ELECTRICAL ENGINEERING

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Electrical Engineering broadly encompasses disciplines such as microelectronics, photonics, computer engineering, signal processing, control systems, and communications. Three degree programs are offered that allow students to select the level of technical depth appropriate for individual goals. The B.S. in Electrical Engineering, accredited by the Engineering Accreditation Commission of ABET, Inc., is appropriate for highly motivated students who are interested in learning the scientific fundamentals and the technologies and creative processes of contemporary electrical engineering. The B.S. in Engineering Sciences (Electrical) provides similar technical exposure while retaining academic options outside the electrical engineering core area. The B.A. in Engineering Sciences (Electrical) is suitable for a career outside technology, in which a student nevertheless benefits from an appreciation of electrical engineering perspectives.

The program’s educational objectives prepare students for four potential paths. An academic path qualifies graduates to enter a top-tier graduate program conducting research with broad applications or significant consequences, and eventually to teach at an academic or research institution. Graduates following an industrial path can enter a managerial or policy-making position that provides significant value to a company. An entrepreneurial path allows graduates to bring broad knowledge to a startup company, which can deliver a device that meets societal needs. Graduates who elect a nontraditional engineering path might complete a professional program such as business, law, or medicine, to which their engineering knowledge can be applied.

PREREQUISITES

All three degree programs require MATH 112, 115, ENAS 151 or MATH 120 or higher, ENAS 130, and PHYS 180, 181 or higher (PHYS 170, 171 is acceptable for the B.A. degree). Acceleration credits awarded on entrance can be used to satisfy the MATH 112 and 115 requirements. Students whose preparation exceeds the level of ENAS 151 or MATH 120 are asked to take a higher-level mathematics course instead, such as MATH 250. Similarly, students whose preparation at entrance exceeds the level of PHYS 180, 181 are asked to take higher-level physics courses instead, such as PHYS 200, 201. Students whose programming skills exceed the level of ENAS 130 are asked to take a more advanced programming course instead, such as CPSC 201; consult with the director of undergraduate studies.

REQUIREMENTS OF THE MAJOR

Because the introductory courses are common to all three degree programs, students do not usually need to make a final choice before the junior year. An interdepartmental program with Computer Science (http://catalog.yale.edu/ycps/subjects-of-instruction/electrical-engineering-computer-science) is also offered, and students can pursue interdisciplinary studies in other areas of engineering and science. Each student’s program must be approved by the DUS.

B.S. degree program in Electrical Engineering The ABET-accredited B.S. in Electrical Engineering requires, beyond the prerequisites, four term courses in mathematics and science and thirteen term courses in topics in engineering. These courses include:

1. Mathematics and basic science (four term courses): ENAS 194; MATH 222 or 225; APHY 322 or equivalent; S&DS 238, S&DS 241, or equivalent.
2. Electrical engineering and related subjects (thirteen term courses): EENG 200, 201, 202, 203, 310, 320, 325, 348, 481 (the senior project); and four engineering electives, at least three of which should be at the 400 level. MENG 390, CPSC 365, and all 400-level Computer Science courses qualify as ABET electives.

For students who have taken the equivalent of one year of calculus in high school, a typical ABET-accredited B.S. program might include:

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<tr>
<th>First-Year</th>
<th>Sophomore</th>
<th>Junior</th>
<th>Senior</th>
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<tbody>
<tr>
<td>EENG 200</td>
<td>EENG 202</td>
<td>APHY 322</td>
<td>EENG 481</td>
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<tr>
<td>EENG 201</td>
<td>EENG 203</td>
<td>EENG 310</td>
<td>Four electives</td>
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<tr>
<td>ENAS 151 or MATH 120</td>
<td>ENAS 130</td>
<td>EENG 320</td>
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<tr>
<td>MATH 222</td>
<td>ENAS 194</td>
<td>EENG 335</td>
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<td>PHYS 180</td>
<td>S&amp;DS 241</td>
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<td>PHYS 181</td>
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The introductory engineering courses are designed such that they may be taken concurrently in the sophomore year; for example, in the fall term students may take EENG 200 and EENG 202, followed by EENG 201 and EENG 203 in the spring term. These courses may be taken in any order, with the exception of EENG 203, which requires EENG 200 as a prerequisite.

B.S. degree program in Engineering Sciences (Electrical) This program requires fewer technical courses and allows more freedom for work in technical areas outside the traditional electrical engineering disciplines (e.g., economics or cognitive psychology). It requires thirteen technical term courses beyond the prerequisites, specifically: MATH 222 or 225; ENAS 194; EENG 200, 201, 202, 203; EENG 471
or 472, or, with permission of the director of undergraduate studies, 481 (the senior project); and six electives approved by the DUS, at least three of which must be at the 400 level.

For students who have taken the equivalent of one year of calculus in high school, a typical program for this degree might include:

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<tr>
<th>First-Year</th>
<th>Sophomore</th>
<th>Junior</th>
<th>Senior</th>
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<tbody>
<tr>
<td>EENG 200</td>
<td>EENG 202</td>
<td>Three electives</td>
<td>EENG 471 or 472</td>
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<tr>
<td>EENG 201</td>
<td>EENG 203</td>
<td></td>
<td>Three electives</td>
</tr>
<tr>
<td>ENAS 151 or MATH 120</td>
<td>ENAS 130</td>
<td></td>
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</tr>
<tr>
<td>MATH 222</td>
<td>ENAS 194</td>
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<td>PHYS 180</td>
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<tr>
<td>PHYS 181</td>
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</table>

As with the ABET degree, the introductory engineering courses may be taken concurrently in the sophomore year; for example, in the fall term students may take EENG 200 and EENG 202, followed by EENG 201 and EENG 203 in the spring term. These courses may be taken in any order, with the exception of EENG 203, which requires EENG 200 as a prerequisite.

The implied flexibility during the junior and senior years in the schedule above is often used to accommodate a second major, such as Economics (http://catalog.yale.edu/ycps/subjects-of-instruction/economics), or to master a related technical area, such as Applied Physics (http://catalog.yale.edu/ycps/subjects-of-instruction/applied-physics) or Computer Science (http://catalog.yale.edu/ycps/subjects-of-instruction/computer-science).

**B.A. degree program in Engineering Sciences (Electrical)** This program is appropriate for those planning a career in fields such as business, law, or medicine where scientific and technical knowledge is likely to be useful. It requires eight technical term courses beyond the prerequisites, specifically: MATH 222 or 225, or ENAS 194; EENG 200, 201, 202, and 471 or 472 (the senior requirement); and three approved electives.

**Credit/D/Fail** Courses taken Credit/D/Fail may not be counted toward the requirements of the major.

**SENIOR REQUIREMENT**

A research or design project carried out in the senior year is required in all three programs. The student must take EENG 471, 472, or 481, present a written report, and make an oral presentation. Arrangements to undertake a project in fulfillment of the senior requirement must be made by the end of the shopping period in the term in which the student will enroll in the course; by this date, a prospectus approved by the intended faculty adviser and the DUS must be submitted.

**ADVISING AND APPROVAL OF PROGRAMS**

All Electrical Engineering and Engineering Sciences majors must have their programs approved by the DUS. Arrangements to take EENG 471, 472, or 481 are strongly suggested to be made during the term preceding enrollment in the course. Independent research courses taken before the senior year are graded on a Pass/Fail basis but may be counted toward the requirements of the major.

**REQUIREMENTS OF THE MAJOR**

**ELECTRICAL ENGINEERING, B.S.**

**Prerequisites** MATH 112, 115; ENAS 151 or MATH 120 or higher; ENAS 130; PHYS 180, 181 or higher

**Number of courses** 17 term courses beyond prereqs, incl senior req

**Specific courses required** ENAS 194; MATH 222 or 225; APHY 322; S&DS 238 or S&DS 241; EENG 200, 201, 202, 203, 310, 320, 325, 348

**Distribution of courses** 4 engineering electives, 3 at 400 level

**Senior requirement** One-term design project (EENG 481)

**ENGINEERING SCIENCES (ELECTRICAL), B.S. AND B.A.**

**Prerequisites** Both degrees – MATH 112, 115; ENAS 151 or MATH 120 or higher; ENAS 130; B.S. – PHYS 180, 181 or higher; B.A. – PHYS 170, 171 or higher

**Number of courses** B.S. – 13 term courses beyond prereqs, incl senior req; B.A. – 8 term courses beyond prereqs, incl senior req

**Specific courses required** B.S. – ENAS 194; MATH 222 or 225; EENG 200, 201, 202, 203; B.A. – 1 from ENAS 194 or MATH 222 or 225; EENG 200, 201, 202

**Distribution of courses** B.S. – 6 electives approved by DUS, 3 at 400 level; B.A. – 3 electives approved by DUS

**Senior requirement** B.S. – one-term research or design project (EENG 471 or 472 or, with permission of DUS, 481); B.A. – one-term research or design project (EENG 471 or 472)

**FACULTY OF THE DEPARTMENT OF ELECTRICAL ENGINEERING**

**Professors** James Duncan, Jung Han, Roman Kuc, Tsao-Ping Ma, Rajit Manohar, A. Stephen Morse, Kumpati Narendra, Daniel Prober, Mark Reed, Peter Schultheiss (Emeritus), Lawrence Staib, Hemant Taqare, Hongxing Tang, Leandros Tassiulas, J. Rimas Vaišnys, Y. Richard Yang
Associate Professors  Richard Lethin (Adjunct), Sekhar Tatikonda, Fengnian Xia
Assistant Professors  Wenjun Hu, Amin Karbasi, Jakub Szefer