Duke UNIVERSITY | ELECTRICAL & COMPUTER ENGINEERING

Undergraduate Program Handbook

For Students Matriculating Fall 2025 or Later

v1.0 Academic Year 2025–2026

The handbook is updated every year.
Students and faculty should always use the latest version of the handbook.

Students matriculating Summer 2025 or earlier should use the updated version of the Undergraduate Program Handbook for Students Matriculating Summer 2025 or Before.

Highlights of Important Changes from F24 Version

- **The Trinity College of Arts and Sciences has approved a new curriculum, which includes new curricular codes.** Students who matriculate in Fall 2025 or later should use the new codes and the new Pratt policy regarding liberal arts courses. Students who matriculated before Fall 2025 should use the old codes and the old policy (and the updated version of the old handbook).
- The Physics Department strongly recommends MATH 219 as a pre-requisite or co-requisite for PHYSICS 152; this is reflected in sample course plans for students matriculating in Fall 2025 or after.
- The ECE Department has approved a Transcripted Concentration in Software Engineering and a Minor in Software Engineering.
- Previously, the terms "ECE Concentration Elective" and "ECE Concentration Course" were used to describe four courses that needed to be selected from specific lists among the five curricular groups in ECE. Now that ECE has two transcripted concentrations, the terms "ECE Approved Curricular Area Elective" and "ECE Approved Curricular Area Course" will be used. These terms may show up in their shortened forms of "ECE Area Elective" and "ECE Area Course."
- Speaking of which, several new ECE Area Electives have been approved:
  - Computer Engineering and Digital Systems:
    - ECE 495 Software Development and Engineering
    - ECE 557 Computer Architecture and Hardware Acceleration
    - ECE 590 Cross-Platform Mobile Application Programming
    - ECE 564 Mobile Application Programming
    - ECE 657 Usable Security and Privacy
    - ECE 653 Human-Centered Computing
  - Engineering Physics:
    - ECE 522 Quantum Engineering with Atoms
  - Solid-State Devices and Integrated Circuits:
    - ECE 431 Power Electronic Circuits for Energy Conversion
    - ECE 516 (c/l ME 516) Thin-Film Photovoltaic Technology
  - Signal Processing, Communications, and Controls:
    - ECE 590 Neural Network Based Large Language Models
    - ECE 661 Computer Engineering Machine Learning and Deep Neural Networks
- The Computer Engineering & Digital Systems (CEDS) area **no longer** has a foundation course. Students wishing to take multiple courses in CEDS are no longer required to take ECE 350L for more than one CEDS course to count as an area course.
- ECE 590 Neural Network Based Large Language Models has been approved as an Option 3/4/5 course for the Transcripted Concentration and Minor in Machine Learning & AI.
- ECE 351 Software Engineering has been given a permanent number. It will be included as an alternative prerequisite for any ECE course currently listing COMPSCI 307D or COMPSCI 308 as prerequisites.
- ECE 522 Quantum Engineering with Atoms has been given a permanent number.
- PHYSICS 385 is now cross-listed as ECE 332.

- The following courses have been removed from the system:
  - ECE 486 Wireless Communication Systems
  - ECE 525 Semiconductor Physics
  - ECE 562 Energy-Efficient Computer Systems
  - ECE 578 Inverse Problems in Electromagnetics and Acoustics
  - ECE 584 Acoustics and Hearing
  - ECE 611 Nanoscale and Molecular Scale Computing
  - ECE 676 Lens Design
- The following courses, while still in the system, have not been taught for several semesters, are currently considered dormant, and will not be included in this handbook:
  - ECE 488 Digital Image and Multidimensional Processing
  - ECE 489 Advanced Robot System Design
  - ECE 496 Wireless Technology and Wave Propagation
  - ECE 561 Datacenter Architecture
  - ECE 563 Cloud Computing
  - ECE 573 Optical Communication Systems
  - ECE 577 Computational Electromagnetics
  - ECE 582 Digital Signal Processing
  - ECE 631 Analog and RF Integrated Circuit Design, Fab and Test
  - ECE 662 Machine Learning Acceleration and Neuromorphic Computing
  - ECE 681 Pattern Classification and Recognition Technology
  - ECE 683 Digital Communication Systems
  - ECE 686 Adaptive Filters

Contents

Section 1 Introduction

This handbook provides an overview of the undergraduate program in electrical and computer engineering (ECE) at Duke University. It covers the program, mission, educational objectives, major requirements, second major options, minor requirements, and research opportunities.

Duke's Department of Electrical and Computer Engineering offers an ABET-accredited Bachelor of Science in Engineering, emphasizing analytical thinking, problem solving, and technology, while fostering the development of ethical leadership, communication, and teamwork skills. The Duke program provides more opportunities and is less restrictive than many other ECE programs. Students use this flexibility to expand their horizons or to explore a personal interest more deeply. The student population is diverse, both geographically and culturally, and is a cross section of the very best students in the nation and from around the world.

For more information about the ECE undergraduate program contact:

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Section 2 Mission

Electrical and computer engineering is a broadly based engineering discipline dealing with the processing, control, and transmission of information and energy by making extensive use of electrical and electromagnetic phenomena, systems theory, and computational hardware and software. The department also encourages students and faculty to develop synergies with disciplines outside of engineering, such as medicine and the life sciences. Students majoring in electrical and computer engineering can also complete a second major or a minor in many fields such as biomedical engineering, computer science, physics, mathematics, and economics. Additional interests such as pre-medicine, pre-law, business, other engineering disciplines, art, music, psychology, and social sciences can be accommodated.

The mission of the Department of Electrical and Computer Engineering is to facilitate the development of well-rounded, educated, productive, and ethical individuals who are well versed in technology and in social, political, and environmental issues. Our goals are to develop within each student a robust repertoire of professional skills, to provide each with avenues for exploring diverse interests, and to launch each successfully into one of a variety of careers offering lifelong learning, service, and leadership within their own local, national, and global communities. To achieve our mission, the department puts forth the following educational objectives for the extremely capable students entering the ECE program.

Section 3 Program Educational Objectives

Our goal is to graduate electrical and computer engineers who embody excellence in a broad sense. We expect our graduates to advance within industry positions or in graduate study, or to carry the attributes of an engineering education into other disciplines. The electrical and computer engineering program of study must include mathematics and basic sciences, fundamentals and applications in several engineering sciences, and team-based experience in the process of design, where theory is applied in the context of real needs and limitations, and where judgment must be exercised. Our electrical and computer engineering graduates should be able to think critically when solving problems and managing tasks and communicate effectively in multidisciplinary professional environments. To be a responsible member of the engineering profession, each graduate must be aware of social, ethical, environmental and economic factors and constraints on engineering activity, and must understand the importance of these matters in a global context. We aspire to have our graduates exhibit intellectual depth and creativity, uphold high ethical standards, and show a commitment to the betterment of society through service and professional work.

The specific Program Educational Objectives that we look for in our graduates are that they:

- **Advance professionally** in their chosen field,
- **Contribute to their professional community and to society**, and
- **Engage in lifelong learning** in professional and personal endeavors.

Section 4 Student Outcomes and Program Criteria

Our students will have the following capabilities upon completion of their degrees:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics,
2. 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,
3. An ability to communicate effectively with a range of audiences,
4. 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,
5. 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,
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions, and
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Section 5 BSE Degree and ECE Major Requirements

As a program accredited by the Engineering Accreditation Commission of ABET (ABET Website), the ECE curriculum must satisfy minimum requirements in mathematics, sciences, and engineering. In addition, the Pratt School of Engineering has requirements for all engineering students. To meet these constraints, the Department of Electrical and Computer Engineering has developed specific requirements for undergraduate students. Samples of programs for students with different ECE-related major choices are provided in Appendix A for students matriculating in Fall 2025 or later. Students matriculating in Summer 2025 or before should consult the updated version of the previous handbook.

5.1. General BSE Requirements

The following courses are part of the Pratt School of Engineering requirements for earning a Bachelor of Science in Engineering.

➢ One Undergraduate Writing Course

WRITING 120 is required for students matriculating Fall of 2025 or later.

➢ Five Mathematics Courses

All ECE majors must take MATH 111L (or have AP credit for MATH 21), 112L or 122L (or have AP credit for MATH 22), 218D-2, 219, and 353. Common questions about math placement are answered on the Department of Mathematics Placement Guideline website. Transfer credits are examined on an individual basis. Here are math options for the first two courses:

- No AP: MATH 111L and MATH 112L
- MATH 21 AP: MATH 122L in the Fall or MATH 112L in the Spring
- MATH 21 AP and MATH 22 AP: proceed to MATH 218D-2

If a student is advised by the Department of Mathematics to skip any courses in the math sequence listed above, *those courses must be replaced with additional math courses approved by the ECE DUS.*

Special Note for students with a second major in math: Students wishing to complete a second major in math will need to take MATH 111L, 112L, 221, 222, and 356. Additional math courses are required to complete the math major – check with the MATH DUS for details.

➢ One Chemistry Course

This requirement may be satisfied by taking CHEM 101DL. AP credit in CHEM [20 or 21] can be used to satisfy this requirement.

➢ Two Physics Courses

Engineering students must take at least one physics course post-matriculation. Students with no AP credit will take the following:

- PHYSICS 151L + PHYSICS 152L

Students with a 4 or 5 on the AP Physics C exam(s) earn Physics 25-Mechanics; and/or Physics 26-Electricity & Magnetism. The following options are available:

- No AP credit or AP<4: PHYSICS 151L and PHYSICS 152L
- PHYSICS 25 (AP≥4 on Physics C Mech) *only*: PHYSICS 152L
- PHYSICS 26 (AP≥4 on Physics C E&M) *only*: PHYSICS 151L
- PHYSICS 25 and PHYSICS 26: A Physics course at Duke (see below)

If you have AP credit for PHYSICS 25 and PHYSICS 26, choose one of the following options as your physics course post-matriculation:

- If you are interested in a second major or a minor in physics, it is suggested that you follow the recommendations for potential physics majors at the Physics Department Introductory Course Placement for Majors/Minors website.
- If you are not planning a second major or a minor in physics, and you have credit for multivariable calculus, it is suggested that you take PHYSICS 264L: Optics & Modern Physics.
- If you do not have credit for multivariable calculus and are not planning a second major or minor in physics, we recommend that you take one of the following:
  - PHYSICS 152L, or
  - an Intermediate Core Physics course, selected from: PHYSICS 361, 362D, 363, 464, or 513, or
  - a Gateway Core Physics course, selected from: PHYSICS 305, 320L, 380, or 414

Further notes on physics requirement:

- You do not have the option of taking PHYSICS 151L and then using AP for PHYSICS 26–unless the only AP Physics credit you have is for PHYSICS 26.
- If you enroll in a course that uses AP Physics as a prerequisite, you are then unable to take the AP equivalent course as your one physics class post-matriculation. For example, if you enroll in a course that uses PHYSICS 26 AP as a prerequisite, you can no longer take PHYSICS 152L as your one physics post-matriculation after that particular semester.

➢ One Mathematics or Natural Science Elective

All ECE majors must satisfy this elective with a course on statistics and/or probability. The approved options can be found in Table D.3.

➢ Five Liberal Arts Courses

The Trinity College of Arts and Sciences changed its curriculum in the Fall of 2025, so Pratt has changed its policies on arts and sciences courses accordingly. The policy for students matriculating in Fall of 2025 (or after) is presented below. Students who matriculated before Fall of 2025 should consult the updated version of the previous handbook.

Students in the Pratt School of Engineering **who matriculated Fall 2025 and later** are required to complete a minimum of **5 full-credit (1.0) courses from a set of categories** that includes Creating & Engaging with Art (CE), Humanistic Inquiry (HI), Interpreting Institutions, Justice & Power (IJ), Social & Behavioral Analysis (SB), and Language (LG). More specifically:

- Students must take five courses that each carry **at least one code of CE, HI, IJ, SB, or LG** and that do not otherwise count towards the requirements of their Pratt School of Engineering major(s).
- Students must complete courses that cumulatively **cover at least four of the five codes (CE, HI, IJ, SB, LG)**.
- **A Century Course that has two *different* codes** may cover both of those codes, but still only counts as one of the five required courses.
- All courses taken to fulfill the Liberal Arts requirement (courses or codes) **must be satisfied by taking courses post-matriculation**.
- Any course taken to satisfy the Liberal Arts requirement **must be taken on a graded basis**, unless the course is only offered on a mandatory Satisfactory/Unsatisfactory grading basis. For courses only offered on an S/U grading basis, up to two such S/U-only courses may contribute (course and/or code) to the Liberal Arts requirement.

➢ One Digital Computation Course

All ECE students must take COMPSCI 201. Students coming to Duke with limited programming experience are also expected to take EGR 105. Students who place into COMPSCI 201 (e.g., by having COMPSCI AP credit) are not required to take EGR 105L. Either EGR 105L or COMPSCI 201 must be taken by the end of the first year.

➢ One Engineering Design & Communication Course

EGR 101L is required of all Pratt students in their first year. Students transferring to Pratt who did not take EGR 101L in their first year must take an *additional* 300-level or higher ECE course that is approved by the ECE DUS in lieu of EGR 101L.

5.2. ECE Required Courses

The following courses are required to earn a major in Electrical and Computer Engineering.

➢ Five ECE Core Courses

The following five core courses are required for all ECE majors: ECE 110L, ECE 230L, ECE 250D, ECE 270DL, and ECE 280L.

➢ Four ECE Approved Curricular Area Electives

ECE majors must select a minimum of four upper-level courses that have been approved as electives in one of our five curricular areas. The five curricular areas are:

- Computer Engineering and Digital Systems (CEDS)
- Signal Processing, Communications, and Control Systems (SPCC)
- Solid-State Devices and Integrated Circuits (SSDIC)
- Engineering Physics (EP)
- Photonics (P)

A complete list of approved ECE Approved Curricular Area Electives can be found in Appendix C.

At least two of the courses must come from *different* curricular areas (breadth) and at least two of the courses must come from the *same* curricular area (depth). If a course is approved by multiple curricular areas, it can count in only one area for a student, but the student can choose which area. For example, a student who has taken ECE 350 (CEDS), ECE 351 (CEDS), ECE 353 (CEDS), and ECE 661 would use ECE 661 as an SPCC class for breadth, while a student who has taken ECE 330 (SSDIC), ECE 350 (CEDS), ECE 545 (P), and ECE 661 would use ECE 661 as a CEDS class (along with ECE 350) for depth.

For students expecting to enter the engineering profession after graduation, a two- or three-course sequence prepares the student for professional work in that area. For all students, including those expecting to enter fields such as medicine, law, or business, these upper-level courses reinforce the broad relevance of the powerful problem-solving methodologies of engineering and illuminate enabling technologies for breathtaking applications of technology.

➢ One ECE Free Elective

Students take elective courses to learn advanced knowledge in specific areas of electrical and computer engineering. Students are required to take at least one elective ECE course at the 300-level or above. An ECE Free Elective can be any 300-level or above ECE course for which you have the prerequisites and which is not otherwise satisfying a requirement for your major. An ECE independent study course (300-level or above) can be counted as the ECE Free Elective. NOTE: For students with a second major, the total number of ECE Approved Curricular Area Electives and ECE Free Electives required depends on the second major (see Appendix A).

➢ One ECE Extension Elective

Students take one ECE Extension Elective course that enables students to either deepen their knowledge in a specific area of ECE or extend their ECE training in a complementary direction. An ECE Extension Elective can be any 300-level or above course that has an NW or QC Trinity Curriculum Code; or any* 300-level or above course in BME, CEE, ECE, or ME; or a course selected from a list of approved 200-level ECE Extension Elective courses (see Table D.2 for approved list). However, *if both ECE 380 and ECE 555 are taken and neither is used to satisfy the ECE statistics requirement, then the ECE Extension Elective is restricted to be an "engineering topics" course at the 300-level or higher that has been approved by the ECE DUS.* An ECE independent study course (300-level or above) can be counted as the ECE Extension Elective.

***Independent Study courses from other departments cannot be used to satisfy the ECE Extension Elective requirement. AP credits cannot be used for this requirement.**

➢ One ECE Approved Design Elective

The undergraduate ECE Program includes an Approved ECE Design Elective. This course is normally taken during the senior year and only after a student has completed the core courses in math and science as well as the core and some advanced courses in ECE. This "capstone design course" involves multidisciplinary teams of students who build and test custom-designed systems, components or engineering processes. Students gain experience in the design, building, testing, and demonstration processes intrinsic to engineering design as practiced by engineering graduates.

The requirements for the team project include:

- a design plan incorporating engineering standards and realistic constraints,
- a timeline indicating project milestones,
- a written project report including an assessment of the results, and
- oral presentations to the class.

The completed project assessment must include most of the following elements:

- cost,
- environmental impact,
- manufacturability,
- ethics,
- health and safety, and
- social and political impacts.

The approved ECE design courses can be found in Table D.1.

➢ Four Unrestricted Electives

The standard ECE curriculum (assuming no AP credit) includes four 1.0 credit unrestricted elective courses to get to 34 credits. Up to four courses *total* may be taken on a Satisfactory/Unsatisfactory basis to count towards the 34 courses required for graduation.

Section 6 Transcripted Concentrations

Students pursuing a major in ECE who are interested in either machine learning or software engineering may *focus* their course selection *within* the major by following a defined thematic pathway, successful completion of which will result in the designation of a Concentration in Machine Learning or a Concentration in Software Engineering on their official transcript. ECE majors can declare a concentration by selecting the appropriate option on the Declaration of Major Form. See the web page on Undergraduate Concentrations for details.

Completion of a concentration requires a minimum of 5 courses. These requirements can be met within the general requirements of the ECE major and **do not require any additional courses**; however, the choice of classes has been constrained. The required courses for each concentration are listed below, along with the ECE major requirement being fulfilled (in square brackets). No course may be used to fulfill more than one requirement.

6.1. Transcripted Concentration in Machine Learning

Requirements (5 courses):

1. ECE 480: Applied Probability for Statistical Learning [ECE Area Elective #1 - SPCC]
2. ECE 580: Introduction to Machine Learning [ECE Area Elective #2 - SPCC]
3. One of the following [ECE Area Elective #3 – any area, including SPCC]:
   - ECE 588: Image & Video Processing
   - ECE 661: Computer Engineering Machine Learning & Deep Neural Networks
   - ECE 662: Machine Learning Acceleration & Neuromorphic Computing
   - ECE 663: Machine Learning in Adversarial Settings
   - ECE 682D/CS 571/Stat 561: Probabilistic Machine Learning
   - ECE 684: Natural Language Processing
   - ECE 685D: Introduction to Deep Learning
   - ECE 687D/CS 671D/Stat 671D: Theory & Algorithms for Machine Learning
   - ECE 495/496/590: Special Topic courses on ML that are approved concentration electives (with DUS approval)
     - ECE 495 Introduction to Natural Language Processing
     - ECE 590 Neural Network Based Large Language Models
4. One of the following [ECE Free Elective]:
   - Any course not already taken from Requirement #3 (above)
   - ECE 689/CS 676: Advanced Topics in Deep Learning
   - ECE 495/496/590: Special Topic courses on Machine Learning (with DUS approval)
5. One of the following [ECE Extension Elective]:
   - Any course not already taken from Requirements #3 and #4 (above)
   - ECE 495/496/590: Special Topics courses on Machine Learning (with DUS approval)
   - BME 590: Machine Learning in Pharmacology (F23)
   - COMPSCI 371: Elements of Machine Learning
   - COMPSCI 527: Computer Vision
   - MATH 412 / COMPSCI 434: Topological Data Analysis
   - MATH 465 / COMPSCI 445: Introduction to High Dimensional Data Analysis
   - ME 555: Robot Learning (F23)
   - STA 340: Introduction to Statistical Decision Analysis
   - STA 360: Bayesian Inference and Modern Statistical Methods

6.2. Transcripted Concentration in Software Engineering

Requirements (5 courses):

1. ECE 351: Software Engineering [ECE Area Elective #1 - CEDS]
2. One of the following [ECE Area Elective #2 – CEDS]
   - ECE 653/COMPSCI 653: Human-Centered Computing
   - ECE 657/COMPSCI 586: Usable Security and Privacy
   - ECE 590: Cross Platform Mobile Application Development
   - ECE 490/495/496/590: Special Topic courses on HCI/UX (with DUS approval and approved as a CEDS area course)
3. One of the following [ECE Area Elective #3 – any area, including CEDS]:
   - ECE 353/COMPSCI 310: Introduction to Operating Systems
   - ECE 356/COMPSCI 356: Computer Network Architecture
   - ECE 553/COMPSCI 553: Compiler Construction
   - ECE 560: Computer and Information Security
   - ECE 566: Enterprise Storage Architecture
4. One of the following [ECE Free Elective]:
   - Any course not already taken from Requirement #2
   - Any course not already taken from Requirement #3
   - ECE 458: Engineering Software for Maintainability
   - ECE 568: Engineering Robust Server Software
   - ECE 661: Computer Engineering Machine Learning and Deep Neural Nets
   - ECE 490/495/496/590: Special Topic courses on Software Engineering (with DUS approval)
5. One of the following [ECE Extension Elective]:
   - Any course not already taken from Requirement #2
   - Any course not already taken from Requirement #3
   - Any course not already taken from Requirement #4
   - Other software-focused computer science classes with DUS approval

Section 7 Other Items

7.1. Second Major, Minor, and Certificate Programs

Students can declare a second major within the Pratt School of Engineering. Opportunities also exist for students to combine the ECE major with a second major, minor, or certificate from Trinity College. (A certificate is similar to a minor but offered for interdisciplinary study.) To do so, the students must meet the same requirements as those for the ECE major plus the specific requirements from other departments/programs outlined in the Bulletin of Undergraduate Instruction. The additional requirements usually consist of $\geq$10 courses for a second major, 5 courses for a minor, and $\geq$6 courses for a certificate. Some of these courses can be double-counted towards both the ECE degree and the second major, minor or certificate in Trinity College. For example, two courses required for the second major in economics may be counted as two of the five liberal arts courses required for the ECE degree. To reduce the workload for obtaining the second major, minor, or certificate in Trinity College during the regular academic semesters, students can either take the required Trinity courses as unrestricted electives in the ECE curriculum or take them in the summer.

Appendix A provides samples of curricula for some of the most popular combinations of the ECE major with a second major.

7.2. Independent Study and Research Opportunities

Independent study courses are designed to allow juniors and seniors to work individually with a faculty member on a project or topic of mutual interest. Courses are arranged on an individual basis at the instigation of the student or faculty member. Most students who undertake Independent Study do so in their senior year, but qualified students can undertake Independent Study after sophomore year.

Many students find that independent study is a rewarding educational experience. Students who anticipate engaging in independent study are encouraged to complete their foundation courses in mathematics, chemistry, physics, and engineering as early as possible, so that they will have the background to address challenging engineering problems in collaboration with their faculty study mentor.

Up to two upper-level independent study courses [ECE 391, ECE 392, ECE 493 and 494] may be used to satisfy ECE major electives (e.g., as an ECE Free Elective or ECE Extension Elective). Students may also take independent study courses as Unrestricted Electives, and all successfully completed Independent Study courses count toward the total of 34 courses required for a Duke degree.

A research experience can be achieved in a number of ways.

- Perform directed ECE research with an ECE faculty member.
- Take independent study courses with a non-ECE faculty member. In such cases, the project must be sponsored by an ECE faculty member. The sponsor is responsible for evaluating the quality of the project and ensuring ECE content as appropriate for ECE course credit.

- Apply for a Pratt Research Fellow position during your Junior year. Pratt Research Fellows perform research in an ECE faculty member's lab for three academic semesters plus a full summer term and earn three ECE Independent Study credits.

All students taking ECE Independent Study courses, *including Pratt Fellows and Graduation with Departmental Distinction candidates*, must participate in an ECE Independent Study Poster Session to present their research results and to answer questions from faculty and other students. Poster sessions are held by the ECE Department late in each semester for the independent study projects done during that semester.

Other opportunities for integrating research into the plan of study include the Duke Smart Home Fellows program, the Katsouleas NAE Grand Challenges Scholars program, and Bass Connections.

7.3. Graduation with Departmental Distinction

Students who aspire to earn Graduation with Departmental Distinction (GWDD) within the Department of Electrical and Computer Engineering conduct supervised research through independent study courses and present the results of individual research and study in both written and oral forms to the department's faculty. Those candidates who are judged by the department's faculty to have distinguished themselves through their paper and presentation earn Graduation with Departmental Distinction honors.

To be considered for Graduation with Departmental Distinction a student must have a 3.5 Cumulative GPA and must successfully complete in his or her senior year a faculty-supervised 1.0 credit independent Study project with significant electrical and computer engineering accomplishment. The significance of this project must be demonstrated in a formal written report and defended in an oral presentation before a committee of faculty members.

Candidates must submit a 10-20 page written report (single-spaced, 12-point Times New Roman, single-column) including figures and references. The entire report must be submitted electronically to the Director of Undergraduate Studies Assistant *no later than one week before the oral presentation begins*. The project report essentially constitutes a senior thesis.

This accomplishment is recognized when the BSE degree is awarded. If that time is different from the principal spring commencement exercises, the student work remains in contention for the research prize for that academic year awarded each Spring Commencement.

7.4. Preparation for Medical School

Students planning to attend medical and dental schools should consult with the Office of Health Professions Advising (HPA) about course planning. The HPA Office provides advice to students planning careers in health professions and also information on the application process, degree requirements, research and volunteer opportunities.

7.5. Planning for Study Abroad

Students interested in participating in the Global Education program need to develop an academic plan with their advisors several semesters in advance. This plan includes the courses to be taken in foreign countries and the remaining courses to be taken at Duke before and after the semester abroad. In the semester prior to study abroad, students submit requests for course approvals (if courses are not already in the GEO database) to the ECE DUS. The process for approval of courses in the study abroad program is the same as that used for all transfer courses. For details, see the Duke Global Education website.

ECE students may take two courses abroad related to the major. The remainder of the courses taken abroad may fulfill other requirements. No more than two courses can be taken in place of required ECE departmental courses (e.g., ECE 280L). In special cases, with prior approval of the Director of Undergraduate Studies, students may take two required courses plus a technical elective required for the major (or second major). This situation arises most often when there is an opportunity to study a subject not normally offered at Duke.

The most common courses for students to receive credit for taking abroad (i.e., the courses for which it is easiest to find an equivalent) include ECE 280L, some ECE Approved Curricular Area Electives (particularly ECE 356, 381, 382L, 383, and 488), ECE Free Electives, and/or Liberal Arts courses.

7.6. 4 + 1 BSE/Master's Program (Five-Year Combined Bachelor/Master's Degree Program)

Completing both a Bachelor of Science in Engineering (BSE) and a master's degree in five years is a great opportunity to advance your training. If you plan accordingly, you can complete all requirements for your BSE degree without requiring a full undergraduate course load in your senior spring. By taking two or more graduate courses in your senior spring (assuming they are not being used to satisfy any BSE requirements), you can complete the remaining graduate courses in one year beyond your BSE.

At Duke there are three engineering master's degree options to consider:

- 4+1: BSE + Master of Engineering
- 4+1: BSE + Master of Science
- 4+1: BSE + Master of Engineering Management

More information about all three 4+1 programs is provided at the 4+1 webpage. In all cases, you want to work with the Director of Undergraduate Studies and the Director of Graduate Studies to develop your academic plan. The main steps are:

- Develop course plans for your senior year and for one graduate year with your academic advisor and obtain Director of Graduate Studies (DGS) approval.
- Take the GRE exam in the senior fall or earlier
- Apply for admission to Duke's Graduate School (for a Master of Science) or Pratt's Master's Program Office (for a Master of Engineering or Master of Engineering Management program) during senior fall.

7.7. Advising

Assignment of ECE advisors: Students are assigned an ECE faculty advisor at the time they declare their major. Students can declare majors or change them at any time after their first year. To do this, students complete an online form.

First-year advising: In order to provide program information to first-year students interested in ECE, all students are invited to an orientation presented by the ECE Director of Undergraduate Studies (DUS) in mid-Fall. The presentation covers the degree requirements and commonly asked questions.

Pre-registration advising of ECE students: Students assigned ECE advisors will meet with their advisors during the pre-registration period in March/April for the fall semester and in October/November for the spring semester. The advisor reviews the student's academic report, discusses with the student the courses that he or she will take in the following semester, and makes the student 'eligible to enroll' in classes for the following semester. Should you make any changes to your course plan *after* meeting with your advisor, it is your responsibility to inform your advisor of those changes. Your advisor is likely to keep notes on your meetings, and this will keep his or her notes accurate. More importantly, your change in plan may trigger a comment from your advisor that could be beneficial to you.

During the advising meeting, you should discuss any concerns or problems that you might be having academically, and you are encouraged to initiate conversations about the field of electrical and computer engineering that you may be interested in exploring further and/or career options within the discipline.

Career advising: Students can discuss their career plans with their advisors. In addition, Duke's Career Center is available for career advising, support for career exploration, and assistance with job search skills such as networking, writing professional documents, and interviewing in preparation for securing summer internships, full-time employment, and other professional opportunities.

7.8. Information on Internships and Employment

Information on internship and employment opportunities is posted on the website of the Duke University Career Center. In addition to maintaining the websites mentioned above, the Career Center organizes various career-related activities. These include (a) career advice sessions, (b) career skills workshops, (c) providing information about specific industries and opportunities, (d) alumni connections, and (d) workshops and seminars on internship and employment that are specific for engineering or ECE students. The workshops and seminars are announced via email and posted on the plasma screens in the engineering buildings.

In addition to the Career Center, Kirsten Shaw (kirsten.shaw@duke.edu), Director of Corporate and Industry Relations, helps Pratt students connect with corporations for internship opportunities. For more information, see the Undergraduate Internship Opportunities webpage.

Information on internships and employment is sometimes sent directly to the ECE faculty or the department. When this happens, the information will be distributed to ECE students via email from the DUS Assistant.

Section 8 Minors

The Department of Electrical and Computer Engineering offers three minors:

- Minor in Electrical and Computer Engineering
- Minor in Machine Learning and Artificial Intelligence
- Minor in Software Engineering

Courses that are used to fulfill the student's major(s) or other minor(s) may not be double-counted toward a minor offered by ECE. In addition, courses with content substantially equivalent to courses in the student's major(s) may not be counted toward a minor offered by ECE. Students majoring in ECE who are interested in machine learning or software engineering are encouraged to pursue a concentration, rather than a minor, in those areas.

It is expected that a student pursuing a minor will satisfy all pre-requisites for each course selected for their minor program. This will potentially involve completion of courses in math, statistics, physics, computer science, and ECE that are pre-requisites for many of the required and elective courses. See Appendix B for major-specific course and pre-requisite equivalents.

Students interested in pursuing any of the minors below are advised to discuss their plan of study with the ECE DUS.

8.1. Requirements for a Minor in Electrical and Computer Engineering

A minor in electrical and computer engineering provides Duke undergraduates with a creditable exposure to ECE that complements the program of study in their first major. It is designed to provide students with a broad, fundamental foundation in ECE, coupled with the opportunity to explore advanced topics tailored to a student's specific interests.

The minor in ECE requires a minimum of five technical courses. Three courses must be drawn from the set of "core courses" required of all ECE majors and two must be upper-level ECE courses.

- ***Core courses (3):*** Choose 3 from the following 5 core ECE courses[a]:
  - ECE 110L Fundamentals of ECE[b]
  - ECE 230L Microelectronic Devices & Circuits
  - ECE 250D Computer Architecture
  - ECE 270DL Fields & Waves
  - ECE 280L Signals & Systems
- ***Upper-level courses (2):*** Two ECE courses at or above the 300-level
  - At most, one ECE Independent Study (supervised by an ECE faculty member) can be used toward satisfying this requirement.
  - At most, one 300-level (or above) course cross-listed between ECE and the major department can be used toward satisfying this requirement. This course may not be double-counted toward a major.

[a] Students with credit for any of these courses (e.g., exact or equivalent course taken to satisfy a requirement of their major(s)) may substitute additional upper-level ECE courses. The ECE DUS must approve such exceptions.

[b] Note that ECE 110L is a prerequisite for ECE 230L, 270DL, and 280L, while COMPSCI 201 is a prerequisite for ECE 250D.

8.2. Requirements for a Minor in Machine Learning and Artificial Intelligence

A minor in machine learning and artificial intelligence provides Duke undergraduates with a creditable exposure to this rapidly growing field in a way that complements the program of study in their first major. It is designed to provide students with the foundations of ML/AI while providing the opportunity to explore advanced topics tailored to a student's specific interests.

The minor in machine learning and artificial intelligence requires a minimum of five technical courses. Three courses provide the statistical and practical underpinnings of the field and two must be upper-level courses.

- ***Fundamental courses (3):*** Complete the following courses[a]:
  - Intermediate Statistics/Probability
    - ECE 480 Applied Probability for Statistical Learning
  - Introductory Machine Learning & Artificial Intelligence
    - ECE 580 Introduction to Machine Learning
  - Intermediate Machine Learning & Artificial Intelligence (choose one):
    - ECE 682D/CS 571D/STA 561D
    - ECE 687D/CS 671D/STA 671D
- ***Upper-level courses (2):*** Two courses at or above the 300-level
  - ECE 585 Signal Detection and Extraction Theory
  - ECE 588 Image & Video Processing
  - ECE 661 Computer Engineering Machine Learning & Deep Neural Networks
  - ECE 662 Machine Learning Acceleration & Neuromorphic Computing
  - ECE 684 Natural Language Processing
  - ECE 685D Deep Learning
  - COMPSCI 527 Computer Vision
  - MATH 412 Topological Data Analysis
  - MATH 465/COMPSCI 445 Introduction to High Dimensional Data Analysis
  - STA 340 Introduction to Statistical Decision Analysis
  - STA 360 Bayesian Inference and Modern Statistical Methods
  - ME 555 (F23, F24, F25): Robot Learning
  - BME 590 (F23) Machine Learning in Pharmacology
  - ECE 590 Special Topics courses on machine learning and artificial intelligence topics (with ECE DUS approval)

[a] Students with credit for any of these courses (e.g., exact or equivalent course taken to satisfy a requirement of their major(s)) may substitute additional upper-level courses. The ECE DUS must approve such exceptions.

8.3. Requirements for a Minor in Software Engineering

A minor in software engineering provides Duke undergraduates with a creditable exposure to this critically important field in a way that complements the program of study in their first major. It is designed to provide students with the foundations of software engineering while providing the opportunity to explore advanced topics tailored to a student's specific interests.

The minor in software engineering requires a minimum of five technical courses. Three courses provide the foundations of software engineering and two must be upper-level courses.

- ***Fundamental courses (3):*** Complete the following courses[a]:
  - Software Engineering Foundation
    - ECE 351 Software Engineering
  - Human-Computer Interaction (HCI) and User Experience (UX) (choose one):
    - ECE 653/CS 653 Human-Centered Computing
    - ECE 657/CS 586 Usable Security and Privacy
    - ECE 590 Cross Platform Mobile Application Development
    - ECE 490/495/496/590 Special Topic courses on HCI/UX (DUS approved)
  - Systems (choose one):
    - ECE 353/CS 310: Introduction to Operating Systems
    - ECE 356/CS 356: Computer Network Architecture
    - ECE 553/CS 553: Compiler Construction
    - ECE 560: Computer and Information Security
    - ECE 566: Enterprise Storage Architecture
- ***Upper-level courses (2):*** Two courses at or above the 300-level:
  - Any courses not already taken from the HCI/UX list above
  - Any courses not already taken from the Systems list above
  - ECE 458: Engineering Software for Maintainability
  - ECE 568: Engineering Robust Server Software
  - ECE 661: Computer Engineering Machine Learning and Deep Neural Nets
  - ECE 490/495/496/590: Special Topic courses on Software Engineering (with DUS approval)
  - Either COMPSCI 307D: Software Design and Implementation or COMPSCI 308: Advanced Software Design and Implementation (only one of these can count towards the five courses; neither is required)
  - COMPSCI 316: Introduction to Database Systems
  - COMPSCI 330: Introduction to the Design and Analysis of Algorithms
  - COMPSCI 333: Algorithms in the Real World
  - COMPSCI 351: Introduction to Computer Security (only if ECE 560 is *not* taken)
  - COMPSCI 408: Delivering Software: From Concept to Client

[a] Students with credit for any of these courses (e.g., exact or equivalent course taken to satisfy a requirement of their major(s)) may substitute additional upper-level courses. The ECE DUS must approve such exceptions.

Appendix A Sample Programs of Study (Fall 2025 Matriculants and After)

Notes:

- The sample programs below assume zero prematirculation or placement credits. Students entering with some college credit can rearrange courses so long as pre-requisite conditions are met.
- Students who take COMPSCI 201 earlier than shown can also take ECE 250D earlier than shown.
- The Department of Physics **strongly** recommends that MATH 219 be a pre- or co-req for PHYSICS 152L. Students who are able to take MATH 219 during their third semester (or before) may want to consider moving PHYSICS 152L to their third semester. Taking PHYSICS 152L earlier will also allow ECE 230L and/or ECE 270DL to be taken earlier.
- Some programs require more than 34 courses:
  - ECE with BME second major
  - ECE major with Energy Engineering minor

Table A.1: Electrical and Computer Engineering (ECE) Major (matric ≥ Fall 2025)

First Year	
Fall Semester	**Spring Semester**
EGR 101L Engineering Design & Communication	ECE 110L Fundamentals of ECE
EGR 105L Computing for Engineers or COMPSCI 201 Data Structures & Algorithms[a]	WRITING 120
MATH 111L Introductory Calculus I	MATH 112L Introductory Calculus II
CHEM 101DL Core Concepts in Chemistry[b]	PHYSICS 151L Introductory Mechanics[c]
Sophomore Year	
Fall Semester	**Spring Semester**
ECE 280L Signals and Systems	ECE 250D Computer Architecture
COMPSCI 201 Data Structures and Algorithms (if not already taken to replace EGR 105L)	MATH 219 Multivariable Calculus
MATH 218D-2 Matrices and Vectors	PHYSICS 152L Intro Electricity, Magnetism, Optics[c]
Liberal Arts Elective 1[d]	Statistics Elective[e]
Junior Year	
Fall Semester	**Spring Semester**
ECE 230L or ECE 270DL	ECE 270DL or ECE 230L
ECE Area Elective 1[f]	ECE Elective[g]
MATH 353 Ordinary & Partial Differential Equations	ECE Area Elective 2[f]
Liberal Arts Elective 2[d]	Liberal Arts Elective 3[d]
Free Elective	Free Elective
Senior Year	
Fall Semester	**Spring Semester**
ECE Extension Elective[h] or ECE Design Elective[i]	ECE Design Elective or ECE Extension Elective
ECE Area Elective 3[f]	ECE Area Elective 4[f]
Liberal Arts Elective 4[d]	Liberal Arts Elective 5[d]
Free Elective	Free Elective

[a] Students who place into COMPSCI 201 are not required to take EGR 105L.
[b] AP credit for CHEM 20 or 21 is also acceptable.
[c] See Physics requirements on page 9.
[d] See Liberal Arts requirements on page 10.
[e] See Statistics requirements on page 9 and Table D.3 on page 41 for a list of all currently approved statistics courses.
[f] See ECE Approved Curricular Area Electives requirements on page 11 and Appendix C ECE Approved Curricular Area Elective Courses starting on page 36 for a complete course listing.
[g] ECE Elective: Any ECE course at the 300 level or above.
[h] See ECE Extension Elective requirements on page 12.
[i] See ECE Design Elective requirements on page 12 and Table D.1 on page 41 for a list of all currently approved design elective courses.

Table A.2: ECE Major w/ ML Concentration (matric ≥ Fall 2025)

First Year	
Fall Semester	**Spring Semester**
EGR 101L Engineering Design & Communication	ECE 110L Fundamentals of ECE
EGR 105L Computing for Engineers or COMPSCI 201 Data Structures & Algorithms[a]	WRITING 120
MATH 111L Introductory Calculus I	MATH 112L Introductory Calculus II
CHEM 101DL Core Concepts in Chemistry[b]	PHYSICS 151L Introductory Mechanics[c]
Sophomore Year	
Fall Semester	**Spring Semester**
ECE 280L Signals and Systems	ECE 250D Computer Architecture
COMPSCI 201 Data Structures and Algorithms (if not already taken to replace EGR 105L)	MATH 219 Multivariable Calculus
MATH 218D-2 Matrices and Vectors	PHYSICS 152L Intro Electricity, Magnetism, Optics[c]
Liberal Arts Elective 1[d]	Statistics Elective[e]
Junior Year	
Fall Semester	**Spring Semester**
ECE 230L or ECE 270DL	ECE 270DL or ECE 230L
ECE 480 (Area Elective 1[f]/ML1)	ECE 580 (Area Elective 2[f]/ML2)
MATH 353 Ordinary & Partial Differential Equations	ECE Elective[g]/ML4 or ECE Area Elective 3[f]
Liberal Arts Elective 2[d]	Liberal Arts Elective 3[d]
Free Elective	Free Elective
Senior Year	
Fall Semester	**Spring Semester**
ECE Extension Elective[h]/ML5 or ECE Design Elective[i]	ECE Design Elective[i] or ECE Extension Elective[h]/ML5
ECE Area Elective 3[f] or ECE Elective[g]/ML4	ECE Area Elective 4[f]/ML3
Liberal Arts Elective 4[d]	Liberal Arts Elective 5[d]
Free Elective	Free Elective

[a] Students who place into COMPSCI 201 are not required to take EGR 105L.
[b] AP credit for CHEM 20 or 21 is also acceptable.
[c] See Physics requirements on page 9.
[d] See Liberal Arts requirements on page 10.
[e] See Statistics requirements on page 9 and Table D.3 on page 41 for a list of all currently approved statistics courses.
[f] See ECE Approved Curricular Area Electives requirements on page 11 and Appendix C ECE Approved Curricular Area Elective Courses starting on page 36 for a complete course listing. For the ML Concentration, these should include ECE 480 (ML Requirement 1), ECE 580 (ML Requirement 2), a course satisfying ML Requirement 3, and at least one course *outside* of the SPCC Area
[g] ECE Elective: Any ECE course at the 300 level or above. For the ML Concentration, this should satisfy ML Requirement 4.
[h] See ECE Extension Elective requirements on page 12. For the ML Concentration, this should satisfy ML Requirement 5.
[i] See ECE Design Elective requirements on page 12 and Table D.1 on page 41 for a list of all currently approved design elective courses.

Table A.3: ECE Major w/ Software Engineering Concentration (matric ≥ Fall 2025)

First Year	
Fall Semester	**Spring Semester**
EGR 101L Engineering Design & Communication	ECE 110L Fundamentals of ECE
EGR 105L Computing for Engineers or COMPSCI 201 Data Structures & Algorithms[a]	WRITING 120
MATH 111L Introductory Calculus I	MATH 112L Introductory Calculus II
CHEM 101DL Core Concepts in Chemistry[b]	PHYSICS 151L Introductory Mechanics[c]
Sophomore Year	
Fall Semester	**Spring Semester**
ECE 280L Signals and Systems	ECE 250D Computer Architecture
COMPSCI 201 Data Structures and Algorithms (if not already taken to replace EGR 105L)	MATH 219 Multivariable Calculus
MATH 218D-2 Matrices and Vectors	PHYSICS 152L Intro Electricity, Magnetism, Optics[c]
Liberal Arts Elective 1[d]	Statistics Elective[e]
Junior Year	
Fall Semester	**Spring Semester**
ECE 230L or ECE 270DL	ECE 270DL or ECE 230L
ECE 351 (Area Elective 1[f]/SWE1)	ECE Area Elective 2[f]/SWE2
MATH 353 Ordinary & Partial Differential Equations	ECE Elective[g]/SWE4 or ECE Area Elective 3[f]
Liberal Arts Elective 2[d]	Liberal Arts Elective 3[d]
Free Elective	Free Elective
Senior Year	
Fall Semester	**Spring Semester**
ECE Extension Elective[h]/SWE5 or ECE Design Elective[i]	ECE Design Elective[i] or ECE Extension Elective[h]/SWE5
ECE Area Elective 3[f] or ECE Elective[g]/SWE4	ECE Area Elective 4[f]/SWE3
Liberal Arts Elective 4[d]	Liberal Arts Elective 5[d]
Free Elective	Free Elective

[a] Students who place into COMPSCI 201 are not required to take EGR 105L.
[b] AP credit for CHEM 20 or 21 is also acceptable.
[c] See Physics requirements on page 9.
[d] See Liberal Arts requirements on page 10.
[e] See Statistics requirements on page 9 and Table D.3 on page 41 for a list of all currently approved statistics courses.
[f] See ECE Approved Curricular Area Electives requirements on page 11 and Appendix C ECE Approved Curricular Area Elective Courses starting on page 36 for a complete course listing. For the SWE Concentration, these should include ECE 351 (SWE Requirement 1), an HCI/UX course (SWE Requirement 2), a Systems course (SWE Requirement 3), and at least one course *outside* of the CEDS Area
[g] ECE Elective: Any ECE course at the 300 level or above. For the SWE Concentration, this should satisfy SWE Requirement 4.
[h] See ECE Extension Elective requirements on page 12. For the SWE Concentration, this should satisfy SWE Requirement 5.
[i] See ECE Design Elective requirements on page 12 and Table D.1 on page 41 for a list of all currently approved design elective courses.

Table A.4: ECE Major w/ BME Second Major (matric ≥ Fall 2025)
Note: The ECE Extension Elective, two the ECE Area Electives, and the ECE Design Elective are satisfied by specific BME courses with significant Electrical & Computer Engineering content.

First Year	
Fall Semester	**Spring Semester**
EGR 101L Engineering Design & Communication	BIO 201L Molecular Biology
EGR 105L Computing for Engineers or COMPSCI 201 Data Structures & Algorithms[a]	WRITING 120
MATH 111L Introductory Calculus I	MATH 112L Introductory Calculus II
CHEM 101DL Core Concepts in Chemistry[b]	PHYSICS 151L Introductory Mechanics[c]
Sophomore Year	
Fall Semester	**Spring Semester**
ECE 110L Fundamentals of ECE	ECE 250D Computer Architecture
EGR 201L Mechanics of Solids	ECE 280L Signals & Systems
MATH 218D-2 Matrices and Vectors	MATH 219 Multivariable Calculus
BME 244L Quantitative Physiology	PHYSICS 152L Intro Electricity, Magnetism, Optics[c]
COMPSCI 201 Data Structures and Algorithms (if not already taken to replace EGR 105L)	CHEM 210DL Modern Apps Chem Principles or CHEM 201DL Organic Chemistry
Junior Year	
Fall Semester	**Spring Semester**
ECE 230L or ECE 270DL	ECE 270DL or ECE 230L
ECE Area Elective 1[d]	BME 354L Intro to Medical Instrumentation
BME 221L Biomaterials or ME 221L Structure and Proiperties of Solids	BME 301L Bioelectricity or BME 303 Modern Diagnostic Systems
MATH 353 Ordinary & Partial Differential Equations	Statistics Elective[e]
BME 260L Modeling Cell & Molecular Systems	Liberal Arts Elective 1[f]
Senior Year	
Fall Semester	**Spring Semester**
ECE Elective[g] or ECE Area Elective 2[d]	ECE Area Elective 2[d] or ECE Elective[g]
BME Design: BME 436L or 464L or 473L+474L[h]	BME General Elective[h]
BME Advanced Elective[i]	Liberal Arts Elective 4[f]
Liberal Arts Elective 2[f]	Liberal Arts Elective 5[f]
Liberal Arts Elective 3[f]	

[a] Students who place into COMPSCI 201 are not required to take EGR 105L.
[b] AP credit for CHEM 21 is also acceptable; for students also completing a BME major, CHEM 20 credit is **not**.
[c] See Physics requirements on page 9.
[d] See ECE Approved Curricular Area Electives requirements on page 11 and Appendix C ECE Approved Curricular Area Elective Courses starting on page 36 for a complete course listing. For students also completing a BME major, only two ECE Area Electives are required and they must be from the same area.
[e] See Statistics requirements on page 9 and Table D.3 on page 41 for a list of all currently approved statistics courses.
[f] See Liberal Arts requirements on page 10.
[g] ECE Elective: Any ECE course at the 300 level or above.
[h] BME 473L and 474L comprise a two-course design sequence; students pursuing this option will take BME 473L as a BME General Elective in the fall and BME 474L as a BME Design Elective in the spring.
[i] If BME 301L is taken, the Advanced Elective must be in the Electrobiology (EL) Area of Focus. If BME 303 is taken, the Advanced Elective must be in the Imaging and Measurements (IM) Area of Focus. See the BME Undergraduate Program Handbook for details.

Table A.5: ECE Major w/ COMPSCI Second Major (matric ≥ Fall 2025)
Students are advised to consult with the Computer Science regarding major requirements.

First Year	
Fall Semester	**Spring Semester**
EGR 101L Engineering Design & Communication	ECE 110L Fundamentals of ECE
EGR 105L Computing for Engineers or COMPSCI 201 Data Structures & Algorithms[a]	WRITING 120
MATH 111L Introductory Calculus I	MATH 112L Introductory Calculus II
CHEM 101DL Core Concepts in Chemistry[b]	PHYSICS 151L Introductory Mechanics[c]
Sophomore Year	
Fall Semester	**Spring Semester**
ECE 280L Signals and Systems	ECE 250D Computer Architecture
COMPSCI 201 Data Structures and Algorithms (if not already taken to replace EGR 105L)	MATH 219 Multivariable Calculus
MATH 218D-2 Matrices and Vectors	PHYSICS 152L Intro Electricity, Magnetism, Optics[c]
Liberal Arts Elective 1[d]	Statistics Elective[e]
	Liberal Arts Elective 2[d]
Junior Year	
Fall Semester	**Spring Semester**
ECE 230L or ECE 270DL	ECE 270DL or ECE 230L
COMPSCI Sys. Elective[f] or Elective[g]	COMPSCI Elective[g] or Sys. Elective[f]
MATH 353 Ordinary & Partial Differential Equations	ECE Area Elective 1[h]
Liberal Arts Elective 3[d]	Liberal Arts Elective 4[d]
Senior Year	
Fall Semester	**Spring Semester**
ECE Area Elective 2[h] or ECE Elective[i]	ECE Elective[i] or ECE Area Elective 2[h]
ECE Area Elective 3[h] or ECE Design Elective[j]	ECE Design Elective[j] or ECE Area Elective 3[h]
ECE Extension Elective: COMPSCI 330 Design & Analysis of Algorithms	COMPSCI Elective[g]
ECE Area Elective 4[h] or COMPSCI Elective[g]	COMPSCI Elective[g] or ECE Area Elective 4[h]
Liberal Arts Elective 5[d]	

[a] Students who place into COMPSCI 201 are not required to take EGR 105L.
[b] AP credit for CHEM 20 or 21 is also acceptable.
[c] See Physics requirements on page 9.
[d] See Liberal Arts requirements on page 10.
[e] See Statistics requirements on page 9 and Table D.3 on page 41 for a list of all currently approved statistics courses.
[f] COMPSCI Systems Elective: Selected from one of the approved systems elective courses (consult with Computer Science for current list).
[g] COMPSCI Elective: Any COMPSCI elective at the 200 level or above, except may not be an independent study course. If a COMPSCI course is cross-listed in ECE, the course may satisfy *both* a COMPSCI elective requirement and either an ECE Area Elective (if the ECE course is approved as one) or ECE Elective (if 300-level or higher). The COMPSCI elective then becomes a Free Elective. Enrollment should be under the ECE course number.
[h] See ECE Approved Curricular Area Electives requirements on page 11 and Appendix C ECE Approved Curricular Area Elective Courses starting on page 36 for a complete course listing.
[i] ECE Elective: Any ECE course at the 300 level or above.
[j] See ECE Design Elective requirements on page 12 and Table D.1 on page 41 for a list of all currently approved design elective courses.

Table A.6: ECE Major w/ Physics Second Major (matric ≥ Fall 2025)
Sample based on hybrid of "B.S. Program in Physics started in spring of first year" and "B.S. Program in Physics started as sophomore" from Physics Sample Course Schedules

First Year	
Fall Semester	**Spring Semester**
EGR 101L Engineering Design & Communication	ECE 110L Fundamentals of ECE
EGR 105L Computing for Engineers or COMPSCI 201 Data Structures & Algorithms[a]	WRITING 120
MATH 111L Introductory Calculus I	MATH 112L Introductory Calculus II
CHEM 101DL Core Concepts in Chemistry[b]	PHYSICS 151L Introductory Mechanics[c]
	PHYSICS 164L Intro Experimental Physics I (0.5 cr)
Sophomore Year	
Fall Semester	**Spring Semester**
ECE 280L Signals and Systems	ECE 250D Computer Architecture
COMPSCI 201 Data Structures and Algorithms (if not already taken to replace EGR 105L)	MATH 219 Multivariable Calculus
MATH 218D-2 Matrices and Vectors	PHYSICS 152L Intro Electricity, Magnetism, Optics[c]
Liberal Arts Elective 1[d]	PHYSICS 165L Intro Experimental Physics II (0.5 cr)
	Statistics Elective[e]
Junior Year	
Fall Semester	**Spring Semester**
ECE 230L or ECE 270DL	ECE 270DL or ECE 230L
ECE Area Elective 1[f]	ECE Elective[g]
MATH 353 Ordinary & Partial Differential Equations	ECE Area Elective 2 + PHYSICS Elective 1[f]
Liberal Arts Elective 2[d]	Liberal Arts Elective 3[d]
ECE Extension Elective[h]: PHYSICS 264L: Optics and Modern Physics	PHYSICS 361 Intermediate Mechanics
Senior Year	
Fall Semester	**Spring Semester**
ECE Area Elective 3[f] or ECE Design Elective[i]	ECE Design Elective[i] or ECE Area Elective 3[f]
Liberal Arts Elective 4[d]	ECE Area Elective 4 + PHYSICS Elective 2[f]
PHYSICS 362 Electricity & Magnetism	Liberal Arts Elective 5[d]
PHYSICS 464 Quantum Mechanics I	PHYSICS 363 Thermal Physics
PHYSICS 417S Advanced Lab	

[a] Students who place into COMPSCI 201 are not required to take EGR 105L.
[b] AP credit for CHEM 20 or 21 is also acceptable.
[c] See Physics requirements on page 9.
[d] See Liberal Arts requirements on page 10.
[e] See Statistics requirements on page 9 and Table D.3 on page 41 for a list of all currently approved statistics courses.
[f] See ECE Approved Curricular Area Electives requirements on page 11 and Appendix C ECE Approved Curricular Area Elective Courses starting on page 36 for a complete course listing. For students also completing a physics major, if one or two of the ECE Area Electives are taken from ECE 340L, 523, 621, or 623 (EP area), these cross-listed courses will also satisfy one or two of the PHYSICS Electives; otherwise, additional PHYSICS Electives courses (one 200+, one 300+) must be taken. The ECE Area Electives must still be from at least two areas.
[g] ECE Elective: Any ECE course at the 300 level or above.
[h] See ECE Extension Elective requirements on page 12.
[i] See ECE Design Elective requirements on page 12 and Table D.1 on page 41 for a list of all currently approved design elective courses.

Table A.7: ECE Major w/ Energy Engineering Minor (Option 1) (matric ≥ Fall 2025)
ME 331L as ECE Extension Elective, EGR 424L as ENRGYEGR Capstone

First Year	
Fall Semester	**Spring Semester**
EGR 101L Engineering Design & Communication	ECE 110L Fundamentals of ECE
EGR 105L Computing for Engineers or COMPSCI 201 Data Structures & Algorithms[a]	WRITING 120
MATH 111L Introductory Calculus I	MATH 112L Introductory Calculus II
CHEM 101DL Core Concepts in Chemistry[b]	PHYSICS 151L Introductory Mechanics[c]
Sophomore Year	
Fall Semester	**Spring Semester**
ECE 280L Signals and Systems	ECE 250D Computer Architecture
COMPSCI 201 Data Structures and Algorithms (if not already taken to replace EGR 105L)	MATH 219 Multivariable Calculus
MATH 218D-2 Matrices and Vectors	PHYSICS 152L Intro Electricity, Magnetism, Optics[c]
Liberal Arts Elective 1[d]	Liberal Arts Elective 2[d]
Junior Year	
Fall Semester	**Spring Semester**
ECE 230L or ECE 270DL	ECE 270DL or ECE 230L
ECE Area Elective 1[e]	ECE Elective[f]
MATH 353 Ordinary & Partial Differential Equations	ECE Area Elective 2[e]
ECE Extension Elective[g] ENRGYEGR Elec. 1: ME 331L Thermodynamics	ENRGYEGR Elec. 2
Liberal Arts Elective 3[d]	Statistics Elective[h]
Senior Year	
Fall Semester	**Spring Semester**
ECE Area Elective 3[e] or ECE Design Elective[i]	ECE Design Elective[i] or ECE Area Elective 3[e]
ENRGYEGR Core: ME 461 Energy Egr. & the Environment	ECE Area Elective 4[e]
ENRGYEGR Elec. 3	ENRGYEGR Elec. 4
Bass Connection 395 (0.5cr)	ENRGYEGR Capstone: EGR 424L
Liberal Arts Elective 4[d]	Liberal Arts Elective 5[d]

[a] Students who place into COMPSCI 201 are not required to take EGR 105L.
[b] AP credit for CHEM 20 or 21 is also acceptable.
[c] See Physics requirements on page 9.
[d] See Liberal Arts requirements on page 10.
[e] See ECE Approved Curricular Area Electives requirements on page 11 and Appendix C ECE Approved Curricular Area Elective Courses starting on page 36 for a complete course listing.
[f] ECE Elective: Any ECE course at the 300 level or above.
[g] See ECE Extension Elective requirements on page 12.
[h] See Statistics requirements on page 9 and Table D.3 on page 41 for a list of all currently approved statistics courses.
[i] See ECE Design Elective requirements on page 12 and Table D.1 on page 41 for a list of all currently approved design elective courses.

Table A.8: ECE Major w/ Energy Engineering Minor (Option 2) (matric ≥ Fall 2025)
ECE Design Elective as ENRGYEGR Capstone

First Year	
Fall Semester	**Spring Semester**
EGR 101L Engineering Design & Communication	ECE 110L Fundamentals of ECE
EGR 105L Computing for Engineers or COMPSCI 201 Data Structures & Algorithms[a]	WRITING 120
MATH 111L Introductory Calculus I	MATH 112L Introductory Calculus II
CHEM 101DL Core Concepts in Chemistry[b]	PHYSICS 151L Introductory Mechanics[c]
Sophomore Year	
Fall Semester	**Spring Semester**
ECE 280L Signals and Systems	ECE 250D Computer Architecture
COMPSCI 201 Data Structures and Algorithms (if not already taken to replace EGR 105L)	MATH 219 Multivariable Calculus
MATH 218D-2 Matrices and Vectors	PHYSICS 152L Intro Electricity, Magnetism, Optics[c]
Liberal Arts Elective 1[d]	Liberal Arts Elective 2[d]
Junior Year	
Fall Semester	**Spring Semester**
ECE 230L or ECE 270DL	ECE 270DL or ECE 230L
ECE Area Elective 1[e]	ECE Elective[f]
MATH 353 Ordinary & Partial Differential Equations	ECE Area Elective 2[e]
ENRGYEGR Elec. 1: ME 331L Thermodynamics	ENRGYEGR Elec. 2
Liberal Arts Elective 3[d]	Statistics Elective[g]
Senior Year	
Fall Semester	**Spring Semester**
ECE Area Elective 3[e]	ECE Design Elective[h]
ENRGYEGR Core: ME 461 Energy Egr. & the Environment	ECE Area Elective 4[e]
ENRGYEGR Elec. 3	ENRGYEGR Elec. 4
Liberal Arts Elective 4[d]	Liberal Arts Elective 5[d]
ECE Extension Elective[i]	

[a] Students who place into COMPSCI 201 are not required to take EGR 105L.
[b] AP credit for CHEM 20 or 21 is also acceptable.
[c] See Physics requirements on page 9.
[d] See Liberal Arts requirements on page 10.
[e] See ECE Approved Curricular Area Electives requirements on page 11 and Appendix C ECE Approved Curricular Area Elective Courses starting on page 36 for a complete course listing.
[f] ECE Elective: Any ECE course at the 300 level or above.
[g] See Statistics requirements on page 9 and Table D.3 on page 41 for a list of all currently approved statistics courses.
[h] See ECE Design Elective requirements on page 12 and Table D.1 on page 41 for a list of all currently approved design elective courses.
[i] See ECE Extension Elective requirements on page 12.

Table A.9: ECE Major - Junior Spring semester at the Marine Lab (matric ≥ Fall 2025)

First Year	
Fall Semester	**Spring Semester**
EGR 101L Engineering Design & Communication	ECE 110L Fundamentals of ECE
EGR 105L Computing for Engineers or COMPSCI 201 Data Structures & Algorithms[a]	WRITING 120
MATH 111L Introductory Calculus I	MATH 112L Introductory Calculus II
CHEM 101DL Core Concepts in Chemistry[b]	PHYSICS 151L Introductory Mechanics[c]
Sophomore Year	
Fall Semester	**Spring Semester**
ECE 280L Signals and Systems	ECE 250D Computer Architecture
COMPSCI 201 Data Structures and Algorithms (if not already taken to replace EGR 105L)	MATH 219 Multivariable Calculus
MATH 218D-2 Matrices and Vectors	PHYSICS 152L Intro Electricity, Magnetism, Optics[c]
Liberal Arts Elective 1[d]	Statistics Elective[e]
Free Elective	
Junior Year	
Fall Semester	**Spring Semester**
ECE 230L	ECE Area Elective 2[g]: ECE 461A Ocean Engineering
ECE 270DL	ECE Elective[f]: ECE 366A Drones in Marine Science
ECE Area Elective 1[g]	ECE Extension Elective[h]: ECE 384LA Marine Bioacoustics
MATH 353 Ordinary & Partial Differential Equations	Liberal Arts Elective 3[d]
Liberal Arts Elective 2[d]	
Senior Year	
Fall Semester	**Spring Semester**
ECE Area Elective 3[g] or ECE Design Elective[i]	ECE Design Elective[i] or ECE Area Elective 3[g]
Liberal Arts Elective 4[d]	ECE Area Elective 4[g]
Liberal Arts Elective 5[d]	Free Elective
Free Elective	Free Elective

[a] Students who place into COMPSCI 201 are not required to take EGR 105L.
[b] AP credit for CHEM 20 or 21 is also acceptable.
[c] See Physics requirements on page 9.
[d] See Liberal Arts requirements on page 10.
[e] See Statistics requirements on page 9 and Table D.3 on page 41 for a list of all currently approved statistics courses.
[f] ECE Elective: Any ECE course at the 300 level or above.
[g] See ECE Approved Curricular Area Electives requirements on page 11 and Appendix C ECE Approved Curricular Area Elective Courses starting on page 36 for a complete course listing.
[h] See ECE Extension Elective requirements on page 12.
[i] See ECE Design Elective requirements on page 12 and Table D.1 on page 41 for a list of all currently approved design elective courses.

Appendix B Major-specific Requirements for the Minor in ECE

The basic requirements for a minor in ECE (described in detail on p. 12) include three courses at the foundational/core level and two upper-level courses. Below are major-specific modifications (e.g., courses that are disallowed for the Minor in ECE because students are required to taken essentially equivalent courses for their major).

B.1. ME Major / ECE Minor

The Mechanical Engineering major requires either ECE 224L Electrical Fundamentals of Mechatronics or both of ECE 110L Fundamentals of ECE and ECE 280L Signals & Systems. Depending on which path an ME major takes, the ECE minor looks a little different:

ME Major / ECE Minor: Path #1 - Taking EGR 224L

- ***Core courses:*** Take a minimum of one and up to three of the following core courses[a]:
  - ECE 230L Microelectronic Devices & Circuits
  - ECE 250D Computer Architecture
  - ECE 270DL Fields & Waves
- ***Upper-level courses:*** Take a minimum of two upper-level (300+) courses[b]. Students may also choose to replace up to two (out of three) ECE core courses with additional upper-level ECE courses to meet the minimum requirement of 5 ECE courses.

[a] An ME major who has taken EGR 224L cannot take ECE 110L or ECE 280L; however, EGR 224L will satisfy prerequisites for ECE classes in lieu of ECE 110L and ECE 280L.

[b] Because the ME major requires a course essentially equivalent to ECE 110L and ECE 280L, a student majoring in ME who has taken EGR 224L can choose to reduce the number of ECE core courses taken to fulfill ECE Minor requirements to as few as one and take additional upper-level courses to meet the minimum requirement of 5 ECE courses.

ME Major / ECE Minor: Path #2 - Taking ECE 110L and ECE 280L

- If a student has taken ECE 110L and ECE 280L, but plans on majoring in Mechanical Engineering, ECE will allow ECE 110L to count for an ECE minor and ME will allow ECE 280L to count for EGR 224L[a].
- ***Core courses:*** Take a minimum of two and up to three of the following core courses:
  - ECE 110L Fundamentals of ECE
  - ECE 230L Microelectronic Devices & Circuits
  - ECE 250D Computer Architecture
  - ECE 270DL Fields & Waves
- ***Upper-level courses:*** Take a minimum of two upper-level (300+) courses[b]. Students may also choose to replace up to one (out of three) ECE core courses with additional upper-level ECE courses to meet the minimum requirement of 5 ECE courses.

[a] An ME major who has taken ECE 110L cannot take EGR 224L; however, ECE 110L and ECE 280L together will satisfy prerequisites for ME classes in lieu of EGR 224L.

[b] Because the ME major requires courses essentially equivalent to ECE 110L and ECE 280L, a student majoring in ME who has taken ECE 110L and ECE 280L can choose to reduce the number of ECE core courses taken to fulfill ECE Minor requirements to as few as two and take additional upper-level courses to meet the minimum requirement of 5 ECE courses.

B.2. BME Major/ECE Minor

The Biomedical Engineering major requires ECE 110L Fundamentals of ECE and either ECE 280L Signals & Systems or BME 271L Signals & Systems.

BME Major / ECE Minor:

- ***Core courses:*** Take a minimum of one and up to three of the following core courses[a][b]:
  - ECE 230L Microelectronic Devices & Circuits
  - ECE 250D Computer Architecture
  - ECE 270DL Fields & Waves
- ***Upper-level courses:*** Take a minimum of two upper-level (300+) courses[c]. Students may also choose to replace up to two (out of three) ECE core courses with additional upper-level ECE courses to meet the minimum requirement of 5 ECE courses.

[a] ECE 110L cannot count toward the ECE minor (ECE 110L is required for BME major)
[b] ECE 280L cannot count toward the ECE minor (ECE 280L or BME 271L is required for the BME major)
[c] Because the BME major requires ECE 110L and ECE 280L or their equivalents, a student majoring in BME can choose to reduce the number of ECE core courses taken to fulfill ECE Minor requirements to as few as one and take additional upper-level courses to meet the minimum requirement of 5 ECE courses.

B.3. Computer Science Major/ECE Minor

The Computer Science major requires ECE 250D Computer Architecture or its equivalent.

Computer Science Major / ECE Minor:

- ***Core courses:*** Take a minimum of two and up to three of the following core courses[a]:
  - ECE 110L Fundamentals of ECE
  - ECE 230L Microelectronic Devices & Circuits
  - ECE 270DL Fields & Waves
  - ECE 280L Signals & Systems
- ***Upper-level courses:*** Take a minimum of two upper-level (300+) courses[b]. Students may also choose to replace up to one (out of three) ECE core courses with additional upper-level ECE courses to meet the minimum requirement of 5 ECE courses.

[a] ECE 250D cannot count towards the ECE Minor (COMPSCI 250D is equivalent)
[b] Because the Computer Science major requiresCOMPSCI 210 or COMPSCI 250D, a student majoring in Computer Science can choose to reduce the number of ECE core courses taken to fulfill ECE Minor requirements to as few as two and take additional upper-level courses to meet the minimum requirement of 5 ECE courses.

B.4. Physics Major/ECE Minor

The Physics major requires a course with significant overlap with ECE 270 DL Fields & Waves.

Physics Major / ECE Minor:

- ***Core courses:*** Take a minimum of two and up to three of the following core courses[a]:
  - ECE 110L Fundamentals of ECE
  - ECE 230L Microelectronic Devices & Circuits
  - ECE 250D Computer Architecture
  - ECE 280L Signals & Systems
- ***Upper-level courses:*** Take a minimum of two upper-level (300+) courses[b]. Students may also choose to replace up to two (out of three) ECE core courses with additional upper-level ECE courses to meet the minimum requirement of 5 ECE courses.

[a] ECE 270DL cannot count toward the ECE minor due to a substantially equivalent requirement for the Physics major.

[b] Because the Physics major requires a course with significant overlap with ECE 270DL, a student majoring in Physics can choose to reduce the number of ECE core courses taken to fulfill ECE Minor requirements to as few as two and take additional upper-level courses to meet the minimum requirement of 5 ECE courses.

Appendix C ECE Approved Curricular Area Elective Courses

C.1. Computer Engineering and Digital Systems

The discipline concerned with the operation and design of computers and computer-based systems. Although analog computers, in which electrical signals directly represent physical quantities, were historically important in the development of modern computers (and continue to be used in some systems), digital computers are predominant and are the primary focus of the computer engineering in the ECE department in the Pratt School. The Computer Engineering and Digital Systems curriculum begins with a core course in computer architecture (ECE 250D). Students can then study logic design, computer networking, VLSI chip design, and other advanced topics. Computer engineering interfaces strongly with many other areas of electrical engineering (electronics, electromagnetics, signal processing, and control theory) as well as with computer science.

Table C.1: Approved Computer Engineering and Digital Systems Area Courses

- ECE 350L Digital Systems [ECE 250D & COMPSCI 201]
- ECE 351 Software Engineering [COMPSCI 201] (ECE 495/496 version before Fall of 2025 also counts)
- ECE 353 Intro to Operating Systems (C/L COMPSCI 310) [ECE 250D or COMPSCI 250D]
- ECE 356 Computer Network Architecture [ECE 250D or COMPSCI 250D]
- ECE 459 Introduction to Embedded System [ECE 330L or ECE 331L or ECE 350L]
- ECE 536 Synthesis & Verification of VLSI Systems [ECE 350L]
- ECE 538 VLSI System Testing [ECE 350L]
- ECE 539 Full Custom VLSI Design [ECE 350L and ECE 331L]
- ECE 552 Advanced Computer Architecture I [ECE 250D or COMPSCI 250D]
- ECE 553 Compiler Construction [ECE 250D or COMPSCI 250D]
- ECE 554 Fault-Tolerant and Testable Computer Systems [ECE 250D or COMPSCI 250D]
- ECE 555 Probability for Electrical and Computer Engineers [MATH 216]
- ECE 556 Wireless Networking and Mobile Computing [ECE 356 or COMPSCI 310]
- ECE 557 Computer Architecture and Hardware Acceleration [(COMPSCI 250D/ECE 250 or COMPSCI 550/ECE 552) and (COMPSCI 350/ECE 350 or ECE 550)]
- ECE 558 Computer Networks and Distributed Systems (C/L COMPSCI 514)
- ECE 559 Advanced Digital System Design [co-req ECE 331L and pre-req 350L]
- ECE 560 Computer & Information Security [COMPSCI 310/ECE 353]
- ECE 564 Mobile Application Development [COMPSCI 307D or COMPSCI 308 or ECE 651]
- ECE 565 Performance Optimization and Parallelism [ECE 250D and COMPSCI 310 and ECE 552]
- ECE 566 Enterprise Storage Architecture [COMPSCI 310/ECE 353]
- ECE 567 Cyberphysical System Design [ECE 350L and ECE 353/COMPSCI 310]
- ECE 590 Cyberphysical System Formal Methods (S17) [ECE 350L and ECE 353/COMPSCI 310]
- ECE 590 Emerging Memory and Computer Architecture (F17, S19) [ECE 250D]
- ECE 590 Cross-Platform Mobile App. Programming (F24,F25) [CS 307D or CS 308 or ECE 651]
- ECE 590 Conventional & Emerging Memory Systems (S20)
- ECE 652 Advanced Computer Architecture II [ECE 552 or COMPSCI 550]
- ECE 653 Human-Centered Computing (F) [COMPSCI 307D or COMPSCI 308 or ECE 651]
- ECE 654 Edge Computing [ECE/CS 350L or ECE/CS 356 or CS 310/ECE 353]
- ECE 655 Full-Stack IoT Systems [ECE 250D or COMPSCI 250D] (ECE 495/496/590 version before Spring of 2025 also counts)
- ECE 657 Usable Security and Privacy [Recommended: COMPSCI 201]
- ECE 661 Computer Engineering Machine Learning and Deep Neural Networks [CS 201]
- ECE 663 Machine Learning in Adversarial Settings [ECE 580 or ECE 687D or COMPSCI 371]

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C.2. Signal Processing, Communications, and Control Systems

The disciplines concerned with representing, storing, interpreting, and transmitting information in systems of finite capacity in the presence of interference and noise; with extracting information from speech, image, video, radar, sonar, and medical data signals; and with using information, including feedback information comparing actual and desired system states, for controlling, shaping and stabilizing system performance in the presence of noise, delay, and inertia. Applications include telecommunications, intra- and inter-system communications, remote sensing, imaging, robotics, feed-back stabilized electronics, and the control of electro-mechanical systems, both large and small.

Table C.2: Approved Signal Processing, Communications, and Control Systems Area Courses

- ECE 381 Fundamentals of Digital Signal Processing [ECE 280L]
- ECE 382L Linear Control Systems [ECE 280L]
- ECE 383 Introduction to Robotics and Automation [ECE 280L or ME 224L] ECE 480 Applied Probability for Statistical Learning [Math 216 or Math 218D-2, and statistics]
- ECE 483 Introduction to Digital Communication Systems [ECE 280L and statistics]
- ECE 485 Digital Audio and Acoustic Signal Processing [ECE 280L and statistics]
- ECE 488 Digital Image and Multidimensional Signal [ECE 280L and statistics]
- ECE 495 Intro to Natural Language Processing (F24) [Math 218D-2 and (EGR 103L or EGR 105L or COMPSCI 201) and statistics]
- ECE 580 Introduction to Machine Learning [(Math 216 or Math 218D-2) and CS 201 and ECE 480]
- ECE 588 Image and Video Processing [ECE 280L and (Math 216 or Math 218D-2) and statistics]
- ECE 590 The Fourier Transform and Applications (S23, S25) [ECE 280L or ECE 270DL]
- ECE 661 Computer Engineering Machine Learning and Deep Neural Networks [CS 201]
- ECE 681 Pattern Class & Recognition Tech [ECE 280L and (Math 216 or 218D-2) and statistics]
- ECE 682D Probabilistic Machine Learning [(Math 216 or Math 218D-2) and (Stat 250 or Stat 611)]
- ECE 684 Natural Language Processing [ECE 480 or ECE 580 or ECE 581 or ECE 682D]
- ECE 685D Introduction to Deep Learning [ECE 580 or ECE 681 or ECE 682D/STA 561D/CS 571D]
- ECE 687D Theory & Algorithms for Machine Learning [ECE 580 or ECE 681 or ECE 682D/STA 561D/CS 571D]

C.3. Solid-State Devices and Integrated Circuits

This area is concerned with the properties and manufacture of building-block devices (diodes, transistors, lasers) used in integrated circuits to build electronic and photonic systems. Example applications include: digital computer components (CPUs, RAM, GPUs), telecommunications equipment components (parts essential for cell phones, digital switches, wifi routers), and displays, which underlie a large array of consumer products (televisions, tablets, touch-screen systems). It also encompasses the burgeoning field of microelectromechanical, micromechanical and microfluidic devices made possible by the fabrication techniques underlying integrated circuit manufacture.

Table C.3: Approved Solid-State Devices and Integrated Circuits Area Courses

- ECE 330L Microelectronic Devices [ECE 230L]
- ECE 331L Fundamentals of Microelectronic Circuits [ECE 230L]
- ECE 431 Power Electronic Circuits for Energy Conversion [ECE 230L or EGR 224L]
- ECE 461/461A Ocean Engineering [ECE 230L or ECE 250D or ECE 270DL or ECE 280L]
- ECE 511 Foundations of Nanoscale Science & Technology [Physics 152L & Chem 101DL]
- ECE 512 Emerging Nanoelectronic Devices [ECE 230L]
- ECE 516 Thin-Film Photovoltaic Technology [Recommended: ECE 230]
- ECE 524 Introduction to Solid State Physics [ECE 521 or Phys 264L]
- ECE 526 Devices for Integrated Circuit [ECE 230L]
- ECE 527 Analog Integrated Circuits [ECE 526]
- ECE 528 Nanoscale Integrated Circuit Chip Technology [ECE 230L and Chem 101DL]
- ECE 529 Digital Integrated Circuits [ECE 331L]
- ECE 532 Analog Integrated Circuit Design [ECE 330L or ECE 331L]
- ECE 539 Full Custom VLSI Design [ECE 350L and ECE 331L]

C.4. Engineering Physics

The discipline concerned with the underlying laws of nature (specifically those governing electromagnetic, optical, and quantum phenomena) and how those laws can be applied. Application areas for electromagnetics, optics, and quantum mechanics are extremely broad and include communication systems, radar, radio astronomy, transmission lines, waveguides, optical fibers, cameras, remote sensing, quantum-based communication encryption, and quantum computing.

Table C.4: Approved Engineering Physics Area Courses

- ECE 340L Optics and Photonics [ECE 270DL]
- ECE 370D Intermediate Electromagnetic Theory [ECE 270DL]
- ECE 420/520 (Grad) Intro to Quantum Engineering [ECE 270DL and ECE 280L and Math 218D-2]
- ECE 521 Quantum Mechanics [Math 216 or Math 218D-2]
- ECE 522 Quantum Engineering with Atoms [ECE 521 or PHY 464] (course taught as ECE 590 S23 also counts)
- ECE 523 Quantum Computing [ECE 521 or PHYSICS 464]
- ECE 524 Introduction to Solid State Physics [ECE 521 or PHYSICS 264L]
- ECE 541 Advanced Optics [ECE 340L]
- ECE 542 Holography and Coherent Imaging [ECE 270DL]
- ECE 543 Statistical Optics [ECE 270DL]
- ECE 571 Electromagnetic Theory [ECE 270DL]
- ECE 572 Electromagnetic Communication Systems [ECE 270DL]
- ECE 574 Waves in Matter [ECE 270DL]
- ECE 575 Microwave Electronic Circuits [ECE 270DL]
- ECE 577 Computational Electromagnetics [ECE 270DL]
- ECE 621 Quantum Error Correction [ECE 420 or ECE 520 or ECE 523]
- ECE 623 Quantum Information Theory [ECE 521 or PHYSICS 464 or (MATH 216 or 218D-2)]

C.5. Photonics

The discipline concerned with the application of optical and optoelectronic technologies in information science. Photonic applications include information transmission on fiber and free space networks, data storage on disks and volume media, visible and infrared imaging systems, and displays. The Duke photonics program emphasizes hands-on experience with optical systems in communications, sensing, and display applications. Photonic engineering at Duke spans experiences as diverse as logical layer analysis of network protocols over fiber systems, analysis and testing of fiber dispersion, materials studies for optical memory, design of 3D microscopes for biomedical imaging, testing of liquid crystal materials and interfaces, analysis and construction of quantum dynamic systems, and explorations of laser-material and laser-tissue interactions.

Table C.5: Approved Photonics Area Courses

- ECE 340L Optics & Photonics [ECE 270DL]
- ECE 341L Solar Cells [PHYSICS 152L or equivalent]
- ECE 449 Sensors and Sensor Interface Design [ECE core courses and one of (ECE 330L or ECE 331L or ECE 340L or ECE 350L)]
- ECE 523 Quantum Computing [ECE 521 or PHYSICS 464]
- ECE 545 Foundations of Nanoelectronics and Nanophotonics [ECE 230L and ECE 270DL]
- ECE 546 Optoelectronic Devices for Optical Fiber Network [ECE 526]

Appendix D Approved ECE Design, Natural Science, and Statistics Electives

Table D.1: Approved ECE Design Electives

- ECE 449 Sensors and Sensor Interface Design (prior to 2024, typically offered in the Spring; offered Fall 2024 and 2025 and not Spring 2024, 2025, or 2026)
- ECE 458 Engineering Software for Maintainability (typically offered in the Spring)
- ECE 459 Embedded Systems Design (typically offered in the Fall)
- ECE 469 Wearable & Ubiquitous Computing Systems Design (typically offered in Spring)
- ECE 487 System Design for Machine Learning & Signal Processing (typically offered Sp)
- ECE 532 Analog Integrated Circuit Design (typically offered in the Spring)
- ECE 539 CMOS VLSI Design Methodologies (typically offered in the Fall)

Table D.2: Approved 200-level ECE Extension Electives
AP credits may not be used to satisfy this requirement.

- BIOLOGY 201L Gateway to Biology: Molecular Biology
- BIOLOGY 202L Gateway to Biology: Genetics and Evolution
- BIOLOGY 203L Molecular Biology, Genetics, and Evolution (not offered as of Spring 2025)
- BIOLOGY 275A Biology for Engineers: Informing Engineering Decisions
- Chemistry 201DL Organic Chemistry I
- Chemistry 202DL Organic Chemistry II
- Chemistry 210DL Modern Applications of Chemical Principles
- Physics 264L Optics and Modern Physics

Table D.3: Approved ECE Statistics Courses

- STA 240L Probability for Statistical Inference, Modeling, and Data Analysis
- MATH 230 Probability
- MATH 231 Algorithmic Introduction to Probability
- MATH 340 Advanced Introduction to Probability
- EGR 238L Data and Decision Science (not offered since Spring 2022)
- ECE 380 Introduction to Random Signals and Noise[a]
- ECE 555 Probability for Electrical and Computer Engineers[b]

[a] If ECE 380 is elected, it may not be double-counted as an ECE Elective.
[b] If ECE 555 is elected, it may not be double-counted as an ECE Approved Curricular Area Elective or ECE Elective.