Electrical Engineering

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Electrical Engineering Tuning Committee

Definition of Tuning

"Tuning" is a faculty-led pilot project designed to define what students must know, understand, and be able to demonstrate after completing a degree in a specific field, and to provide an indication of the knowledge, skills, and abilities students should achieve prior to graduation at different levels along the educational pipeline – in other words, a body of knowledge and skills for an academic discipline in terms of outcomes and levels of achievement of its graduates. Tuning provides an expected level of competency achievement at each step along the process of becoming a professional: expectations at the beginning of pre-professional study, at the beginning of professional study, and at the transition to practice. It involves seeking input from students, recent graduates, and employers to establish criterion-referenced learning outcomes and competencies by degree level and subject area. Through Tuning, students have a clear "picture" of what is expected and can efficiently plan their educational experience to achieve those expectations. The objective is not to standardize programs offered by different institutions but to better establish the quality and relevance of degrees in various academic disciplines. An overview of Lumina Foundation for Education's "Tuning USA" Initiative is available at: http://www.luminafoundation.org/our_work/tuning/; an overview of Tuning work to date in Texas is available at: http://www.thecb.state.tx.us/tuningtexas.

Definition of the Electrical Engineering discipline in terms of outcomes for successful preparation for students:

Electrical engineers design, develop, test, and supervise the manufacture, installation, maintenance, and operation of electrical and electronic equipment and systems. Some of this equipment includes electric motors; machinery controls, lighting, and wiring in buildings; radar and navigation systems; communication systems; computers and computer-related equipment; and power generation, control, and transmission devices used by electric utilities. Electrical engineers also design the electrical systems for automobiles and aircraft. Electrical engineers utilize the tools of mathematics, physics, and other natural sciences (i.e., biology and chemistry) to solve technical problems and satisfy the needs of society. Electrical engineers specialize in areas such as power systems engineering, electrical equipment manufacturing, computer hardware, signal processing, control systems, electronic devices and systems; virtual reality, biomedical devices;, Micro-Electromechanical Systems (MEMS), semiconductor devices, communication systems, renewable energy, reconfigurable logic and memory, optical computing, quantum computing, and computer systems.

Source: BLS Occupational Outlook Handbook, 2010-2011

Expertise Profile (Types of course work necessary for the completion of a BS degree)

The Electrical Engineering Expertise Profile lists 12 types of coursework necessary for the completion of a baccalaureate degree in Electrical Engineering. Note: General undergraduate degree requirements (i.e., the core curriculum) are not considered for the purpose of this expertise profile.

A degree in Electrical Engineering includes the following scientific and technical subject areas:

- 1. Mathematics: arithmetic, algebra, geometry, trigonometry, calculus, (differential, integral, and multivariate), differential equations, discrete, optimization, probability, random variables, statistics, set theory, numerical methods, vector analysis, linear algebra, and complex variables
- 2. Chemistry and Physics (calculus-based)
- 3. Circuits and Systems: Analog and Digital
- 4. Communications and Signal Processing: Analog and Digital
- 5. Electronics and Solid-State Devices
- 6. Electromagnetics
- 7. Computer Engineering: Hardware and Software Systems

A degree in Electrical Engineering may include the following specialized subject areas (typically found at the upper division):

- 1. Energy Systems
- 2. Computer Engineering including Discrete Mathematics and Architecture
- 3. Communications and Networking
- 4. Control Systems
- 5. Nanotechnology
- 6. Biomedical Devices
- 7. Photonics



Employment Profile

(Types of jobs available for Electrical Engineers)

A baccalaureate-degreed student can seek employment in these industries or application areas:

- 1. Aerospace and Defense
- 2. Biomedical Devices
- 3. Communications and Networking
- 4. Computers (hardware and software)
- 5. Control Systems (or automatic controls)
- 6. Education
- 7. Electronics and Integrated Circuits
- 8. Government
- 9. Instrumentation and Measurement
- 10. Manufacturing and Installation
- 11. Nanotechnology, Solid-State Devices, and Opto-electronics
- 12. Power Generation/Transmission, Conversion and Renewable Energy Systems
- 13. Research, Design, Development, and Testing
- 14. Robotics
- 15. Security
- 16. Sensors
- 17. Signal and Image Processing
- 18. Technical Sales and Marketing
- 19. Transportation and Navigation

The Electrical Engineering Employment Profile:



Electrical Engineering Key Competencies Profile

The key competencies profile is a schematic diagram that is derived from the competency table. It lists for each learning outcome (columns) the required competency levels according to Bloom's taxonomy (rows) that have to be gained at each educational level.

The Electrical Engineering competency table has four learning outcome categories:

- 1. core competencies needed to enter higher education in electrical engineering (HS)
- pre-engineering competencies gained during first two years of undergraduate study (CC)
- 3. baccalaureate-level engineering competencies (BS)
- 4. post-graduate engineering competencies (G)

The Electrical Engineering Key Competencies Profile

Evaluations	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Synthesis	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Synthesis	G	G	BS	BS	G	BS	G	G	G	G	G	G	G	BS
Analysis	BS	G	BS	BS	BS	BS	G	BS	G	BS	G	G	BS	BS
Application	BS	сс	сс	BS	BS	BS	BS	BS	BS	сс	BS	BS	сс	BS
Application	сс	сс	сс	сс	BS	BS	BS	BS	BS	сс	BS	BS	сс	BS
Comprehension	сс	сс	сс	сс	сс	сс	BS	сс	сс	сс	BS	сс	сс	BS
Comprehension	сс	сс	сс	сс	сс	сс	сс	сс	сс	сс	сс	сс	сс	BS
Knowledge	сс	сс	сс	сс	сс	сс	сс	сс	сс	HS	сс	сс	сс	BS
Knowledge	HS	HS	сс	сс	HS	сс	сс	сс	сс	HS	HS	HS	HS	BS
	(a1) Math, Probability, and Statistics	(a2) Science	(a3) Circuits and Systems	(a4) Computer Engineering	(b) Experiment	(c) Engineering Design	(d) Multidisciplinary	(e) Engineering Problems	(f) Professional/Ethical	(g) Communication	(h) *Engineering Impact and Contemporary Issues	(i) Lifelong Learning	(k) Engineering Tools	* Specialization (Depth and Breadth)

Electrical Engineering Key Competencies Profile

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Lumina Foundation Grant Electrical Engineering Committee
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G	graduate level competencies
BS	baccalaureate level competencies
СС	pre-engineering competencies
HS	secondary education competencies

The level of response for each of the Bloom's taxonomy levels are described through active verbs, for example:

(http://www.teach-nology.com/worksheets/time_savers/bloom/):

Knowledge	count, define, describe, draw, find, identify, label, list, match, name, quote, recall, recite, sequence, tell, write
Comprehension	conclude, demonstrate, discuss, explain, generalize, identify, illustrate, interpret, paraphrase, predict, report, restate, review, summarize, tell
Application	apply, change, choose, compute, dramatize, interview, prepare, produce, role-play, select, show, transfer, use
Analysis	analyze, characterize, classify, compare, contrast, debate, deduce, diagram, differentiate, discriminate, distinguish, examine, outline, relate, research, separate,
Synthesis	compose, construct, create, design, develop, integrate, invent, make, organize, perform, plan, produce, propose, rewrite
Evaluation	appraise, argue, assess, choose, conclude, critic, decide, evaluate, judge, justify, predict, prioritize, prove, rank, rate, select,

The Electrical Engineering Key Competency Table

The Electrical Engineering competency table has 13 learning outcome titles (columns from left to right):

- 1. Math, Probability, and Statistics
- 2. Science
- 3. Circuits and Systems
- 4. Computer Engineering
- 5. Experiment
- 6. Engineering Design
- 7. Multidisciplinary Teams
- 8. Engineering Problems
- 9. Professional/Ethical Responsibility
- 10. Communication
- 11. Lifelong Learning
- 12. Contemporary Issues/Engineering Impact
- 13. Engineering Tools
- (14.) Specialization (Depth and Breadth)

The competency table has four learning outcome categories (columns from left to right):

- 1. core competencies needed to enter higher education in civil engineering
- 2. pre-engineering competencies gained during first two years of study
- 3. baccalaureate level engineering competencies
- 4. post-graduate engineering competencies

Learning outcome descriptions are written for each of the 13 outcome titles of the competency table. Outcome descriptions explain the knowledge skills and attitudes that graduates need to achieve.

Electrical Engineering Outcome Summaries

(a1) Math, Probability, and Statistics

Mathematics is the science of numbers and their operations, interrelations, combinations, generalizations, and abstractions, and of space configurations and their structure, measurement, transformations, and generalizations. A core of knowledge of these branches of mathematics and the ability to apply that knowledge to solving engineering problems are essential skills for electrical engineers. The knowledge and problem-solving tools derived from the study of mathematics are essential to the understanding and the practice of electrical engineering; the mathematics required for electrical engineering produce must be learned at the undergraduate level and should prepare students for subsequent courses in graduate engineering curricula. The branches of mathematics relevant to the study of electrical engineering are arithmetic, algebra, geometry, trigonometry, calculus, (differential, integral, and multivariate), differential equations, optimization, probability, random variables, statistics, set theory, numerical methods, vector analysis, linear algebra, and complex variables.

MATHEMATICS, PROBABILITY, AND STATISTICS					
Core Competencies Needed to enter Higher Education in Electrical Engineering	Pre-Engineering Competencies gained during first two years of study	Baccalaureate Level Engineering Competencies	Post-Graduate/ Work Experience Engineering Competencies		
Solve problems in	Explain key	Solve problems in	Analyze a		
mathematics in	concepts and	mathematics	complex problem		
algebra, plane	problem-solving	ithrough	to determine the		
geometry,	processies in	differential	relevant		
trigonometry,	mathematics	equations, linear	mathematical		
and analytical	through	algebra, and	andsystems		
geometry (or pre-	multivariate	discrete math)	modeling		
calculus), and	calculus and	and apply this	principles and		
applythis	differential	knowledgetothe	then apply that		
knowledgetothe	equations	solution of	knowledgeto		
solution of		engineering	solvethe		
science and		problems;	problem		
technology		competence in			
problems.		probability and			
Students should		statistics is also			
be ready to		required			
complete					
Calculus lin their					
first college					
semester.					

(a2) Science

Science is the systematic study of the natural world through the scientific method. Science relies on experimental, quantifiable data and focuses on accuracy and objectivity. Science is the foundation from which technology is developed. The scientific method is the basis of experimental design and technological development. The principle branches of science relevant to electrical engineering are chemistry and calculus-based physics. Subsets of those bodies of knowledge important for electrical engineers include: atomic and nuclear structure, trends in chemical and physical properties of the elements, mechanics, electromagnetism, electro-optics, and thermodynamics. The knowledge of these principles from a calculus-based perspective and the ability to apply them to solve engineering problems are essential skills for electrical engineers.

Students obtaining undergraduate degrees in electrical engineering should be able to define, describe, and calculate mechanical characteristics of systems: define, describe, and calculate thermal characteristics of systems: define, describe, and calculate electromagnetic characteristics of charge systems in appropriate regular simple geometries. They should be able to identify appropriate sources of information for conducting laboratory experiments involving principles of chemistry and physics. They should be able to determine the basic nuclear and electronic structure of atoms and identify trends in chemical and physical properties of the elements using the Periodic Table.

The science required for electrical engineering must be learned at the undergraduate level with a calculus-based approach and should prepare students for subsequent courses in the engineering curricula.

SCIENCE				
Core Competencies Needed to enter Higher Education in Electrical Engineering	Pre-Engineering Competencies gained during first two years of study	Baccalaureate Level Engineering Competencies	Graduate Level Engineering Competencies	
Explain key electrical and material concepts in physics, chemistry, and biology to solve related problems	Explain key electrical and material concepts in problem-solving processes in chemistry and calculus-based physics	Solve electrical engineering problems in calculus-based physics, chemistry, and apply this knowledge to the solution of electrical engineering problems	Analyze complex problems to determine the relevant physics, chemistry, and/or other areas of natural science principles and then apply that knowledge to solve the problem	

(a3) Circuits and Systems

Electrical engineering students must demonstrate the ability to analyze and synthesize electrical and electronic circuits, devices, and systems. Circuits, devices, and systems encompass electrical networks and electronic networks from small-scale (e.g., electronic components) to large-scale (e.g., power systems). Graduates must be able to analyze means to determine the electrical behavior of an electrical or electronic network by experimental methods (measurements of actual circuits), simulation methods (model-building, numerical simulation methods, use of simulation software), or theoretical methods (involving Kirchhoff's laws, linear superposition, phasor, Laplace, Fourier, and Z-transforms). They should be able to use both classical analytical methods (nodal and mesh analysis) and modern circuit analysis software tools to determine Thevenin and Norton equivalents, two-port models, and the frequency response of given circuits in the time and frequency domains. Students at the undergraduate level must be able to derive Fourier, Laplace, and Z-transforms of mathematical operations in addition to those of energy signals and power signals. Synthesis means the design of a circuit or system using modern engineering tools. They must be able to design and analyze electronic amplifier circuits, including those with operational amplifiers. They must also be able to derive and analyze feedback control models for circuits and systems.

	CIRCUITS AND SYTEMS				
Core Competencies Needed to enter Higher Education in Electrical Engineering	Pre-Engineering Competencies gained during first two years of study	Baccalaureate Level Engineering Competencies	Graduate Level Engineering Competencies		
Intentionally left blank	Apply analysis of circuits in both time and frequency domain	Demonstrate the ability to analyze and design electrical and electronic circuits, devices, and systems using appropriate methods	Synthesize and evaluate electrical and electronic circuits, devices, and systems using appropriate methods		

(a4) Computer Engineering

The area of computer engineering includes interrelated aspects of electrical engineering and computer science. It is often regarded as the area of overlap between the hardware (electrical and electronics) and the software (operating system and applications) of a computer system. Thus, computer engineering may be thought of as the knowledge of hardware-software interaction and co-design. A student of electrical engineering should demonstrate the requisite knowledge to analyze, design, and evaluate computer systems including the hardware, software, and any interaction thereof between the sub-systems and the external world. Computer engineering forms the fundamental basis of many systems including integrated circuits, computers, transducers, analog/digital converters, and control systems.

The body of knowledge in this area includes: digital systems, microprocessors, microcontrollers, gate arrays, assembly language, hardware/software interfacing, and a working knowledge of programming high- and low-level languages. Students need to demonstrate proficiency in the following areas: Boolean algebra, logic gates: number systems and codes: combinational logic: sequential logic: design of logic circuits: analog-digital interface: memory devices: microprocessor architecture, programming, and interfacing: assembly language programming: microcomputers: microcontrollers: instruction sets: chip interfacing: addressing modes: interrupts: input/output, and: communications.

COMPUTER ENGINEERING						
Core	Pre-Engineering	Baccalaureate	Post-Graduate/			
Competencies	Competencies	Level	Work Experience			
Needed to enter	gained during	Engineering	Engineering			
Higher Education	first two years	Competencies	Competencies			
in Electrical	of study					
Engineering						
Intentionally left	Demonstrate	Design and apply	Synthesize and			
blank	ability to use a	digital systems	evaluate digital			
	higher-level	using	systems			
	programming	microprocessor				
	language in	languages, logic,				
	engineering	and computer				
	applications;	architecture				
	analyze and					
	design basic					
	digital systems					

(b) Experiment

Experiments are controlled trials to study effects, establish hypotheses, or verify that equipment meets stated specifications. Electrical engineering students must have the ability to design, conduct, and verify laboratory experiments to explore and investigate physical and mathematical relationships of electrical and electronic circuits and systems. They must demonstrate the ability to analyze and interpret experimental results. The design of experiments encompasses the selection of: 1) control variables, 2) variables to measure, 3) measurement instruments, and 4) procedures.

To conduct experiments is to carry out the procedures. To analyze and interpret experiments involves data reduction using appropriate graphical methods and/or numerical methods (e.g., regression, statistical techniques) to draw conclusions. Students must also be able to prepare laboratory reports that clearly communicate experimental information in a logical and scientific manner. They must be able to evaluate the accuracy of physical measurements and the potential sources of error in measurements. In addition, students must be able to apply experimental results to find solutions to engineering problems. Students must have a working knowledge of laboratory test equipment including: power supplies, voltmeters, ammeters, function generators, oscilloscopes, and spectrum analyzers. Students must be able to design and conduct experiments to measure fundamental parameters of electrical and electronic circuits and systems to include voltage, current, power, impedance, frequency, amplitude, phase, and power gain.

	EXPERIMENT					
Core	Pre-Engineering	Baccalaureate	Post-Graduate/			
Competencies	Competencies	Level Engineering	Work Experience			
Needed to enter	gained during	Competencies	Engineering			
Higher Education	first two years		Competencies			
in Electrical	of study					
Engineering						
Conduct	Conduct and	Electrical	Specify an			
experiments in	explain the	engineering	experiment to			
natural science	purpose,	students must have	meet a need,			
courses	procedures,	the ability to	conduct the			
according to the	equipment, and	design, conduct,	experiment, and			
scientific	practical	and verify	analyze and			
method; report	applications of	laboratory	evaluate the			
results and	experiments in	experiments; to	experiment for			
evaluate the	natural sciences	explore and	effectiveness in			
accuracy of the	and electrical	investigate physical	meeting a real-			
results	engineering	and mathematical	world need			
consistent with		relationships of				
the scientific		electrical and				
method		electronic circuits				
		and systems. They				
		must demonstrate				
		the ability to				
		analyze and				
		interpret				
		experimental				
		results				

(c) Engineering Design

The engineering design process includes, but is not limited to, the following process steps: definition of a problem, understanding criteria and constraints, developing specifications, identifying and evaluating solutions, use of project management tools, knowledge of societal and ethical impacts of the viable solutions, differentiation of optimal from sub-optimal solutions, modeling and simulation, optimal implementation of the chosen solution, and test and validation. Electrical and electronics engineering graduates must have the ability to design circuits, devices, and systems to meet application requirements. The engineering design process yields a viable solution to an engineering problem. Design includes all phases of the creation of circuits, devices, and systems to satisfy needs. The undergraduate student should step through the entire design process as a senior: however, the student should have experienced this process before reaching the capstone design course as a senior. Application requirements include basic functionality, environmental specifications (e.g., operating temperature range, operating supply-voltage range, ability to withstand shock and vibration), packaging constraints (e.g., size, weight), manufacturability, reliability, and cost.

ENGINEERING DESIGN				
Core Competencies Needed to enter Higher Education in Electrical Engineering	Pre-Engineering Competencies gained during first two years of study	Baccalaureate Level Engineering Competencies	Graduate Level Engineering Competencies	
Intentionally left blank	Understand purpose and steps of engineering design process and their use in solving basic engineering problems	Apply the design process to create a solution to an electrical engineering problem while meeting the requirements of real-world constraints, and IEEE standards	Synthesize and evaluate design of complex systems and assess compliance with applicable standards of practice, user needs, and relevant constraints	

(d) Multidisciplinary Teams

At the time a student completes the undergraduate degree requirements, the student must have the ability to function successfully on multidisciplinary teams.

Multidisciplinary engineering teams are groups of persons engaged in engineering who represent a spectrum of engineering and technical specialties. Students must be able to identify distinctions between the various disciplines and functions within engineering. To contribute successfully is to take an active, participatory, and productive role in the accomplishment of the tasks of a team. They must possess effective leadership, management, and communication skills. They should demonstrate knowledge of the importance of planning and organizing tasks to accomplish project goals; know the importance of effectively utilizing resources; know the techniques used to run effective meetings; know the techniques used to promote team harmony; and know the techniques used to foster high levels of performance, creativity, and professionalism. Students must also be able to define, specify, and successfully complete a major engineering design project as part of a multidisciplinary design team.

MULTIDISCIPLINARY TEAMS					
Core	Pre-Engineering	Baccalaureate	Graduate Level		
Competencies	Competencies	Level	Engineering		
Needed to enter	gained during	Engineering	Competencies		
Higher Education	first two years	Competencies			
in Electrical	of study				
Engineering					
Have experience	Discuss and	Function	Function		
in collaborative	demonstrate	effectively as a	effectively as a		
learning and	collaborative	member of an	member of a		
teamwork on	learning and	interdisciplinary	multidisciplinary		
class projects	teamwork on	team	team		
	class projects				

(e) Engineering Problems

Electrical engineering graduates must demonstrate the ability to apply advanced mathematics, scientific principles, and modern engineering tools to solve practical engineering problems that confront an electrical or computer engineer. In addition to using theoretical knowledge, electrical and computer engineers must possess the ability to conduct, analyze, and interpret experiments and creatively apply experimental results to find solutions to engineering problems. At the time a student completes the degree requirements and graduates with a Bachelor of Science in Electrical Engineering, the student must have the ability to identify, formulate, and solve problems in the practice of electrical engineering using appropriate theoretical and experimental methods.

ENGINEERING PROBLEMS					
Core Competencies Needed to enter Higher Education in Electrical Engineering	Pre-Engineering Competencies gained during first two years of study	Baccalaureate Level Engineering Competencies	Post-Graduate/ Work Experience Engineering Competencies		
Explain key concepts related to problem recognition, problem articulation, and problem-solving processes related to math and science applications	Identify key factual information related to math, science, and basic electrical engineering problem recognition, problem solving, and applicable techniques and	Develop problem statements and solve electrical engineering problems by applying appropriate techniques and tools	Synthesize and evaluate the solution to an advanced engineering problem		

(f) Professional/Ethical

The role of ethics is the application of moral reasoning in engineering decision making. Electrical engineering graduates must demonstrate the ability to understand the global context in which engineering is practiced, including the role of ethics in the practice of engineering. The role of ethics is the application of moral reasoning in engineering decision making (e.g., acting in accordance with the protection of public health, safety, and well-being). Students should understand the professional and ethical responsibilities of an engineering career, as codified by, for example, the National Society of Professional Engineers (NSPE) and the Institute of Electrical and Electronic Engineers (IEEE); understand the impact of unprofessional/unethical behavior through knowledge of engineering disaster case studies; and understand the importance of service to the community. Students must also develop an understanding of the significance of quality, timeliness, and continuous improvement.

PROFESSIONAL/ETHICAL RESPONSIBILITY			
Core Competencies Needed to enter Higher Education in Electrical Engineering	Pre-Engineering Competencies gained during first two years of study	Baccalaureate Level Engineering Competencies	Graduate Level Engineering Competencies
Intentionally left blank	Identify appropriate academic and professional ethical standards and behaviors	Analyze a situation and apply standards of professional and ethical responsibility to determine appropriate action	Synthesize and evaluate studies and experiences to foster professional and ethical conduct

(g) Communication

Written communication skills involve the drafting of documents (technical and non-technical) commonly encountered in engineering (e.g., lab reports, business letters, project proposals, peer-reviewed articles, specifications, test procedures, users' manuals). Visual communication skills involve conveying information through the use of graphics, images, and video. Communication skills involve the ability to communicate effectively (e.g., in meetings, presentations, conferences). Students graduating with an undergraduate degree in Electrical Engineering must possess clear and effective written, visual, and oral communication skills.

COMMUNICATION			
Core Competencies Needed to enter Higher Education in Electrical Engineering	Pre-Engineering Competencies gained during first two years of study	Baccalaureate Level Engineering Competencies	Post-Graduate/ Work Experience Engineering Competencies
List and use basic elements of oral, written, virtual, and graphical communication	Apply the rules of grammar and composition in verbal, written, and virtual communications, properly cite sources, and use appropriate graphical standards	Organize and deliver effective oral, written, virtual, and graphical communication	Synthesize and evaluate the effectiveness of the integrated verbal, written, virtual, and graphical communication of a project to technical and non technical audiences

(i) Lifelong Learning

Electrical engineering students must demonstrate the ability to understand the necessity of lifelong learning within the profession. Students must develop an understanding that continuous education has a profound impact on longevity, productivity, and career trajectories. Students must understand the roles of job experience; informal learning (conferences, seminars, magazines, journals); and formal education. Students should understand the need for lifelong learning as a professional and ethical responsibility to ensure competence and protect public welfare.

LIFELONG LEARNING			
Core Competencies Needed to enter Higher Education in Electrical Engineering	Pre-Engineering Competencies gained during first two years of study	Baccalaureate Level Engineering Competencies	Post-Graduate/ Work Experience Engineering Competencies
Demonstrate the use of informational resources	Explain the impact of continuous education on longevity, productivity, and career trajectories	Understand the necessity of lifelong learning within the profession	Incorporate the need for lifelong learning as a professional and ethical responsibility to ensure competence and protect public welfare

(j) Contemporary Issues and (h) Engineering Impact

Students graduating with an undergraduate degree in Electrical Engineering will possess an educational background to understand the global context in which engineering is practiced, including knowledge of contemporary issues related to science and engineering. Contemporary issues related to science and engineering are evolving technical, social, and legal developments and market trends that affect the direction of technological development (e.g., federal research and development funding decisions, laws regulating the practice of engineering, environmental policy decisions, and de facto technical standards established by market forces). Students should demonstrate the ability to identify and analyze contemporary national and international issues and situations and to discuss their effects and implications on individuals and organizations, economics, and the engineering profession.

Electrical engineering graduates must demonstrate tht their students have an understanding of the social, environmental, and economic impact of the discipline in a local, regional, and global context. The impact of engineering on society includes the ways in which technological developments affect individuals and organizations. Students will develop the ability to incorporate the impact of engineering solutions into the design process. Students will develop an understanding of the ethical implications of impact analysis in engineering problem solving. Students will also develop an informed historical perspective on engineering solutions to allow for a greater understanding of the impact of the discipline.

CONTEMPORARY ISSUES AND IMPACT			
Core Competencies Needed to enter Higher Education in Electrical Engineering	Pre-Engineering Competencies gained during first two years of study	Baccalaureate Level Engineering Competencies	Graduate Level Engineering Competencies
Describe economic, environmental, public policy, and societal aspects of modern history	Explain the historical perspective and the impact of engineering solutions on the economy, environment, public policy, and society	Understand historical and contemporary issues and apply them in solution of engineering problems	Synthesize and evaluate the impacts and relationship among engineering and historical, contemporary, and emerging issues

(k) Engineering Tools

Students graduating with an undergraduate degree in Electrical Engineering will have the ability to use modern engineering tools, techniques, and software in the practice of electrical engineering. Modern engineering tools and techniques include equipment, computer programs, and programming languages. Equipment and software provide the means to model, modify, and verify known circuit and system behavior.

ENGINEERING TOOLS			
Core Competencies Needed to enter Higher Education in Electrical Engineering	Pre-Engineering Competencies gained during first two years of study	Baccalaureate Level Engineering Competencies	Graduate Level Engineering Competencies
Perform scientific calculations using appropriate instruments and tools; demonstrate computer literacy	Apply modern engineering tools, techniques, and software at a basic level	Apply modern engineering tools, techniques, and software in the practice of electrical engineering	Synthesize and evaluate modern engineering tools, techniques, and software

(I) Specialization (Depth and Breadth)

Students graduating with an undergraduate degree in Electrical Engineering will have sufficient breadth and depth in specialized areas of electrical engineering. They should demonstrate an ability to apply scientific principles and mathematical concepts to analyze a variety of practical application problems in the specialized areas of electrical engineering, including but not limited to: signal processing, real time embedded systems, power electronics, solid-state devices, optoelectronics and fiber-optics, image processing, reconfigurable logic, power systems analysis, communications, and controls.