The following is a description of our curriculum. Our bachelor of science degree in electrical engineering requires 124 credit hours covering mathematics and basic science (39 hours); engineering topics consisting of engineering sciences and design (59 hours); and general education (22 hours) --- Figure VI.1 shows the elements of the curriculum. Note that one track, computer has moved to computer engineering:

- **Mathematics** (20 hours): Calculus I (basic concepts; differentiation with applications; integration) through IV (multiple integrals; line integrals and Green's Theorem; surface integrals, Stoke's and Gauss's Theorems), differential equations, and matrices. It also includes a thorough understanding of probability and statistics in EE 342 (3 credit hours).
- **Basic Sciences** (18 credit hours): The required chemistry courses and 1-credit laboratory cover basic principles of chemistry, including stoichiometry; introduction to solution phase chemistry; gas phase chemistry; thermodynamics, including enthalpies of formation and reaction, entropy and free energy; atomic structure, periodic trends, chemical bonding, molecular structure; liquids and solids; solutions and colligative properties; principles and applications of chemical equilibrium, including acid-base chemistry (titrations, buffers); kinetics; redox reactions and electrochemistry.

  The required physics courses and laboratories cover mechanics of particles and rigid bodies, wave motion, thermodynamics and kinetic theory; electricity and magnetism; relativity, introduction to quantum mechanics, atomic and nuclear physics, geometrical and physical optics.
- **Engineering Topics** (59 hours): There are two types of engineering topics courses: EE Required Courses, which are required by all EE students; and EE Technical Electives. The EE Technical Elective are upper division EE courses and are divided into three Tracks: Computers, Electro-Physics (EP), and Systems. Computers covers computer hardware and software; EP covers circuits, solid-state devices, and electro-magnetics; and Systems covers signal and image processing, communications, networking, and control. Tracks allow students to explore specialized topics of their choice. The exploration is in depth and yet provides breadth within a Track. A student must choose a Track to specialize in advanced topics. There are two types of Track courses: Group I, which is required by all students in a Track; and Group II. Students that find the track system too restrictive may, with the help and consent of a faculty advisor, propose an alternate set of electives, i.e., students may design their own track. The proposal must have the same breadth and depth as an existing Track, and requires approval from the Department's Undergraduate Curriculum Committee.
- **General Education** (22 hours): This is discussed in Appendix L.
- **Other Courses** (4 hours):

Table VI.2 is a list of our program course requirements. In the table, "Major Track Group I" is an EE Technical Elective Track Group I course.

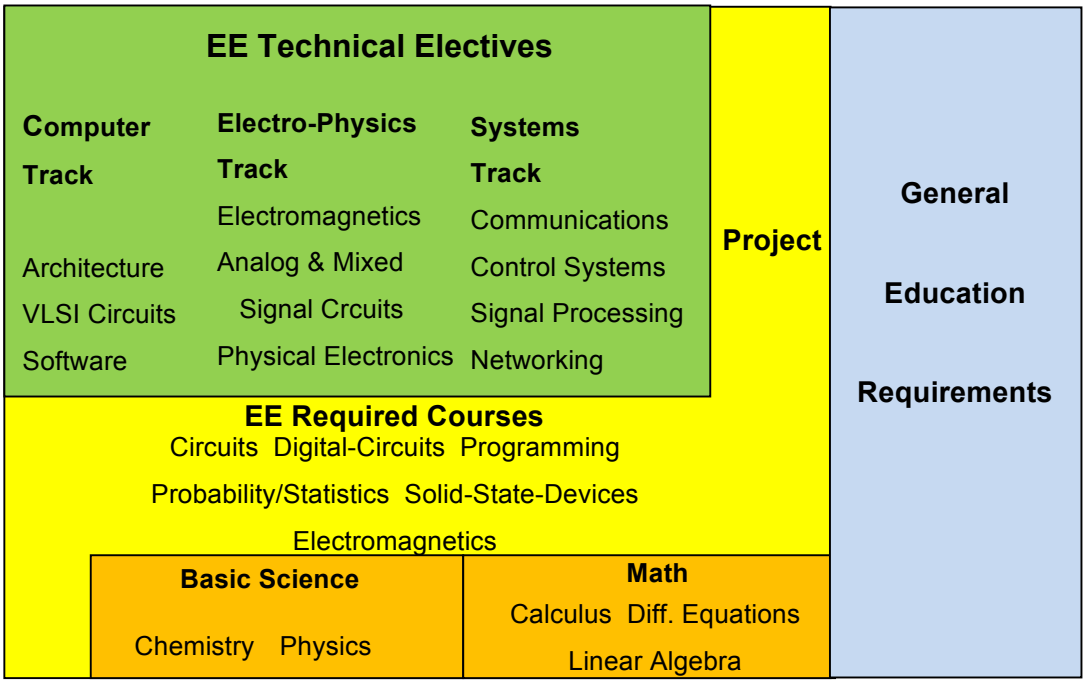

Figure VI.1. Undergraduate curriculum.

Table VI.2. Basic-Level Curriculum.

Semester	Course (Department, Number, Title)	Category (Credit Hours)			
		Math & Basic Sciences	Engineering Topics *Check if Contains Significant Design* (✓)[1]	General Education	Other
Freshman Fall	ENG 100 Composition I		( )	3	
	MATH 241 Calculus I	4	( )		
	CHEM 161 & 161L General Chemistry I and Lab	4	( )		
	Global and Multicultural Perspectives Requirement (e.g., HIST 152 World Civilization II)			3	
Freshman Spring	EE 160 Programming for Engineers		4 ( )		
	MATH 242 Calculus II	4	( )		
	PHYS 170 & 170L General Physics I and Lab	5	( )		
	CHEM 162 General Chemistry II	3	( )		
Sophomore Fall	EE 211 Basic Circuit Analysis I		4 ( )		
	EE 260 Introduction to Digital Design		4 (✓)		
	MATH 243 Calculus III	3	( )		
	PHYS 272 & 272L General Physics II and Lab	4	( )		
Sophomore Spring	EE 213 Basic Circuit Analysis II		4 ( )		
	MATH 244 Calculus IV	3	( )		
	PHYS 274 General Physics III	3	( )		
	EE 296 Sophomore Project		1 ( )		
	SP 251 Principles of Effective Public Speaking		( )	3	
	Economics Elective[2]		( )	3	
Junior Fall	EE 315 Signal and Systems Analysis		3 ( )		
	EE 342 EE Probability and Statistics	3	( )		
	EE 324 Physical Electronics		3 ( )		
	EE 371 Engineering Elecgtromagnetics I		3 ( )		
	MATH 307 Linear Algebra & Diff. Equations	3	( )		

(continued on next page)

[1] Courses with design credits (1 design credit or higher) are designated as having significant design. Note that all EE students are required to have a sum of 16 design credits to graduate. Figures VI.4 and VI.5 show the design credits for EE courses.

[2] The Economics Elective is satisfied by one of either ECON 120 Introduction to Economics, ECON 130 Principles of Economics, or ECON 131 Principles of Economics.

Table VI.2. Basic-Level Curriculum (continued)

Year; Semester or Quarter	Course (Department, Number, Title)	Category (Credit Hours)			
		Math & Basic Sciences	Engineering Topics *Check if Contains Significant Design (✓)*	General Education	Other
Junior Spring	EE 323 & 323L Microelectronic Circuits I and Lab		4 (✓)		
	EE 396 Junior Project		2 (✓)		
	EE Technical Elective and Lab (Major Track Group I)		4 (✓)		
	EE Technical Elective		3 ( )		
	Engineering Breadth[3]		( )		3
Senior Fall	EE Technical Elective and Lab (Major Track Group I)		4 ( )		
	EE Technical Elective (Major Track Group I)		3 ( )		
	EE Technical Elective (Outside Major Track)		3 ( )		
	EE Technical Elective Lab		1 ( )		
	Humanities (DH) or Literature (DL) requirement		( )	3	
Senior Spring	EE 496 Senior Capstone Design		3 (✓)		
	EE 495 Ethics in Electrical Engineering		( )	1	
	EE Technical Elective (Major Track)		3 ( )		
	EE Technical Elective (Major Track)		3 ( )		
	Social Science (DS)			3	
	Global and Multicultural Perspectives Requirement		( )	3	
	Elective (UH general education requires 124 total credit hours, so this credit hour is to make up for this)				1
Add rows as needed to show all courses in the curriculum.					
TOTALS-ABET BASIC-LEVEL REQUIREMENTS		39 hrs	59 hrs	22 hrs	4 hrs
OVERALL TOTAL FOR DEGREE					
PERCENT OF TOTAL		31%	48%	18%	3%
Totals must satisfy one set	Minimum semester credit hours	32 hrs	48 hrs		
	Minimum percentage	25%	37.5 %		

[3] Engineering breadth is an engineering or science course. It either satisfies Basic Science/Math or Engineering Topics but it depends on the course. Therefore, we categorized it under "Other".

The Engineering Required courses have the following features:

- *Laboratory Experience*: Our program has a significant hands-on component of laboratories and design experience. Five of the Engineering Required courses have a 3-hour laboratory session per week. These laboratories are either part of a 4-credit course, e.g., EE 260, or a 1-credit laboratory course, e.g., EE 323L. Four of the Engineering Required courses use laboratory equipment including oscilloscopes, digital multi-meters, power supplies, signal or function generators, proto-boards, discrete parts, and PCs with appropriate software such as design tools and Microsoft Office software.

  Four of the courses with laboratory components (EE 160, 260, 211 and 213) should be taken during the first two years of college. This gives students early hands-on experience.

- *Required Project Courses*: Our curriculum has a significant design component to prepare students for the engineering profession. It has 6 credit hours of project courses at the sophomore, junior, and senior level: EE 296 Sophomore Project (1 credit), EE 396 Junior Project (2 credits), and EE 496 Senior Capstone Design (3 credits). Note that the sophomore project is an early introduction to project activity to students. Also note that in EE 296 and 396, students are not required to be completely responsible for a design. They are expected to learn design methodologies and tools, participate in some phase of the design process, and get hands-on project experience. On the other hand, EE 496 is the Senior Capstone Design, where students are expected to do a major design.

- *Design Experience*: Each of our courses has a certain amount of design content which we quantify by a "design credit". It is assigned by the faculty course coordinator for the course. For example EE 496 Senior Capstone Design is mostly dedicated to design content, so it has 3 design credits of its 3 credit hours. Another example is EE 361 Digital Systems and Computer Design which has a moderate amount of design so it has 1 design credit of its 3 credit hours. Our program requires that students have a total of 16 design credits to graduate so that they have sufficient design experience. Appendix L has the list of EE courses and their design credits (see Figures L.1 and L.2).

- *Engineering Breadth* (3 hrs). This is a 3-credit hour elective to broaden the engineering education of our students. It may be satisfied by CEE 270 Applied Mechanics I, ME 311 Thermodynamics, or a Civil and Environmental Engineering

(CEE), Mechanical Engineering (ME), or Bioengineering (BE) course that is at the 300 level or higher. It may also be satisfied by a physical or biological science course that is at the 300 level or higher and approved by the Department's Undergraduate Curriculum Committee. The current list of approved courses is in Appendix L (see Figure L.3). Since the list includes non-engineering courses, we do not count Engineering Breadth towards the 59 credits of Engineering Topics in Table VI.2.

- EE 495 Ethics in Electrical Engineering (1 hr). A course covering ethics in electrical engineering. It satisfies the Ethics (E) Focus general requirements of the University.

Figure VI.3 describes the EE Technical Electives requirements of 17 credit hours. A student must take all Group I courses within his/her chosen Track, and 3 credits outside his/her chosen Track.

EE Technical Electives Requirements (23 credit hours) A student must take a minimum of 17 credit hours in one of the major tracks, which includes all courses in Group I (11 credit hours) and the remaining courses in Group II (6 credit hours). Group I is for breadth within a track, while Group II is for depth. Group I courses include at least two 1-credit hour laboratories. A student must also take an additional 6 credit hours of EE courses at the 300 level or higher of which 3 credit hours must be outside the major Track.		**Credits**
Electro-Physics Track: This is focused on the EE applications of physics and chemistry, and covers analog circuits, micro- and millimeter-wave engineering, optics, and solid-state devices.		
Group I	EE 326 Microelectronics Circuits II	3
	EE 326L Microelectronics Circuits II Lab	1
	EE 327 Theory and Design of IC Devices	3
	EE 372 Engineering Electromagnetics II	3
	EE 372L Engineering Electromagnetics II Lab	1
Group II	EE 328 Physical Electronics Lab Techniques	3
	EE 328L Physical Electronics Lab	1
	EE 422 Electronic Instrumentation	3
	EE 422L Instrumentation Lab	1
	EE 426 Advanced Si IC and Solid State Devices	3
	EE 427 Computer-Aided Circuit Design	3
	EE 473 Microwave Engineering	3
	EE 475 Optical Communications	3
	EE 477 Fundamentals of Radar, Sonar, and Navigation Systems	3
Systems Track: This is focused on signals and systems, and covers communications, controls, networking, and signal processing.		
Group I	EE 341 Introduction to Communication Systems	3
	EE 341L Introduction to Communication Systems Lab	1
	EE 351 Linear Systems and Control	3
	EE 351L Linear Systems and Control Lab	1
	EE 415 Digital Signal Processing	4
Group II	EE 344 Networks I	4
	EE 442 Digital Communications	3
	EE 449 Computer Communication Networks	3
	EE 452 Digital Control Systems	3
	EE 453 Modern Control Theory	3

Figure VI.3. EE Technical Electives requirements.

How the curriculum is consistent with the Program Outcomes.

Figures VI.4 and VI.5 are a quick summary of how EE Required Courses and EE Technical Electives, respectively, cover the Outcomes. Figure VI.4 has all required courses of all EEs including math and basic science courses, and University general education requirements. Figure VI.5 has the Track Group I courses, which are required for a Track. A quick summary of Track Group II technical electives can be found in Appendix I. Figures show whether the course contributes significantly, moderately, at a low level, or not at all to the Outcomes. The ratings per EE course are given by the EE faculty course coordinator. For non-EE courses, the ratings are given by the Undergraduate Curriculum Committee.

Figures VI.4 and VI.5 show that some Outcomes are well covered (e.g., Outcome 1) while other Outcomes are much less (e.g., Outcome 6). However, all Outcomes have some coverage by courses. Next, we will discuss how the curriculum covers the Outcomes in more detail.

- Outcome 1 (math and basic sciences): Our curriculum has math and basic science (39 hours); engineering topics consisting of engineering sciences and design (59 credit hours); and design experience as described in Section VI.A.4. Section X (Criterion 9) describes how our program covers probability and statistics, mathematics through differential and integral calculus, basic sciences, and engineering sciences necessary to analyze and design complex devices and systems containing hardware and software, and advanced mathematics including differential equations.
- Outcome 2 (experimental): Our curriculum has sufficient basic science laboratories and the required EE circuit laboratories. In addition, students must take laboratories of Group I courses of their chosen Track. Listed in Figure VI.6 are 1-credit laboratory courses or courses with a laboratory component that is equivalent to 1 credit. All of these courses have laboratory class rooms with standard circuit laboratory equipment including oscilloscopes, digital multi-meters, power supplies, and signal or function generators. In addition, students are required to take EE 342 EE Probability and Statistics which is useful in interpreting statistical data.
- Outcome 3 (design): A detailed description of the design experience is presented in Section VI.A.3.

	Credits	OUTCOMES (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
MATHEMATICS												
Math 241 Calculus	4											
Math 242 Calculus II	4											
Math 243 Calculus III	3											
Math 307 Linear Algebra & Diff Equations	3											
EE 342 EE Prob & Stat	3											
BASIC SCIENCES												
Chem 161 General Chem I	3											
Chem 161L General Chem I Lab	1											
Chem 162 General Chem II	3											
Phys 170 General Physics I	3											
Phys 170L General Physics I Lab	1											
Phys 172 General Physics II	3											
Phys 172L General Physics II Lab	1											
Phys 274 General Physics III	3											
ENGINEERING REQUIRED												
EE 160 Programming for Engrs	4											
EE 211 Basic Circuit Analysis I	4											
EE 213 Basic Circuit Analysis II	4											
EE 260 Intro to Digital Design	4											
EE 296 Soph Projects	1											
EE 315 Signals & Systems Analysis	3											
EE 323 Microelectronic Circuits I	3											
EE 323 Microelectronic Circuits I Lab	1											
EE 324 Physical Electronics	3											
EE 371 Engineering Electromagnetics I	3											
EE 396 Junior Projects	2											
EE 495 Ethics in Electrical Engineering	1											
EE 496 Senior Capstone Design Project	3											
Engineering Breadth												
GENERAL EDUCATION												
ENG 100 Composition I	3											
SP 251 Principles of Eff Pub Speaking I	3											
Writing Intensive (W)-- 5 courses												
Oral Communication (O)-- 1 course												
Hawaiian, Asian, and Pac Issues (H) -- 1 course												
Global & Multicultural Perspectives	6											
Social Science	3											
Economics ECON 120, 130, or 131	3											

Key: (= 0, no emphasis) (=1, some emphasis) (=2, moderate emphasis) (=3, significant emphasis)

Figure VI.4. Relationship of Outcomes to Required Courses.

	Credits	OUTCOMES (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
ELECTRO-PHYSICS TRACK GROUP I												
EE 326 Microelectronic Circuits II	3											
EE 326L Microelectronic Circuits II Lab	1											
EE 327 Theory & Design of IC Devices	3											
EE 372 Engineering Electromagnetics II	3											
EE 372L Engineering Electromagnetics II Lab	1											
SYSTEMS TRACK GROUP I												
EE 341 Intro to Communication Systems	3											
EE 341L Communication SYstems Lab	1											
EE 351 Linear Systems & Control	3											
EE 351L Linear Sys & Control Lab	1											
EE 415 Digital Signal Processing	4											

Key: (= 0, no emphasis) (=1, some emphasis) (=2, moderate emphasis) (=3, significant emphasis)

Figure VI.5. Relationship of Outcomes to Track Group I courses.

Laboratory Types	Courses
Basic Science	Chem 161L General Chemistry Lab I Phys 170L General Physics I Lab Phys 272L General Physics II Lab
EE Required	EE 211 Basic Circuit Analysis I EE 213 Basic Circuit Analysis II EE 260 Introduction to Digital Design EE 323L Microelectronic Circuits I Lab
Electro-Physics Track Group I	EE 326L Microelectronics Circuits II Lab
Systems Track Group I	EE 341L Introduction to Communication Systems Lab EE 351L Linear Systems and Control Lab

Figure VI.6. Laboratory courses that contribute to Outcome 2.

- Outcome 4 (teamwork): Students learn teamwork through laboratory courses and projects. Figure VI.6 shows the laboratory courses or courses with a laboratory component that have students working in teams. Typically, teams are pairs of students, but they can get larger. For example, EE 160 can have groups of three. Students may also work in teams in EE 296 Sophomore, 396 Junior, and 496 Senior Capstone Design projects.
- Outcome 5 (EE problems): Almost all EE courses educate students on identifying, formulating and solving electrical engineering problems (the exception is EE 495 Ethics in Electrical Engineering). These courses cover circuits, signals and systems, electro-magnetics, solid state devices, and computers. Students are required to take 61 credit hours of courses that deals with Outcome 5, which is about two years of coursework.
- Outcome 6 (professional and ethics): Our program requires a 1 credit-hour ethics course: EE 495 Ethics in Electrical Engineering.
- Outcome 7 (communication): Our program covers written communication skills as follows:
    - University general education requirements (see Appendix L)
        - ENG 100 Composition (3 credits)
        - Five Writing Intensive (W) courses, a minimum of 2 in the upper division (see Appendix L for a description of a W course). Note that the required EE 496 Senior Capstone Design is a W course. Another EE course that is W is EE 361L Digital Systems and Computer Design Lab, which has substantial writing.
    - Laboratories: EE laboratories require written laboratory reports.

  Our program covers oral communication skills as follows
    - Our program requires a speech course: SP 251 Principles of Effective Public Speaking (3 hrs).
    - University general education requirements have one Oral Communication (O) course (see Appendix L for a description of an O course).
    - The project courses EE 296, 396, and 496 each have a "speaking intensive" requirement, which is 30 minutes of presentation.

- Outcome 8 (global and societal impact): The University's general education requirements (see Appendix L) support this Outcome:
    - Global and Multicultural Perspectives requirements (6 credit hours), e.g., HIST 152 World History since 1500 which may cover such topics as the Industrial Revolution.
    - ECON 120 Introduction to Economics (3 credit hours) provide to our students an understanding of economics in society.

- Hawaiian, Asian, and Pacific Issues (H) "Focus" course requirement expose our students to issues in Hawaiian and Asian or Pacific cultures and history and promotes cross-cultural understanding between nations and cultures.
- Social science requirements (3 credit hours). Anthropology, geography, or similar courses give a student a global perspective, and on how technology can impact societies.

In addition, many of our courses cover how engineering technologies can impact the world. This can occur at the beginning of the course, when there is a discussion of why the course material is important. It can occur in a reading assignment such as the introductory chapter in a textbook which will have examples of the impact of EE technology. It also occurs in homework and project assignments, where the assignment may be written for a particular application. For example in EE 361L Digital Systems and Computer Design Lab there is a project assignment where teams of students research a microprocessor of their interest. Through their research they learn about the applications of their microprocessors such as for video games or mobile devices.

- Outcome 9 (lifelong learning): It is evident that EE students realize the need for life-long learning since they are pursuing higher education. They also understand that EE technologies change rapidly because this is emphasized in many courses, especially the upper division courses. In addition, project courses (EE 296, 396, and 496) help students to practice self-learning skills which is an important part of lifelong learning. Project activities often require students to self-learn new design tools and methodologies, and to research engineering topics. There are also courses that have research assignments, e.g., EE 361L that we mentioned above for Outcome 8.

- Outcome 10 (contemporary issues): Our students have knowledge of contemporary issues in a couple of ways. First, the University general education requirements have courses on Global and Multicultural Perspectives (6 credit hours). An example course that fulfills this requirement is GEOG 151 Geography and Contemporary Society. Our students also take ECON 120 Introduction to Economics (3 credit hours).

  Second, some of our courses cover contemporary issues. This can be a discussion in part of a lecture. It can be a reading assignment such as in a textbook or articles. It can be through Internet resources. For example, EE 361 Digital Systems and Computer Design had a web site in Fall 2008 with links to www.youtube.com videos. One of the videos described the One Laptop Per Child project and the XO laptop.

- Outcome 11 (design tools): Our Engineering Required and EE Technical Electives are EE courses that cover techniques, and skills necessary for engineering practice. This is 61 credit hours or about two years of coursework. Many of these courses apply design tools. Figure VI.7 has the tools used in Engineering Required courses. Appendix N has the list of EE Required and EE Technical Elective Track Group I courses that use tools.

Project courses EE 296, 396, and 496 often have design techniques and tools. For example, in Dr. Tep Dobry's micromouse projects, students use microcontrollers. Also, advanced technical electives will have design techniques and tools.

The Department's instructional laboratories for circuits and systems have standard electronic laboratory equipment: digital multimeters, power supplies, oscilloscopes, and function generators. They also have PCs, appropriate CAD software, and Microsoft Office software including Word, Excel, and Powerpoint. The PCs are connected to the Internet so that web sites and the Department's UNIX servers can be accessed using web browsers or SSH. The systems lab also has spectrum analyzers and electro-mechanical modules for control experiments.

There is also a common computing laboratory room, Holmes Hall 387, with a number of PCs and UNIX workstations that are open for students and faculty. They have all of the instructional software. The room is open Monday through Friday from 8AM to 930PM and on Saturday from 8AM to noon. The Department has a UNIX server that has a number of software tools such as Synopsis and Cadence.

Tools	**Courses**
Electronic laboratory equipment: digital multimeters, power supplies, oscilloscopes, function generators.	EE 211, 213, 260, 323L
Capilano's Logicworks digital circuit simulator tool with schematic capture and VHDL	EE 260
EPROM programmer	
UNIX environment including software tools for converting truth table information to HEX files, and Boolean function minimizer using the Quine-McCluskey algorithm	
Matlab	EE 213, 315, 342
PSPICE	EE 323, 323L
Unix environment	EE 160, 260

Figure VI.7. Tools in Engineering Required courses.

Our Department is currently investigating how to better educate and assess Outcomes 8, 9, and 10. Example proposals to accomplish this are presented in Appendix G. The proposal is a research and writing assignment about these three Outcomes.

The last table below shows our mapping of direct assessments from program outcomes to courses. This table was done at the beginning of 2009 and will be modified in the coming year.

Table VI.8. The courses used in Measuring Outcomes Achievement in EE Courses. The starred courses ("*") are required of all EE students.

Outcome		F10	S11	F11	S12	F12
1. Math and science	Probability				EE342*	
	Basic science					EE324
	Basic math			EE213*, EE260*		
	Adv math		EE315*		EE 367	
2. Experimental	Conduct experiment				EE 323L*	
	Design Experiment		EE 160*			
3. Design			-	EE 361, 361L, 415	EE 367, EE 367L	
4. Teamwork			EE 160*			
5. EE and CompE problems			-	EE 361, 361L 415	EE 367, EE 367L	
6. Profession and ethics			EE 495*			
7. Communication	Oral	EE496*	EE496*	EE496*, EE 361, 361L,415	EE496*	EE496*
	Written	EE 496*	EE 496*	EE 496*, EE 361, 361L, 415	EE496*	EE496*
8. Global and societal impact			EE 495*			
9. Lifelong learning	Need for					
	Ability	EE496*	EE496*	EE496*	EE496*	EE496*
10. Contemporary issues						
11. Design tools				EE 361, 361L,415	EE 367L	