

Bachelor of Science in Electrical and Computer Engineering

The Bachelor of Science in Electrical and Computer Engineering is introduced in this catalog as a replacement for the two Electrical Engineering degrees offered in past catalogs. Students pursuing those degrees should refer to the appropriate earlier catalog for degree requirements. ABET accreditation for the new degree is planned and is expected to be requested during this catalog cycle.

The curriculum in electrical engineering and computer engineering is designed to educate students in the fundamentals of engineering, which are built upon a foundation of mathematics, science, communication, and the liberal arts. Graduates should be equipped to advance their knowledge while contributing professionally to a rapidly changing technology. Areas in which electrical and computer engineers contribute significantly are: communications, signal processing, networks and systems, electronics and integrated circuits, energy systems and renewable energy, fields, waves and electromagnetic systems, nanoelectronics and nanotechnology, computer architecture and embedded systems, and software engineering and design. Typical career paths of graduates include design, development, management, consulting, teaching, and research. Many graduates seek further education in law, medicine, business, or engineering.

The core requirements of the Bachelor of Science in Electrical and Computer Engineering provide a foundation of engineering fundamentals. Students then build on the core requirements by choosing an advanced technical component and a set of free electives from within or outside of the department. Once the technical core area is chosen, the student is assigned a faculty advisor with expertise in that area to help the student select technical core courses that are appropriate to his or her career and educational goals. The curriculum thus ensures breadth through the core courses and the choice of a technical elective; technical core area coursework provides additional depth.

Student Outcomes

Electrical and computer engineering graduates should demonstrate:

- An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
- An ability to communicate effectively with a range of audiences
- An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
- An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
- An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Program Educational Objectives

Electrical and computer engineering graduates should:

- Be highly skilled, trained, and educated for the ethical practice of electrical and computer engineering in industry and public service
- Exhibit leadership in technical or business activity through engineering ability, communication skills, and knowledge of contemporary and global issues
- Continuously educate themselves through professional study and personal research to expand and apply knowledge within and outside the discipline
- Use their engineering ability and creative potential to create technology solutions that consider environmental and social impacts to improve the quality of life in society
- Be able to develop and design systems, artifacts, and methods either individually or in teams
- Be prepared for admission to, and to excel in, the best graduate programs in the world

Portable Computing Devices

Students enrolled in a degree program in electrical and computer engineering will be expected to own a portable computing device capable of compiling and running a program suitable for use in the classroom and on the University wireless network. Use of these devices in the classroom and as a general part of the learning experience within our programs is at the discretion of faculty and not all classes or courses of instruction will require the use of these devices. Once admitted, students will be informed by the Electrical and Computer Engineering Department (ECE) office about specific device requirements.

Curriculum

Course requirements include courses within the Cockrell School of Engineering and other required courses. In addition, each student must complete the University's core curriculum. In some cases, a course that fulfills one of the following requirements may also be counted toward the core curriculum; these courses are identified below.

In the process of fulfilling engineering degree requirements, students must also complete coursework to satisfy the following flag requirements: one independent inquiry flag, one course with a quantitative reasoning flag, one ethics flag, one global cultures flag, one cultural diversity in the US flag, and two writing flags. The independent inquiry flag, the quantitative reasoning flag, the ethics flag, and two writing flags are carried by courses specifically required for the degree; these courses are identified below. Courses that may be used to fulfill [flag requirements](#) are identified in the [Course Schedule](#). More information about flags is given in [Skills and Experiences Flags](#).

Enrollment in Electrical and Computer Engineering 333T, 160, 260, 360, 460, and 379K requires completion of Electrical and Computer Engineering 312 or 313 with a grade of at least C-.

Pre-approved courses are used to fulfill technical core, advanced math and/or science and core technical electives; other elective courses must be approved by the electrical and computer engineering faculty before the student enrolls in them.

Transfer Coursework: No more than 25 semester credit hours of transfer electrical and computer engineering coursework may be counted for credit toward the electrical and computer engineering degree.

Requirements		Hours
Electrical and Computer Engineering Courses		
ECE 302	Introduction to Electrical Engineering (part II science and technology)	3
or ECE 302H	Introduction to Electrical Engineering: Honors	
ECE 306	Introduction to Computing	3
ECE 411	Circuit Theory	4
ECE 312	Software Design and Implementation I	3
or ECE 312H	Software Design and Implementation I: Honors	
ECE 313	Linear Systems and Signals	3
ECE 319K	Introduction to Embedded Systems	3
or ECE 319H	Introduction to Embedded Systems: Honors	
ECE 333T	Engineering Communication (writing flag)	3
ECE 351K	Probability and Random Processes	3
ECE 364D	Introduction to Engineering Design (writing flag)	3
or ECE 364E	Interdisciplinary Entrepreneurship	
One of the following senior design project courses:		4
ECE 464G	Multidisciplinary Senior Design Project (independent inquiry flag)	
ECE 464H	Honors Senior Design Project (independent inquiry flag)	
ECE 464K	Senior Design Project (independent inquiry flag)	
ECE 464R	Research Senior Design Project (independent inquiry flag)	
ECE 464S	Start-Up Senior Design Project	
Advance technical component: Within an identified "core":	two core courses (6-7 hours), one core laboratory course (4 hours), one advanced mathematics course (3-4 hours)	14
Advanced technical component electives: Within the same identified "core":	four courses (minimum 12 hours)	12
Advanced technical elective: Within any core of Electrical Engineering:	one upper-division electrical engineering course (or ECE 316) (3-4 hours) ¹	3
Set of free electives:	at least 14 hours of additional coursework taken for a letter grade. ²	14
Other Technical Courses		
Mathematics		
M 408C & M 408D	Differential and Integral Calculus and Sequences, Series, and Multivariable Calculus (mathematics; quantitative reasoning flag)	8
or		
M 408K & M 408L & M 408M	Differential Calculus and Integral Calculus and Multivariable Calculus	
M 427J	Differential Equations with Linear Algebra (quantitative reasoning flag)	4
M 340L	Matrices and Matrix Calculations	3
Physics		
PHY 105M	Laboratory For Physics 302K, 303K, and 317K	1

PHY 105N	Laboratory For Physics 302L, 303L, and 317L	1
PHY 303K	Engineering Physics I (part I science and technology; quantitative reasoning flag)	3
PHY 303L	Engineering Physics II (part I science and technology; quantitative reasoning flag)	3

Rhetoric and Writing

RHE 306	Rhetoric and Writing (English composition)	3
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Remaining Core Curriculum Courses

E 316L	British Literature ³	3
or E 316M	American Literature	
or E 316N	World Literature	
or E 316P	Masterworks of Literature	

American and Texas government ⁴ 6

American history ⁴ 6

Visual and performing arts ⁵ 3

Social and behavioral science ⁵ 3

UGS 302 First-Year Signature Course ⁶ 3

or UGS 303 First-Year Signature Course

1. E E Option: Advanced Technical Component (mathematics) is four hours and one Advanced Technical Component Requirement is three hours. C E Option: Advanced Technical Component (mathematics) is three hours and one Advanced Technical Component Elective is four hours.

2. Must include at least one advanced mathematics or basic science course (three hours); no more than three hours of lower-division coursework; all coursework must count for a major in the offering department; all coursework must be taken in residence, except that up to three credit hours can be transferred with approval; no course can duplicate a course the student has taken or is required to take as part of the other Electrical and Computer Engineering coursework requirements.

3. Some sections of the English humanities courses (E 316L, 316M, 316N, 316P) carry a global cultures or cultural diversity flag.

4. Some sections carry a cultural diversity flag.

5. Some sections carry a global cultures and/or cultural diversity flag.

6. In UGS 302, all sections carry a writing flag; in UGS 303, some sections carry a writing flag.

Total Hours **125**

Electrical and Computer Engineering Honors Program

The Electrical and Computer Engineering Honors program is a curriculum program. Students admitted to, and who complete the program and all its requirements, receive a Bachelors of Science in Electrical and Computer Engineering with the ECE Honors transcript distinction. Students entering the University as first time in college applicant may apply to the ECE Honors program by completing a separate online application available through the Office of Admissions. The ECE Honor's committee considers and reviews all supplemental material required in the online application for the ECE Honors program. All admission decisions must be made by the UT Austin Office of Admissions, with the ECE Honors Selection Committee providing recommendations. Students

may also apply and be admitted into the ECE Honors Program after matriculating to The University of Texas at Austin. External transfer students are required to complete the separate online application process. The internal application process for internal transfer students requires a copy of the student's record at UT Austin; a transcript of high school courses and grades; a resume detailing relevant accomplishments, experience, and activities; and written statements. The ECE Honors Selection Committee will consider these applications, and on that basis, will decide admission to the ECE Honors Program. In order to remain in the program, ECE Honors Students must maintain a GPA of at least 3.3 in their ECE courses (honors and non-honors), and must be in good standing according to current policies of the ECE department.

Students must take and successfully complete at least 17 hours of ECE honors courses to be considered for graduation as an ECE Honors Student. Students who join the program in the first semester of their freshman year must take the following in their first year: one-hour lower-division ECE honors course, ECE 302H, ECE 312H, ECE 319H. Additional courses to be used towards the ECE Honors program include three-hour upper-division ECE honors course, ECE 364D, and ECE 464H. Approved ECE graduate courses used as part of the ECE Undergraduate Degree may also be counted or substituted for ECE Honors credit. Note that this does not apply for graduate courses taken for graduate credit as part of a graduate or joint ECE BS/MS program. All ECE honors courses are used to fulfill ECE course requirements. Students in the ECE Honors Program must complete all curriculum requirements and a minimum of 125 hours.

Honors Electrical and Computer Engineering and Business (ECB-Program)

Honors Electrical and Computer Engineering and Business (ECB) is a dual degree program between the Canfield Business Honors Program (Canfield BHP) and the Department of Electrical and Computer Engineering (ECE). The dual degree program's four-year undergraduate curriculum is aimed at preparing students for engineering and business careers. Students must successfully complete all requirements for both programs to receive a Bachelor of Science in Electrical and Computer Engineering with the ECE Honors transcript distinction and a Bachelor of Business Administration.

Admissions

Admission to the ECB program is limited to a small number of high-performing students who are chosen on a competitive basis. Students selected for the program will have demonstrated exceptional potential for success in both engineering and business. Admission decisions are made by the ECB committee. Students enter the program as a freshman.

The ECB program has its own admissions criteria and requirements that supplement the standard admissions requirements for the Cockrell School of Engineering, Canfield BHP, and UT Austin. Students will apply to the dual degree program in parallel with their application to UT Austin, the Cockrell School of Engineering, and the McCombs School of Business.

Students entering the university as freshmen may apply to the ECB program by completing a separate online application available through the UT Austin Office of Admissions. The committee considers the student's SAT Reasoning Test or ACT scores, high school rank, preparatory courses, extracurricular activities, evidence of leadership ability, and other objective criteria.

Academic Standards

A student who enters ECB as a freshman must have a grade point average of at least 3.25 on the Canfield BHP courses taken in residence

during the fall and spring semesters of the first year to continue in the program. An ECB student must maintain a GPA of at least 3.3 in their ECE courses (honors and non-honors) and must be in good standing according to current policies of the ECE department and Canfield BHP. Students must complete at least 12 semester hours in residence on a letter-grade basis during the fall and spring semesters of the first year.

After freshman year, students are dismissed from the program if their overall business GPA drops below 3.25 or ECE GPA drops below a 3.3. Students failing to meet these requirements will be placed on probation for one semester, and then dismissed from the ECB program if they fail to improve their GPA. Students dismissed from the honors program become part of their first-choice major indicated on their admissions application unless they petition to join their second-choice major.

In addition to this grade point average requirement, students must know and abide by the academic and disciplinary policies given in this catalog and in the General Information Catalog. Those who fail to do so will be considered for academic dismissal from the program. Under special circumstances, and at the discretion of the ECB program committee, a student will be allowed to continue in the program under academic review. Students in scholastic difficulty should discuss their problems with the ECB program director(s) and their academic advisor(s).

Graduation

To graduate under the ECB program, the student must earn a university grade point average of at least 3.25, a grade point average of at least 3.25 in business courses, and a grade point average of at least a 3.3 in electrical and computer engineering courses. A candidate for any degree must be enrolled at The University of Texas at Austin in the semester or summer session in which the degree is awarded.

Students in the ECB program must satisfy the university Core Curriculum and the combined degree requirements for a Bachelor of Science in Electrical and Computer Engineering with the ECE Honors transcript distinction and a Bachelor in Business Administration. If students later elect to complete only one degree, they must consult their academic advisor(s) and fulfill all degree requirements.

Degree Requirements

- a. The Core Curriculum requirements and the BBA Degree Requirements.
- b. Mathematics 408C and 408D, or 408K, 408L, and 408M; 340L, and 427J.
- c. Physics 303K and 105M, 301 and 101L or 317K and 117M; and 303L and 105N, 316 and 116L, or 317L and 117N.
- d. Economics 304K and 304L
- e. Three semester hours of coursework in anthropology, psychology, educational psychology, or sociology with a primary focus other than statistics or data processing. Courses dealing primarily with statistics or data processing may not be used to fulfill this requirement. Social Science 302C, 302D, 302E, and 302F (for Plan II dual majors only), are also accepted.
- f. Students must take and successfully complete at least 16 hours of ECE Honors courses.
 - i. Electrical and Computer Engineering 302H and 319H in their first year.
 - ii. Additional courses to be used towards the ECE Honors program include: two three-hour upper-division ECE honors courses, Electrical and Computer Engineering 312H, and 464H.
 - iii. Approved ECE graduate courses used as part of the ECE undergraduate degree may also be counted or substituted. Note that this does not apply for graduate courses taken for

graduate credit as part of a graduate or integrated BSECE/MSECE program.

This dual major program requires 155 hours for completion of both degrees

- iv. All ECE honors courses are used to fulfill ECE course requirements.
- g. Students in the ECB Honors Program must complete all ECE curriculum requirements and a minimum of 125 hours. Please refer to the Engineering “Degrees and Programs” section of this catalog for technical course options within each linked degree major program.
 - i. 17 hours of business honors courses that substitute for ECE courses required for the ECE degree:
 - Business Administration 324H (substitutes for Electrical and Computer Engineering 333T)
 - Accounting 311H (substitutes for ECE lower-division elective)
 - Statistics 235H (substitutes for ECE advanced math or basic science)
 - Finance 357H (substitutes for ECE technical elective)
 - Management 336H (substitutes for ECE free elective)
 - Management 327H (substitutes for ECE free elective)
 - ii. Electrical and Computer Engineering 306, 411, and 313.
 - iii. Advance technical component within an identified component area: two component area courses (6-7 hours), one component laboratory course (four hours), one advanced mathematics course (3-4 hours).
 - iv. Three electrical and computer engineering advanced technical elective courses (nine hours).
 - v. Advanced technical elective: Within any core of electrical and computer engineering: one upper-division electrical and computer engineering course (or Electrical and Computer Engineering 316) (3-4 hours).
- h. Completion of the following business and business honors courses:
 - i. Accounting 311H (may fulfill the quantitative reasoning flag)
 - ii. Accounting 312H (may fulfill the quantitative reasoning flag)
 - iii. Business Administration 101H
 - iv. Business Administration 151H
 - v. A professional, business-related experiential learning course chosen from the following: Accounting 366P, Business Administration 353 653, Finance 366P Management 347P, 366P, 367P, 369P, Management Information Systems 366P Marketing 366P, Operations Management 366P. Only one of the following courses may be counted toward the degree: Business Administration 353, Business Administration 653
 - vi. Business Administration 324or Communication 324H (may fulfill the writing flag)
 - vii. Decision Science 235H
 - viii. Finance 357H
 - ix. Legal Environment of Business 323H
 - x. Management 101H
 - xi. Management 336H (may fulfill the ethics flag)
 - xii. Management 327H
 - xiii. Management 374H (may fulfill the writing and independent inquiry flags)
 - xiv. Management Information Systems 301H
 - xv. Marketing 337H
 - xvi. Operations Management 235H
 - xvii. Statistics 301H
 - xviii. Statistics 235H(may fulfill the quantitative reasoning flag)

Integrated Bachelor of Science in Electrical Engineering/Master of Science in Engineering Program

The integrated degree program results in simultaneously awarding a Bachelor of Science in Electrical and Computer Engineering: Integrated Option (BSECE) degree, and a Master's of Science in Engineering (MSE) degree in any one of the ten graduate tracks offered by the graduate program in electrical and computer engineering (ECE).

There are two stages to admission, an informal non-binding department based stage and a second stage in which the student formally applies to the Graduate School within the integrated BSECE/MSE program and within one of the available ECE graduate tracks. At stage one, undergraduate students in the ECE department may apply to the integrated degree program after qualifying for admission to major sequence. The purpose of stage one is primarily to provide appropriate advising to students interested in and appropriate for the integrated program. Admission to the integrated program at stage one is based on the applicant's grade point average, letters of recommendation, a statement of purpose, and other relevant examples of academic ability and leadership. Students will be advised by the integrated program advisor about the appropriate courses to take and reserve for graduate credit in their senior year in order to complete the integrated program as efficiently as possible. As for admission to the regular standalone MSE program, all admissions decisions at stage two are made by the admissions committee in the respective graduate track, with admission requirements set by the graduate track, with the exception that Graduate Record Exam (GRE) test scores are not required of integrated program participants. While optimal, application and admission at stage one are not required for application and admission to the integrated program at stage two.

The integrated program requires 120 semester credit hours (SCH) for the BSECE portion of the integrated program, as opposed to the 125 SCH minimum required for the BSECE degree alone. Students in the integrated program begin taking graduate courses as seniors. Students admitted to the integrated program will normally take and reserve for graduate credit two graduate courses in place of approved electives from the advanced technical coursework that would *otherwise* be required in the regular/standalone BSECE program. However, precisely which BSECE electives are to be replaced by the graduate courses can be adjusted as approved by technical core faculty advisors.

Students in this program will receive the BSECE and MSE degrees simultaneously after successfully completing a minimum total of 150 semester credit hours, 30 of which must qualify for the MSE program of work in electrical and computer engineering. Students unable to successfully complete the integrated program may obtain a BSECE degree by satisfying all of the requirements for the standalone BSECE degree. Since the regular BSECE degree requirements are a subset of the Integrated BSECE/MSE Program degree requirements, an undergraduate student should still be on a trajectory to graduate with the regular BSECE degree in the same timeframe that the student was on when applying to the Integrated BSECE/MSE Program. A student dismissed from the integrated program while a graduate student should already meet the degree requirements for the regular BSECE degree.

Information regarding the integrated program requirements and policies may be obtained from the ECE advising offices.

Upper-Division Technical Component Areas

Electrical and computer engineering students must choose an advanced technical component area from the electrical engineering or computer engineering areas listed below.

For all technical component areas, the student must complete all courses in the area on the letter-grade basis.

Electrical Engineering Advanced Technical Component Areas *Communications, Signal Processing, Networks, and Systems*

Communications, signal processing, networks, and systems broadly encompasses the principles underlying the design and implementation of systems for information transmission. The field considers how information is represented, compressed, and transmitted on wired and wireless links and how communication networks can be, and are, designed and operated. A student who chooses this technical component area should recognize that communications and networking is a broad application domain where many engineering tools come into play: from circuit design for wireless phones to embedded network processors to system and application software for networked systems.

Students complete the following:

- a. Either Electrical and Computer Engineering 325, *Electromagnetic Engineering* or ECE 351M *Digital Signal Processing*
- b. One of the following: Electrical and Computer Engineering 362K, *Introduction to Automatic Control*, Electrical and Computer Engineering 371Q, *Digital Image Processing*, or ECE 360K *Introduction to Digital Communications*
- c. Core laboratory course: Either Electrical and Computer Engineering 445S, *Real-Time Digital Signal Processing Laboratory*, or ECE 471C *Wireless Communications Laboratory*
- d. Core mathematics course: Mathematics 427L, *Advanced Calculus for Applications II*
- e. Four courses from the following list:
Electrical and Computer Engineering 325, *Electromagnetic Engineering*
Electrical and Computer Engineering 325K, *Antennas and Wireless Propagation*
Electrical and Computer Engineering 445S, *Real-Time Digital Signal Processing Laboratory*
Electrical and Computer Engineering 351M, *Digital Signal Processing*
Electrical and Computer Engineering 360C, *Algorithms*
Electrical and Computer Engineering 460J, *Data Science Laboratory*
Electrical and Computer Engineering 360K, *Introduction to Digital Communications*
Electrical and Computer Engineering 461P, *Data Science Principles*
Electrical and Computer Engineering 362K, *Introduction to Automatic Control*
Electrical and Computer Engineering 363M, *Microwave and Radio Frequency Engineering*
Electrical and Computer Engineering 471C, *Wireless Communications Laboratory*
Electrical and Computer Engineering 371Q, *Digital Image Processing*
Mathematics 325K, *Discrete Mathematics*
Mathematics 362M, *Introduction to Stochastic Processes* (carries a quantitative reasoning flag)
Mathematics 365C, *Real Analysis I*

Electronics and Integrated Circuits

The electronics and integrated circuits technical component area involves the design and analysis of the circuits that provide the functionality of a system. The types of circuits that students encounter

include analog and digital integrated circuits, radio frequency circuits, mixed signal (combination of analog and digital) circuits, power electronics, and biomedical electronics. The design and implementation of integrated circuits and systems using analog and digital building blocks are included in this core area. A student should choose this technical component area if he or she is interested in designing chips for applications, such as computing, telecommunications, and signal processing.

Students complete the following:

- a. Electrical and Computer Engineering 325, *Electromagnetic Engineering*
- b. Electrical and Computer Engineering 339, *Solid-State Electronic Devices*
- c. Core laboratory course: Electrical and Computer Engineering 438, *Fundamentals of Electronic Circuits I Laboratory*
- d. Core mathematics course: Mathematics 427L, *Advanced Calculus for Applications II*
- e. Electrical and Computer Engineering 316, *Digital Logic Design*
- f. Three courses from the following list:
Electrical and Computer Engineering 321K, *Mixed Signal and Circuits Laboratory*
Electrical and Computer Engineering 438K, *Analog Electronics*
Electrical and Computer Engineering 338L, *Analog Integrated Circuit Design*
Electrical and Computer Engineering 440, *Integrated Circuit Nanomanufacturing Techniques*
Electrical and Computer Engineering 445L, *Embedded Systems Design Laboratory*
Electrical and Computer Engineering 445S, *Real-Time Digital Signal Processing Laboratory*
Electrical and Computer Engineering 460M, *Digital Systems Design Using Hardware Description Languages*
Electrical and Computer Engineering 460N, *Computer Architecture*
Electrical and Computer Engineering 460R, *Introduction to VLSI Design*
Electrical and Computer Engineering 360S, *Digital Integrated Circuit Design*
Electrical and Computer Engineering 361R, *Radio-Frequency Electronics*
Electrical and Computer Engineering 363M, *Microwave and Radio Frequency Engineering*
Electrical and Computer Engineering 374K, *Biomedical Electronic Instrument Design*
Electrical and Computer Engineering 374L, *Applications of Biomedical Engineering*

Energy Systems and Renewable Energy

This technical component area provides the foundation for a career in electric power systems, generation, grid operation, motors and drives, and renewable energy sources. This area involves the study and design of reliable and economic electric power systems, including both traditional and renewable resources. Energy conversion involves conversion to and from electrical energy, including the study and design of electrical machines.

Students complete the following:

- a. Electrical and Computer Engineering 325, *Electromagnetic Engineering*
- b. Electrical and Computer Engineering 368L, *Power Systems Apparatus and Laboratory* or Electrical and Computer Engineering 369, *Power Systems Engineering*
- c. Core laboratory course: Electrical and Computer Engineering 462L, *Power Electronics Laboratory*

- d. Core mathematics course: Mathematics 427L, *Advanced Calculus for Applications II*
- e. Electrical and Computer Engineering 362K, *Introduction to Automatic Control*
- f. Three courses from the following list:
 - Electrical and Computer Engineering 339, *Solid-State Electronic Devices*
 - Electrical and Computer Engineering 339S, *Solar Energy Conversion Devices*
 - Electrical and Computer Engineering 341, *Electric Drives and Machines*
 - Electrical and Computer Engineering 362Q, *Power Quality and Harmonics*
 - Electrical and Computer Engineering 362R, *Renewable Energy and Power Systems*
 - Electrical and Computer Engineering 362S, *Development of a Solar-Powered Vehicle*
 - Electrical and Computer Engineering 368L, *Power Systems Apparatus and Laboratory*
 - Electrical and Computer Engineering 369, *Power Systems Engineering*
 - Mechanical Engineering 337C, *Introduction to Nuclear Power Systems*

Fields, Waves, and Electromagnetic Systems

Students in this technical component area study different aspects of applied electromagnetics, including antennas, radio wave propagation, microwave and radio frequency circuits and transmission structures, optical components and lasers, and engineering acoustics. A student should choose the electromagnetic engineering area if he or she is interested in engineering that involves the physical layer in modern communication and radar systems. Graduates are well positioned for jobs in antenna design and testing, propagation channel characterization, microwave and radio frequency circuit design, electromagnetic emission testing from electronic devices and systems, radar system design and development, optical telecommunication, optical information and signal processing systems, and component design and development.

Students complete the following:

- a. Electrical and Computer Engineering 325, *Electromagnetic Engineering*
- b. Electrical and Computer Engineering 339, *Solid-State Electronic Devices*
- c. Core laboratory course: Electrical and Computer Engineering 438, *Fundamentals of Electronic Circuits I Laboratory* or Electrical and Computer Engineering 462L, *Power Electronics Laboratory*
- d. Core mathematics course: Mathematics 427L, *Advanced Calculus for Applications II*
- e. Either Electrical and Computer Engineering 325K, *Antennas and Wireless Propagation* or Electrical and Computer Engineering 363M, *Microwave and Radio Frequency Engineering*
- f. Three courses from the following list:
 - Electrical and Computer Engineering 321K, *Mixed Signal and Circuits Laboratory*
 - Electrical and Computer Engineering 325K, *Antennas and Wireless Propagation*
 - Electrical and Computer Engineering 334K, *Quantum Theory of Electronic Materials*
 - Electrical and Computer Engineering 341, *Electric Drives and Machines*
 - Electrical and Computer Engineering 347, *Modern Optics*
 - Electrical and Computer Engineering 348, *Laser and Optical Engineering*
 - Electrical and Computer Engineering 361R, *Radio-Frequency Electronics*

- Electrical and Computer Engineering 363M, *Microwave and Radio Frequency Engineering*
- Electrical and Computer Engineering 363N, *Engineering Acoustics*
- Electrical and Computer Engineering 369, *Power Systems Engineering*
- Electrical and Computer Engineering 374K, *Biomedical Electronic Instrument Design*
- Electrical and Computer Engineering 374L, *Applications of Biomedical Engineering*

Nanoelectronics and Nanotechnology

Students in this technical component area learn about the materials and devices used in modern electronic and optoelectronic systems. Through required and elective courses, students learn about the fundamentals of charge transport and interactions with light in semiconductors. They learn about devices beginning with diodes and transistors, the building blocks of integrated circuits, and extending to photodiodes, semiconductor lasers, photodetectors and photovoltaic devices. They learn about microelectronics fabrication techniques. And they are introduced to quantum mechanics, particularly as it applies to electronic and optoelectronic materials and devices. Students may also explore device applications through digital and analog circuit design. With exposure to the topics in this area, students are well positioned to work in a wide variety of fields that rely on semiconductor devices, such as computers, telecommunications, the automotive industry, and consumer electronics.

Students complete the following:

- a. Electrical and Computer Engineering 325, *Electromagnetic Engineering*
- b. Electrical and Computer Engineering 339, *Solid-State Electronic Devices*
- c. Core laboratory course: Electrical and Computer Engineering 440, *Integrated Circuit Nanomanufacturing Techniques*
- d. Core mathematics course: Mathematics 427L, *Advanced Calculus for Applications II*
- e. Four courses from the following list:
 - Electrical and Computer Engineering 334K, *Quantum Theory of Electronic Materials*
 - Electrical and Computer Engineering 438, *Fundamentals of Electronic Circuits I Laboratory*
 - Electrical and Computer Engineering 338L, *Analog Integrated Circuit Design*
 - Electrical and Computer Engineering 339S, *Solar Energy Conversion Devices*
 - Electrical and Computer Engineering 347, *Modern Optics*
 - Electrical and Computer Engineering 348, *Laser and Optical Engineering*
 - Electrical and Computer Engineering 360S, *Digital Integrated Circuit Design*
 - Electrical and Computer Engineering 438, *Fundamentals of Electronic Circuits I Laboratory*
 - Electrical and Computer Engineering 460R, *Introduction to VLSI Design*

Computer Engineering Advanced Technical Component Areas

Computer Architecture and Embedded Systems

Computer architecture involves understanding the operation and design of computers on many different levels. These levels include the instruction set, microarchitecture, and logic design. Embedded systems represent the combination of software and hardware that are designed to perform specific functions. These systems may be stand-alone items or an integral part of a larger system. Within this technical component area, students are exposed to logic design, programming,

computer architecture, systems design, and digital signal processing. The student studying computer architecture will be well positioned to join the microprocessor design industry as a logic designer or a circuit designer. After a good deal of experience on the job, the student would be well positioned to become the chief architect of a new design.

Jobs in embedded systems involve defining, designing, and fabricating application-specific processors and computers in areas such as automotive electronics, consumer devices, and telecommunications.

Students complete the following:

- a. Electrical and Computer Engineering 316, *Digital Logic Design*
- b. Electrical and Computer Engineering 460N, *Computer Architecture*
- c. Core laboratory course: Electrical and Computer Engineering 445L, *Embedded Systems Design Laboratory*
- d. Core mathematics course: Mathematics 325K, *Discrete Mathematics*
- e. Electrical and Computer Engineering 360C, *Algorithms*
- f. Three courses from the following list:
Electrical and Computer Engineering 422C, *Software Design and Implementation II*
Electrical and Computer Engineering 445M, *Embedded and Real-Time Systems Laboratory*
Electrical and Computer Engineering 445S, *Real-Time Digital Signal Processing Laboratory*
Electrical and Computer Engineering 460M, *Digital Systems Design Using Hardware Description Languages*
Electrical and Computer Engineering 360P, *Concurrent and Distributed Systems*
Electrical and Computer Engineering 460R, *Introduction to VLSI Design*
Electrical and Computer Engineering 362K, *Introduction to Automatic Control*
Computer Science 375, *Compilers*

Software Engineering and Design

Courses in this area cover the engineering life cycle of software systems, including requirement analysis and specification, design, construction/programming, testing, deployment, maintenance, and evolution. Area courses are intended to teach students theory, practical methods, and tools for designing, building, delivering, maintaining, and evolving software to meet stakeholder requirements. Every software engineer must understand how software systems operate and how they can be used to solve engineering problems and deliver solutions. The courses in this area are designed to educate students about a diverse and relevant set of technologies and about the ways that technology can be used to design and build software systems.

Students complete the following:

- a. Electrical and Computer Engineering 422C, *Software Design and Implementation II*
- b. Electrical and Computer Engineering 360C, *Algorithms*
- c. Core laboratory course: Electrical and Computer Engineering 461L, *Software Engineering and Design Laboratory*
- d. Core mathematics course: Mathematics 325K, *Discrete Mathematics*
- e. Four courses from the following list:
Electrical and Computer Engineering 316, *Digital Logic Design*
Electrical and Computer Engineering 445L, *Embedded Systems Design Laboratory*
Electrical and Computer Engineering 445M, *Embedded and Real-Time Systems Laboratory*
Electrical and Computer Engineering 360F, *Introduction to Software Engineering*
Electrical and Computer Engineering 460N, *Computer Architecture*

- Electrical and Computer Engineering 360P, *Concurrent and Distributed Systems*
Electrical and Computer Engineering 361Q, *Requirements Engineering*
Electrical and Computer Engineering 372N, *Telecommunication Networks*
Electrical and Computer Engineering 360T, *Software Testing*
Electrical and Computer Engineering 461P, *Data Science Principles*

Data Science and Information Processing

This technical component trains students in information and signal processing, data mining as well as decision and control algorithms. Applications include data analytics, machine learning, sound and image processing as well as knowledge extraction and actuation.

Students complete the following:

- a. Electrical and Computer Engineering 461P, *Data Science Principles*
- b. *Electrical and Computer Engineering 360C, Algorithms*
- c. Core laboratory course: Electrical and Computer Engineering 460J, *Data Science Laboratory*
- d. Core mathematics course: Mathematics 325K, *Discrete Mathematics*
- e. Electrical and Computer Engineering 351M, *Digital Signal Processing*
- f. Three courses from the following list:
Electrical and Computer Engineering 422C, *Software Design and Implementation II*
Electrical and Computer Engineering 445S, *Real-Time Digital Signal Processing Laboratory*
Electrical and Computer Engineering 360P, *Concurrent and Distributed Systems*
Electrical and Computer Engineering 361C, *Multicore Computing*
Electrical and Computer Engineering 462L, *Power Electronics Laboratory*
Electrical and Computer Engineering 362K, *Introduction to Automatic Control*
Electrical and Computer Engineering 471C, *Wireless Communications Laboratory*
Electrical and Computer Engineering 371Q, *Digital Image Processing*

Alternate Mathematics Courses

For students who choose an advanced technical component area in computer engineering:

- Mathematics 427L, *Advanced Calculus for Applications II*
Mathematics 328K, *Introduction to Number Theory*
Mathematics 343K, *Introduction to Algebraic Structures*
Mathematics 344K, *Intermediate Symbolic Logic*
Mathematics 348, *Scientific Computation in Numerical Analysis* (carries a quantitative reasoning flag)
Mathematics 358K, *Applied Statistics* (carries a quantitative reasoning flag)
Mathematics 374M, *Mathematical Modeling in Science and Engineering*
Computer Science 341, *Automata Theory*
Computer Science 346, *Cryptography*

For students who choose an advanced technical component area in electrical engineering:

- Mathematics 325K, *Discrete Mathematics*
Mathematics 328K, *Introduction to Number Theory*
Mathematics 346, *Applied Linear Algebra*
Mathematics 348, *Scientific Computation in Numerical Analysis* (carries a quantitative reasoning flag)
Mathematics 358K, *Applied Statistics* (carries a quantitative reasoning flag)
Mathematics 361, *Theory of Functions of a Complex Variable*

Mathematics 362M, *Introduction to Stochastic Processes*
Mathematics 372K, *Partial Differential Equations and Applications*
Mathematics 374, *Fourier and Laplace Transforms*
Mathematics 374M, *Mathematical Modeling in Science and Engineering*