (e) and (k) for that assignment. Only assignments contributing to an outcome are utilized to score the outcome for the course. If an assignment has nothing to do with a given outcome, no weight is given to it. Each instructor assigns the relevant outcomes to each assignment.

Assignments	Expected Outcomes
Q1: Quiz to convert Boolean functions to truth table, and logic gate circuit	a
Q2: Canonical POS/SOP forms	a, c
Q3: NAND, NOR and DeMorgan's Theorem	a, c
Q4: Convert Binary/Octal/Hex/Decimal numbers, and VHDL entity	a, c, k
Q5: Convert Binary/Gray's/BCD/Decimal/ASCII codes, ATD conversion	a,c
Q6: Reduced SOP, 2/3 variable Karnaugh maps	a,c
Q7: Decoders and NAND/NAND forms	a,c
Q8: Multiplexers and NOR/NOR forms	a,c
P1: Write VHDL code, implement on FPGA, unique boolean function per student	c,e,k
P2: Write VHDL code, implement on FPGA, decoder and MUX ckts per student	c,e,k
P3:Write VHDL code, implement on FPGA, NAND and NOR latches	c,e,k
Mid Ex: Number/code conversions, boolean forms, ckt. Design (k-maps), VHDL	a,c,e
Final: Number/code conversions, boolean forms, comb. design problem, FSM design	a,c,e

Figure 58. Example Course Assignments to SO Mappings

These weighted SO scores are tracked throughout the semester, and translated to provide an ongoing measurement of the SO achievement while the course is being conducted. This is accomplished with the aid of an Excel spreadsheet application for each course to help moderate the amount of paperwork required for instructors. This application was developed by the EE program faculty in response to previous ABET reviews.

For the example course, which has twenty-five students, the completed spreadsheet is shown in Figure 59. For a given assignment, the instructor enters students' scores as normal, but must also designate the assignment outcomes in the section below student scores. A '1' in the column of the ABET Course Outcomes matrix corresponding to an assignment indicates that the outcome is represented in that assignment, a blank indicates the outcome is not represented. More than one outcome is permitted per assignment. No entries in the column means the assignment is not considered in the Outcomes evaluation.

The calculation for the overall SO attainment in the course is a function of the scores on individual assignments correlated to the outcomes pertaining to that assignment, then scaled to provide a 0 – 100% measurement. All assignments that pertain to a given SO are treated equally in the assessment of that SO. The results of this calculation are shown in Figure 60.

The results for each of the twenty-five students on each of the outcomes (a), (c), (e) and (k) are evaluated and shown in the table as a scaled percentage score. The average (mean) score for the class is also shown. At the bottom of the table, the students scoring in the categories corresponding to (High, Medium and Low) are tallied as a percentage of the total students in the class. This data is used to generate the Instructor's Course Report for the example course.

EE204 Section 1 - SP 2018

Title:	**Digital Circuits**
Course # & Section:	**EE 204 - (01)**
Instructor:	**A. R. Scott**
Semester	**SP 2018**
Expected Outcomes:	**a, c, e, k**

Color Key

- (pink) **Please don't edit, these formulas update the plots, and assessment reports on subsequent sheets**
- (green) **OK to edit, use "Insert Row" to add students, use "Insert Column" to add assignments.**

Instructions

You need to insert comments for Observed Shortcomings, and Corrective Actions Planned on the Midterm Assessment, a

Select the Midterm or Final Plot and Assessment Tabs. The plots and data on the forms are automatically updated. Select

EE204 Section 1 - SP 2018

Stud. ID	Last	First	Q1	Q2	Q3	Q4	Q5	Q6	Q7	MID %	Mid	M-Ex.	Q8	Q9	P1	P2	Q10	P3	F-Ex	2-lowQ	Final	Letter	Stud. ID
1			25	23	24.42857	25	21	22	29	82.0%		81	26		50	50		49	74		86.9%		1
2			22	20	22	22	22	22	24	61.1%		38	22		50	50		50	59		72.3%		2
3			25		17		5	32	23	59.1%		78	26		50	50		50	73		75.3%		3
4										0.0%											0.0%		4
5			24	25	19	20	16	32		80.6%		81.5	19		45	50		49	43		73.4%		5
6			25	17	21	22	18	33	25	66.6%		46.5	13		50	37.5		44	62		71.2%		6
7			25	15	22	20	29	35	27	73.3%		54.5	12		40	50		49	66		76.6%		7
8			24	11	22	30	30	28	25	75.4%		60.5	24		50	50		49	76		82.9%		8
9				20	21	30	21	27	29	61.0%		47.5	25		50	50		48	67		75.0%		9
10			16	10	21	30	30	30	23	61.8%		33.5	17		38	50		43	74		71.4%		10
11			25		10	29	18	19	25	62.8%		68	10			37		41	59		60.1%		11
12			25	22	24	24	24	24	25	65.1%		36.5	24		50	50		48	76		77.6%		12
13			25	25	26	27.5714	26	32	29	94.6%		94	30		50	50		50	88		96.5%		13
14			17	13	6	1	27	8	18	37.0%		29	18		50	50		49	41		55.7%		14
15			25	21.4286	28	27	8	14	28	80.4%		92	20		50	50		50	76		85.7%		15
16				4	6	24	3	26	30	61.8%		99	26		50	50		49	70		77.3%		16
17			25	12	14	28	19.5	13	25	65.2%		64.5	19.5		45	37.5		49	74		74.3%		17
18			25	25	24	20	23	30	28	91.1%		98	20		50	50		50	58		87.1%		18
19			23	23	17	18	28	33	25	81.3%		78	17		38	50		47	66		80.5%		19
20			25	19	20.66667	20.6667	4	23	30	59.2%		49	23		50	37.5		49	71		72.9%		20
21										0.0%											0.0%		21
22			25	23	25	30	26	35	28	93.9%		90	30		50	50		48	69		91.8%		22
23			25	16	22	30	23	35	29	79.9%		66.5	26		50	50		49	74		85.7%		23
24			25	12	23	23	30	27	23	59.6%		25.5	25		50	50		49	78		75.3%		24
25			25	22	13	10	20.2857	28	25	69.1%		68.5	19		40	37.5		49	56		71.7%		25
		Points Poss.	25	25	30	30	30	30	25	100.0%		100	25	0	50	50	0	50	100	0	100.0%		
		High	25	25	28	30	30	35	30	94.6%		99	30	0	50	50	0		88	0	96.5%		
		Low	16	4	6	1	3	8	18	0.0%		25.5	10	0	38	37	0	41	41	0	0.0%		
		Avg:	23.8571	18.0204	19.4824	23.2381	20.5124	26.43478	26.0455	64.9%		64.326	21.37	#DIV/0!	47.545	47.2609	#DIV/0!	48.1739	67.391	#DIV/0!	71.1%		Average
			Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**MID %**	**Mid**	**M-Ex.**	**Q8**	**Q9**	**P1**	**P2**	**Q10**	**P3**	**F-Ex**	**2-lowQ**	**Final**	**Letter**	**Stud. ID**

ABET Course Outcomes

Outcome	Description	Q1	Q2	Q3	Q4	Q5	Q6	Q7	MID %	Mid	M-Ex.	Q8	Q9	P1	P2	Q10	P3	F-Ex	2-lowQ	Total (a)-(k) pts.		Outcome
a	math, science engineering	**1**	**1**	**1**	**1**	**1**	**1**	**1**			**1**	**1**						**1**		**420**	**420**	**a**
b	design, conduct experiments, data																			**0**	**1**	**b**
c	design system, component, process		**1**	**1**	**1**	**1**	**1**	**1**			**1**	**1**		**1**	**1**		**1**	**1**		**545**	**545**	**c**
d	function on multi-disciplinary teams																			**0**	**1**	**d**
e	formulate and solve engr. Probs.										**1**			**1**	**1**		**1**	**1**		**350**	**350**	**e**
f	professional and ethical responsib.																			**0**	**1**	**f**
g	effective communication																			**0**	**1**	**g**
h	impact in a global/societal context																			**0**	**1**	**h**
i	need to engage in life-long learning																			**0**	**1**	**i**
j	knowledge of comtemporary issues																			**0**	**1**	**j**
k	use of modern engineering tools				**1**									**1**	**1**		**1**			**180**	**180**	**k**

Figure 59. Example Course Level SO Assessment Spreadsheet

	Student Learning Outcomes										
Student	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
1	83.4%	0.0%	87.1%	0.0%	86.9%	0.0%	0.0%	0.0%	0.0%	0.0%	96.7%
2	65.0%	0.0%	73.6%	0.0%	70.6%	0.0%	0.0%	0.0%	0.0%	0.0%	95.6%
3	66.4%	0.0%	74.1%	0.0%	86.0%	0.0%	0.0%	0.0%	0.0%	0.0%	83.3%
4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5	66.5%	0.0%	73.3%	0.0%	76.7%	0.0%	0.0%	0.0%	0.0%	0.0%	91.1%
6	67.3%	0.0%	71.4%	0.0%	68.6%	0.0%	0.0%	0.0%	0.0%	0.0%	85.3%
7	72.7%	0.0%	77.0%	0.0%	74.1%	0.0%	0.0%	0.0%	0.0%	0.0%	88.3%
8	78.7%	0.0%	83.6%	0.0%	81.6%	0.0%	0.0%	0.0%	0.0%	0.0%	99.4%
9	68.5%	0.0%	79.9%	0.0%	75.0%	0.0%	0.0%	0.0%	0.0%	0.0%	98.9%
10	67.7%	0.0%	73.3%	0.0%	68.1%	0.0%	0.0%	0.0%	0.0%	0.0%	89.4%
11	62.6%	0.0%	58.0%	0.0%	58.6%	0.0%	0.0%	0.0%	0.0%	0.0%	59.4%
12	72.5%	0.0%	78.4%	0.0%	74.4%	0.0%	0.0%	0.0%	0.0%	0.0%	95.6%
13	95.9%	0.0%	96.8%	0.0%	94.9%	0.0%	0.0%	0.0%	0.0%	0.0%	98.7%
14	42.4%	0.0%	56.9%	0.0%	62.6%	0.0%	0.0%	0.0%	0.0%	0.0%	83.3%
15	80.8%	0.0%	85.2%	0.0%	90.9%	0.0%	0.0%	0.0%	0.0%	0.0%	98.3%
16	68.6%	0.0%	80.2%	0.0%	90.9%	0.0%	0.0%	0.0%	0.0%	0.0%	96.1%
17	70.1%	0.0%	73.6%	0.0%	77.1%	0.0%	0.0%	0.0%	0.0%	0.0%	88.6%
18	83.6%	0.0%	87.3%	0.0%	87.4%	0.0%	0.0%	0.0%	0.0%	0.0%	94.4%
19	78.1%	0.0%	80.7%	0.0%	79.7%	0.0%	0.0%	0.0%	0.0%	0.0%	85.0%
20	67.9%	0.0%	72.8%	0.0%	73.3%	0.0%	0.0%	0.0%	0.0%	0.0%	87.3%
21	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
22	90.7%	0.0%	92.5%	0.0%	87.7%	0.0%	0.0%	0.0%	0.0%	0.0%	98.9%
23	82.5%	0.0%	86.3%	0.0%	82.7%	0.0%	0.0%	0.0%	0.0%	0.0%	99.4%
24	69.4%	0.0%	76.2%	0.0%	72.1%	0.0%	0.0%	0.0%	0.0%	0.0%	95.6%
25	68.3%	0.0%	71.2%	0.0%	71.7%	0.0%	0.0%	0.0%	0.0%	0.0%	75.8%
Average	74.0%	0.0%	78.9%	0.0%	78.5%	0.0%	0.0%	0.0%	0.0%	0.0%	92.3%

Student

Percentage of Students by Performance Category

Outcome	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
H (80 - 100%)	24.0%		36.0%		36.0%						84.0%
M(40 - 80%)	68.0%		56.0%		56.0%						8.0%
L (<40%)	8.0%		8.0%		8.0%						8.0%
N (Not Measured)		X		X		X	X	X	X	X	

Figure 60. Example Course Level SO Results

The numeric results for the course SOs are used to evaluate the success of the course via two means; 1) student performance bar graphs, and 2) the Instructor's Course Report. The bar graphs provide a measurement of the performance of every student on each SO supported by the course, and the class average on that SO.

For the example course shown here, the graph for Outcomes (a), (c), (e) and (k) are shown in Figure 61 through Figure 64.

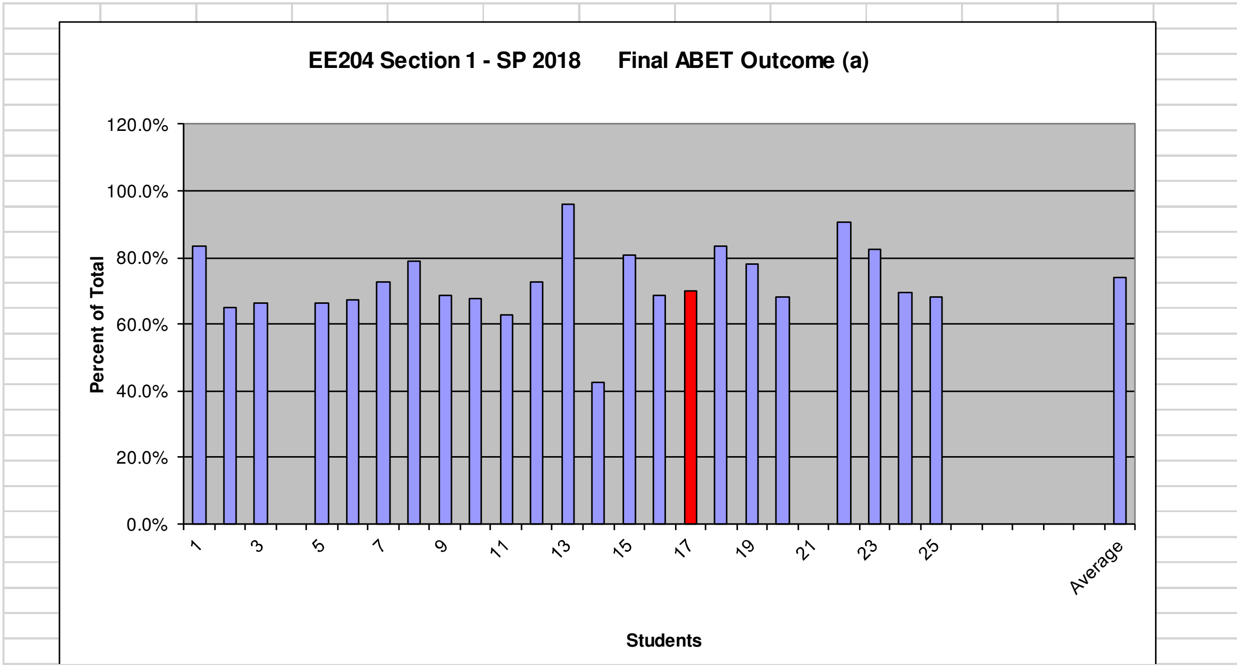

Figure 61. Example Course Level Results – Outcome (a)

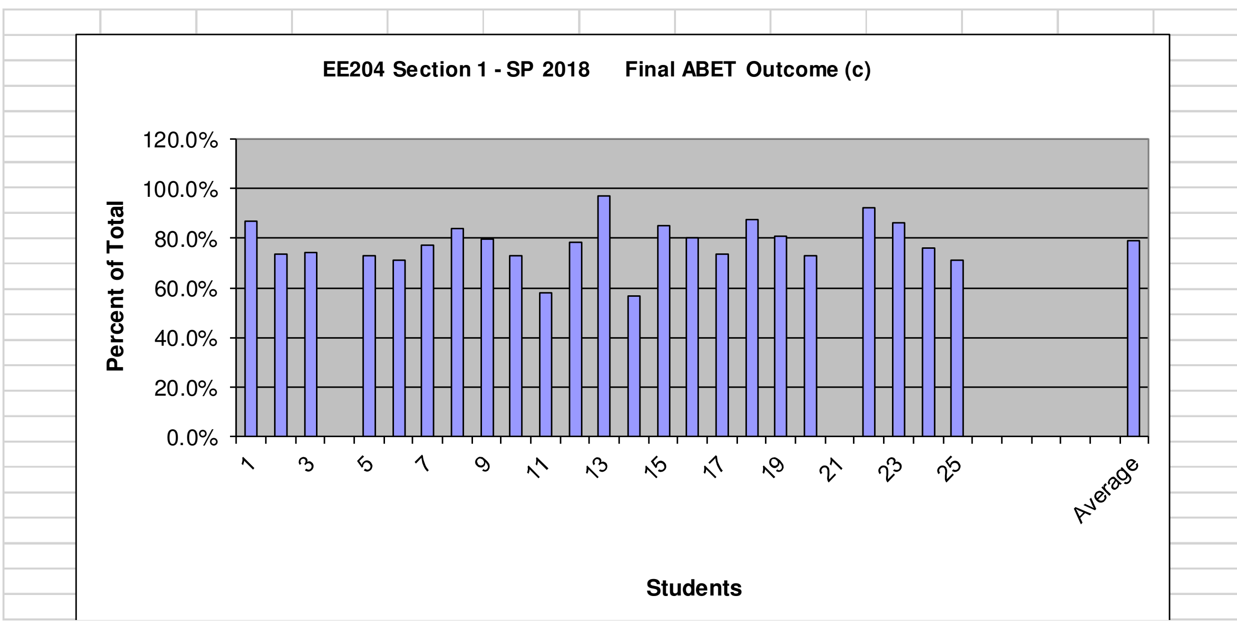

Figure 62. Example Course Level Results – Outcome (c)

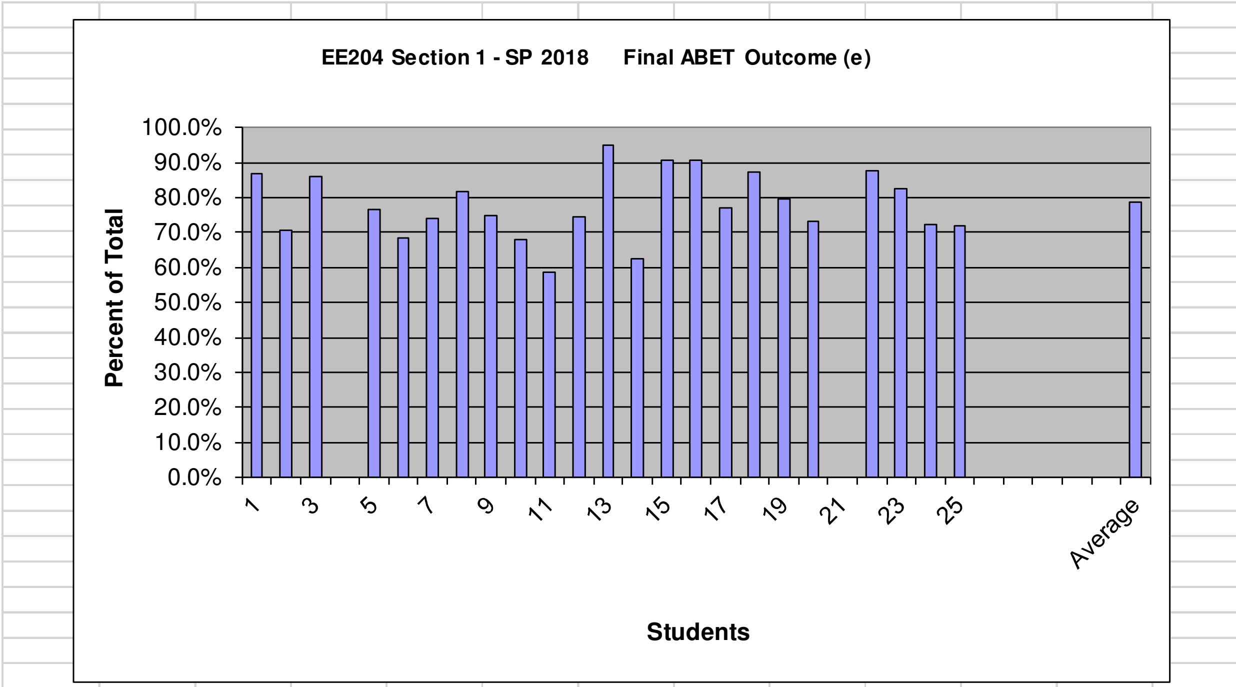

Figure 63. Example Course Level Results – Outcome (e)

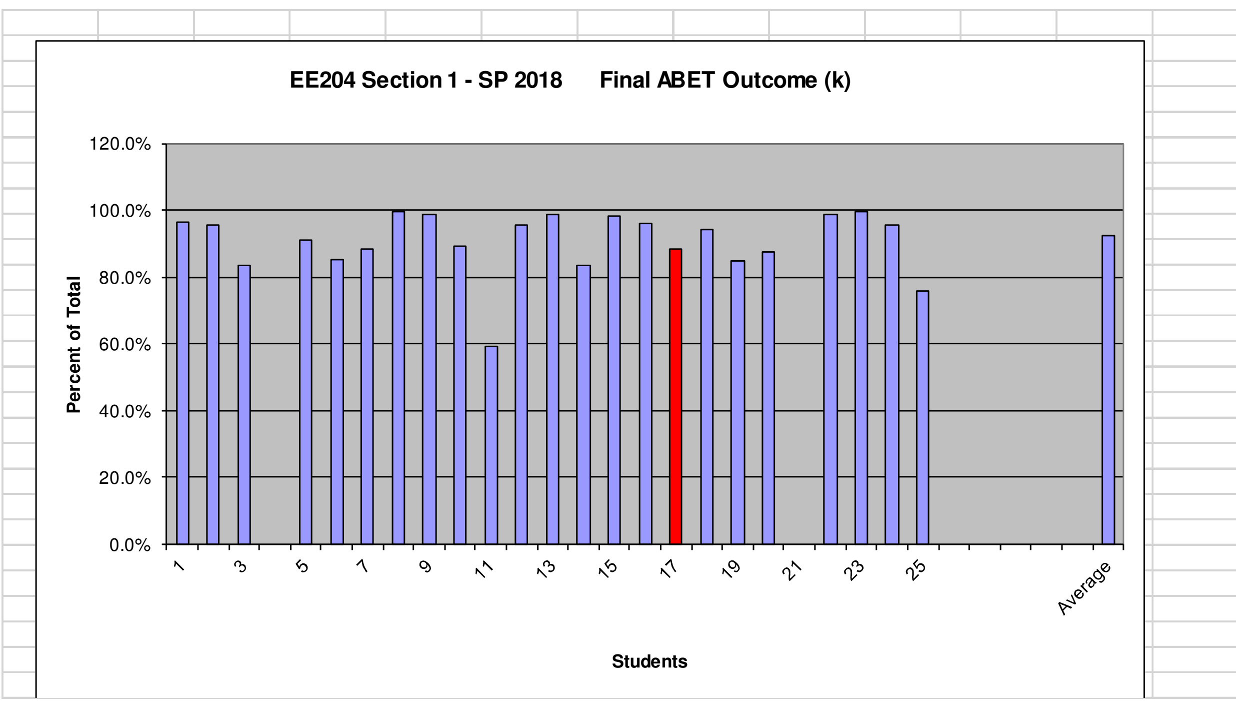

Figure 64. Example Course Level Results – Outcome (k)

The Instructor's Course Report summarizes the overall SO performance in the course by grouping student performance on each SO into one of four categories High, Medium, Low, and Not Assessed (H, M, L, and N). The percentage of students meeting the H, M and L categories is recorded on the form. The form also contains sections for instructor notes on Observed Shortcomings and Corrective Actions Planned.

The resulting bar graph data for all courses is aggregated to obtain overall SO measurement providing feedback for program level continuous improvements. The individual student performances and the Instructor's Course Reports are used to provide course level continuous improvements. The Observed Shortcomings and Corrective Actions Planned sections on the Instructors Course Reports can be utilized by the instructor(s) to provide documentation for continuous improvement efforts at the course level.

For the example course developed here, the bar graphs are shown above, and the Instructors Course Report is shown in Figure 65. This shows the aggregate student performance in H, M and L groups. The instructor has goals for SO performance prior to the course offering, and the report is used to help assess the level of attainment. If shortcomings exist, the instructor can use the Observed Shortcomings and Corrective Actions Planned sections to document those, and prescribe remedies for continuous improvement purposes.

The resulting bar graphs and Instructor's Course Reports are generated for each required course and most elective courses taught in the BSEE curriculum. These results are displayed in the Course Folder Portfolios for each course and will be available for examination by the reviewer during the general review.

Alabama A&M University

Department of Electrical Engineering

Instructor's Course Report and Assessment

FINAL

1. Course Information:

Title:	Digital Circuits
Course # & Section:	EE 204 - (01)
Instructor:	A. R. Scott
Semester	SP 2018
Expected Outcomes:	a, c, e, k

Rubric of Students' Performance

Category by Percent of Class
H : Much above average
M : Average
L : Much below average
N : Outcome not assessed

2. Assessment of Course Outcomes from Student Performance:

Outcome	Criteria	H	M	L	N
a	Ability to apply knowledge of mathematics, science and engineering	24.0%	68.0%	8.0%	
b	Ability to design and conduct experiments, as well as to analyze and interpret data				X
c	Ability to design a system, component, or process to meet a desired goal	36.0%	56.0%	8.0%	
d	Ability to function on multi-disciplinary teams				X
e	Ability to identify, formulate and solve engineering engineering problems	36.0%	56.0%	8.0%	
f	An understanding of professional and ethical responsibility				X
g	Ability to communicate effectively				X
h	The broad eduction necessary to understand the impac of engineering solutions in a global and societal contex				X
i	A realization of the need for and an ability to engage in life-long learning				X
j	A knowledge of contemporary issues				X
k	Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	84.0%	8.0%	8.0%	

3. Observed Shortcomings:

i	Student Attendance	Some students frequently come late to class, and are often absent.
ii	Study habits of the students	There appears to be little motivation outside the classroom to study.
iii	Lab FPGAs are missing/poor condition	Not enough FPGAs, students must share
iv		

4. Corrective Actions Planned:

i	Student Attendance	Hold regular quizzes, take roll early
ii	Study habits of the students	Emphasize the VHDL and FPGA implementations to interest students in the material
iii	Lab FPGAs are missing/poor condition	Encourage students to purchase FPGAs, and purchase newer devices with departmental funds
iv		

Figure 65. Example SO Results – Instructors Course Report

FOR ANY QUESTIONS, PLEASE CONTACT

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