The concentration in Engineering equips students with a solid foundation for careers in engineering, to advance the knowledge base for future technologies, and to merge teaching, scholarship, and practice in the pursuit of solutions to human needs. The concentration offers one standard Bachelor of Arts (A.B.) program and nine Bachelor of Science (Sc.B.) degree program tracks. Of these, Sc.B. programs in biomedical, chemical and biochemical, computer, electrical, materials, and mechanical engineering are accredited by the Engineering Accreditation Commission of ABET (http://www.abet.org). Sc.B. degree programs in environmental engineering and engineering physics are also offered, but they are not accredited by ABET. (Note: Students interested in structural engineering entering in the class of 2017 and beyond may pursue a Structures track within the Mechanical Engineering program). Other programs leading to the Sc.B. or A.B. degrees in Engineering may be designed in consultation with a faculty advisor. These programs must meet the general requirements for concentration programs in the School of Engineering. Students interested in an individualized program should consult with an Engineering faculty member willing to serve as an advisor and obtain the approval of the Engineering Concentration Committee. Engineering students with a particular interest in using their technical skills for the public benefit might also consider the Engaged Scholars Program (https://www.brown.edu/academics/engineering/undergraduate-study/engaged-scholars-program).

Please note that all student concentration forms must be approved by the Engineering Concentration Committee, which reviews them for compliance with all relevant program and accreditation requirements.

Mathematics
Mathematics 0190, 0200 is the preferred sequence of courses to be taken in the freshman year. Students who would prefer a more introductory level calculus course may start in MATH 0100 and take MATH 0200 or MATH 0180 in second semester. Students without one year of secondary school level mathematics should start in MATH 0090, MATH 0100 in their first year, and should begin their sequence of engineering courses with ENGN 0030 in sophomore year. The courses APMA 0330 & APMA 0340 (Methods of Applied Math I, II) can be taken in the sophomore year as well.

Advanced Placement
Students who have taken Advanced Placement courses in high school and/or have shown proficiency through advanced placement examinations are often able to start at a higher level than suggested by the standard programs below. However, please note that Advanced Placement credit cannot be used to satisfy any concentration requirements. For example, our Sc.B. programs specify that students must take 4 semesters of math while enrolled here at Brown, beginning with MATH 0190 or MATH 0170. If a student comes in with advanced placement credit (e.g., placing out of MATH 0190 or MATH 0200), he/she is strongly recommended to take a higher level math course as a replacement. Examples of such courses are MATH 0520 (Linear Algebra), MATH 1260 (Complex Analysis), MATH 1610 (Probability), MATH 1620 (Statistics), APMA 1170 (Numerical Analysis), APMA 1210 (Operations Research), or APMA 1650 (Statistical Inference). However, the student with advanced placement should consult with MATH 0190 or MATH 0200 also has the option of replacing the math course with an advanced-level science course, subject to the approval of the concentration advisor.

Transfer Credit
Students who have successfully completed college courses elsewhere may apply to the University for transfer credit. (See the “Study Elsewhere” section of the University Bulletin for procedures, or contact the Dean of the College.) Transfer courses that are used to meet Engineering concentration requirements must be approved by the student’s concentration advisor, and must be described briefly on the student’s electronic concentration form. Transfer courses that are determined by the concentration advisor to be substantially equivalent to a required Brown course automatically fulfill concentration requirements. In rare cases, students may petition the concentration committee to use courses that do not have an equivalent offered at Brown to meet a concentration requirement. Substitutions of this nature can only be approved if the student’s overall program meets published educational outcomes for the concentration and has sufficient basic science, mathematics, and engineering topics courses to meet relevant accreditation requirements. Students should consult their concentration advisor for assistance with drafting a petition. The decision whether to award concentration credit is made by majority vote of the Engineering Concentration Committee.

Substitutions for Required Courses
A student may petition the Concentration Adviser to substitute a course in place of a requirement. Such substitutions can only be approved if the student’s modified program continues to meet the published educational outcomes for the concentration, and has sufficient basic science, mathematics, and engineering topics courses to meet accreditation requirements. If the substitution involves taking an equal or higher level course in substantially the same area, whether at Brown or elsewhere, it can be approved by the Concentration Adviser. (For courses taken elsewhere, the credit must be officially transferred.) Students wishing to make substitutions of a broader nature should consult their Concentration Adviser for assistance with drafting their petition to the Engineering Concentration Committee, which may be approved by a majority vote.

Standard Program for the A.B. degree:
Candidates for the Bachelor of Arts (A.B.) degree with a concentration in Engineering must complete at least eight approved Engineering courses. The eight courses must include at least two 1000-level Engineering courses. Of these 1000-level courses, one must be a design or independent study course and the other an in-classroom experience. The set of Engineering courses must be chosen with careful attention to the prerequisites of the 1000-level courses. Please note that this A.B. degree program is not accredited by ABET.

Not all engineering courses may be used to satisfy the engineering course requirement for the A.B. degree. For example, the following courses cannot be used to satisfy the engineering course requirement for the A.B. degree: ENGN 0020, ENGN 0090, ENGN 0900, ENGN 0900A, ENGN 0930C, ENGN 1010. Therefore, the program of study must be developed through consultation with the concentration advisor. The A.B. program also requires preparation in Mathematics equivalent to MATH 0200 and APMA 0330, as well as at least one college-level science course from the general areas of chemistry, life sciences, physics, or geological sciences. Remedial courses, such as CHEM 0100, cannot be used to satisfy this requirement. A programming course is also recommended, but not required. The entire program is subject to approval by an Engineering Concentration Advisor and the Chair of the Engineering Concentration Committee.

Standard programs for the Sc.B. degree:
All Bachelor of Science (Sc.B.) program tracks build upon a common core of engineering knowledge and skills applicable across all engineering disciplines. The goal of this engineering core curriculum is to prepare to practice engineering in an age of rapidly changing technology. Two-thirds of this four-year program consists of a core of basic mathematics, physical sciences and engineering sciences common to all branches of engineering, including a thorough grounding in programming and technical problem solving. This core provides our graduates with the basis of theory, design, and analysis that will enable them to adapt to whatever may come along during their careers.

At the same time, the core courses assist students in making informed choices in determining their areas of specialization, at the end of their sophomore year. To this end, first-year students are given an introduction to engineering - featuring case studies from different disciplines in engineering as well as guest speakers from industry. This aspect of the program is different from that at many other schools where students are expected to select a specific branch of engineering much earlier in their academic program.

In addition, all Sc.B. programs in Engineering must be complemented by at least four courses in humanities and social sciences. The minimum
The student outcomes of this program are the ABET (a) - (k) Student in an ethical, safe, sustainable, and environmentally responsible manner. Professionals and audiences of diverse backgrounds, and to pursue problems; (3) to communicate effectively, both orally and in writing, to a broad range of complex, multidisciplinary technological and societal engineering, problem-solving skills, and critical and independent thinking to a broad range of projects that can produce the technical innovations aimed at satisfying the future needs of society. The student outcomes of this program are the ABET (a) - (k) Student Outcomes as defined by the "ABET Criteria for Accrediting Engineering Programs" (available online at http://www.abet.org/accreditation-criteria-policies-documents/).

Special Concentrations

In addition to the standard programs described above, students may also petition the Engineering Concentration Committee to pursue a special engineering Sc.B. degree of their own design. Such special Sc.B. programs are not ABET-accredited. Students with a special concentration will receive an Sc.B. degree in engineering, but a specific area of specialization will not be noted on their transcript. A special Sc.B. concentration is intended to prepare graduates for advanced study in engineering or for professional practice, but in an area that is not covered by one of the existing Sc.B. programs. Accordingly, special concentration programs are expected to consist of a coherent set of courses with breadth, depth and rigor comparable to an accredited degree. A total of 21 engineering, mathematics, and basic science courses are required.

The program must include at least 3 courses in mathematics, at least 2 courses in physical or life sciences; and at least 12 courses in engineering. At least five of the engineering courses must be upper level courses, and one must be a capstone design course or independent study, which must be advised or co-advised by a member of the regular engineering faculty. Note that not all engineering courses may be used to meet Sc.B. requirements: for example, the courses not allowed to count toward the A.B., will not qualify.

Special Concentrations

1. Core Courses:
   - ENGN 0030 Introduction to Engineering 1
   - ENGN 0040 Advanced Placement Calculus (Physics/Engineering) 1
   - ENGN 0031 Honors Introduction to Engineering 1
   - ENGN 0040 Dynamics and Vibrations 1
   - ENGN 0410 Materials Science 1
   - ENGN 0510 Electricity and Magnetism 1
   - ENGN 0520 Electrical Circuits and Signals 1
   - ENGN 0720 Thermodynamics 1
   - ENGN 0810 Fluid Mechanics 1
   - BIOL 0200 The Foundation of Living Systems 1
   - CHEM 0330 Equilibrium, Rate, and Structure 1
   - MATH 0190 Advanced Placement Calculus 1
   - MATH 0170 Honors Calculus 1

2. Upper-Level Chemical & Biochemical Engineering Curriculum
   - ENGN 1110 Transport and Biotransport Processes 1
   - ENGN 1120 Chemical and Biochemical Reactor Design 1
   - ENGN 1130 Phase and Chemical Equilibria 1
   - ENGN 1710 Heat and Mass Transfer 1
   - CHEM 0350 Organic Chemistry 1

Advanced Chemistry elective course 1
- CHEM 0360 Organic Chemistry 1
- CHEM 0400 Biophysical and Bioinorganic Chemistry 1
- CHEM 0500 Inorganic Chemistry 1
- CHEM 1140 Physical Chemistry: Quantum Chemistry 1

Advanced Natural Sciences elective course 2
- APMA 0330 Methods of Applied Mathematics I, II 1
- APMA 0350 Applied Ordinary Differential Equations 1
- APMA 0340 Methods of Applied Mathematics I, II 1
- APMA 0360 Applied Partial Differential Equations 1

Total Credits 21

Note: ENGN 1120 and 1130 are only offered in alternate years.

An advanced chemistry course approved by concentration advisor; the following courses are pre-approved for this requirement.

An advanced course in the natural sciences approved by the concentration advisor. For suggestions of acceptable courses that fulfill this requirement, please see the concentration advisor.

Computer Engineering Track:

The Computer Engineering program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. The education objectives of the Computer Engineering program are to prepare graduates: (1) to pursue distinctive multidisciplinary scientific and technical careers beginning with either entry-level computer engineering positions in industry or graduate study in computer engineering and related fields; to or to successfully pursue other careers that benefit from the analytical or quantitative skills acquired through the Brown CBE Program; (2) to effectively apply the principles of chemical and biochemical engineering, problem-solving skills, and critical and independent thinking, to a broad range of complex, multidisciplinary technological and societal problems; (3) to communicate effectively, both orally and in writing, to professionals and audiences of diverse backgrounds, and to pursue technical approaches and innovations that address the needs of society in an ethical, safe, sustainable, and environmentally responsible manner.

The student outcomes of this program are the ABET (a) - (k) Student Outcomes as defined by the "ABET Criteria for Accrediting Engineering Programs" (available online at http://www.abet.org/accreditation-criteria-policies-documents/).

The Computer Engineering concentration shares much of the core with the other engineering programs, but is structured to include more courses in computer science, and a somewhat different emphasis in mathematics.

1. Core Courses:
   - ENGN 0030 Introduction to Engineering 1
   - ENGN 0031 Honors Introduction to Engineering 1
   - ENGN 0030 Introduction to Engineering 1
   - ENGN 0040 Advanced Placement Calculus 1
   - ENGN 0031 Honors Introduction to Engineering 1
   - ENGN 0040 Dynamics and Vibrations 1
   - ENGN 0510 Electricity and Magnetism 1
   - ENGN 0520 Electrical Circuits and Signals 1
   - APMA 1650 Statistical Inference I 1
   - or APMA 1655 Statistical Inference I 1
   - or CSCI 1450 Probability and Computing 1
   - MATH 0190 Advanced Placement Calculus (Physics/Engineering) 1
   - MATH 0170 Advanced Placement Calculus 1
or MATH 0100  Introductory Calculus, Part II 1
MATH 0200  Intermediate Calculus (Physics/Engineering) 1
or MATH 0180  Intermediate Calculus 1
or MATH 0350  Honors Calculus 1
APMA 0330  Methods of Applied Mathematics I, II 1
or APMA 0350  Applied Ordinary Differential Equations 1
or APMA 1170  Introduction to Computational Linear Algebra 1
or APMA 1710  Information Theory 1
or ENGN 0220  Introduction to Discrete Structures and Probability 1
or ENGN 1570  Design and Analysis of Algorithms 1
or MATH 1260  Complex Analysis 1
CHEM 0330  Equilibrium, Rate, and Structure 1
or ENGN 0410  Materials Science 1
or NEUR 0010  The Brain: An Introduction to Neuroscience 1
Select one of the following series (other CSCI courses subject to approval): 2
CSCI 0150 & CSCI 0160  Introduction to Object-Oriented Programming and Computer Science and Introduction to Algorithms and Data Structures 1
CSCI 0170 & CSCI 0180  Computer Science: An Integrated Introduction and Computer Science: An Integrated Introduction 1
CSCI 0190  Accelerated Introduction to Computer Science (and one additional CSCI course subject to approval) 1

2. Upper-Level Computer Engineering Curriculum:
ENGN 1570  Linear System Analysis 1
ENGN 1630  Digital Electronics Systems Design 1
ENGN 1640  Design of Computing Systems 1
MATH 0520  Linear Algebra 1
or MATH 0540  Honors Linear Algebra 1
One advanced Computer Engineering foundations course: 1
ENGN 1580  Communication Systems 1
ENGN 1600  Design and Implementation of Very Large-Scale Integrated Systems 1
ENGN 1610  Image Understanding 1
ENGN 1620  Analysis and Design of Electronic Circuits 1
ENGN 2530  Digital Signal Processing 1
One advanced Computer Science course with significant systems programming: 1
CSCI 0330  Introduction to Computer Systems 1
or CSCI 0320  Introduction to Software Engineering 1
or CSCI 1230  Introduction to Computer Graphics 1
or CSCI 1380  Distributed Computer Systems 1
or CSCI 1670  Operating Systems 1
or CSCI 1680  Computer Networks 1
Select at least one Computer Engineering/Electrical Engineering course (other CE/EE courses subject to approval): 1
ENGN 1220  Neuroengineering 1
ENGN 1560  Optics 1
ENGN 1580  Communication Systems 1
ENGN 1590  Introduction to Semiconductors and Semiconductor Electronics 1
ENGN 1600  Design and Implementation of Very Large-Scale Integrated Systems 1
ENGN 1610  Image Understanding 1
ENGN 1620  Analysis and Design of Electronic Circuits 1
ENGN 1680  Design and Fabrication of Semiconductor Devices 1
ENGN 1690  Photonics and Applications 1
ENGN 1930B  Biomedical Optics 1
ENGN 1931A  Photovoltaics Engineering 1
ENGN 1931B  Introduction to Power Engineering 1
ENGN 1931I  Design of Robotic Systems 1
ENGN 1931Y  Control Systems Engineering 1
ENGN 1931Z  Interfaces, Information + Automation 1
ENGN 2520  Pattern Recognition and Machine Learning 1
ENGN 2530  Digital Signal Processing 1
ENGN 2560  Computer Vision 1
ENGN 2610  Physics of Solid State Devices 1
ENGN 2620  Solid State Quantum and Optoelectronics 1
ENGN 2910A  Advanced Computer Architecture 1
ENGN 2911X  Reconfigurable Computing 1
ENGN 2912B  Scientific Programming in C++ 1
ENGN 2912E  Low Power VLSI System Design 1
Select at least one Computer Science Course (Other CSCI courses subject to approval): 1
CSCI 0320  Introduction to Software Engineering 1
CSCI 0330  Introduction to Computer Systems 1
CSCI 1230  Introduction to Computer Graphics 1
CSCI 1270  Database Management Systems 1
CSCI 1300  User Interfaces and User Experience 1
CSCI 1320  Creating Modern Web Applications 1
CSCI 1380  Distributed Computer Systems 1
CSCI 1410  Artificial Intelligence 1
CSCI 1480  Building Intelligent Robots 1
CSCI 1570  Design and Analysis of Algorithms 1
CSCI 1600  Real-Time and Embedded Software 1
CSCI 1660  Introduction to Computer Systems Security 1
CSCI 1670  Operating Systems 1
CSCI 1680  Computer Networks 1
CSCI 1730  Design and Implementation of Programming Languages 1
CSCI 1760  Multiprocessor Synchronization 1
CSCI 1900  csciStartup 1
Select up to one interdisciplinary science course: 2
CLPS 1491  Neural Modeling Laboratory 1
CLPS 1520  Computational Vision 1
ENGN 1450  Properties and Processing of Electronic Materials 1
NEUR 2110  Statistical Neuroscience 1

3. Capstone Design:
ENGN 1650  Embedded Microprocessor Design 1
or ENGN 1000  Projects in Engineering Design I 1

4. General Education Requirement: At least four approved courses must be taken in humanities and social sciences

Total Credits: 21

---

1 Or Biology course beyond BIOL 0200 subject to Concentration Advisor approval
2 Student should consult with concentration advisor for recommendation and approval.
Subject to approval by the concentration advisor, an independent study course (ENGN 1970/ENGN 1971) may be used to fulfill the Engineering Capstone Design requirement. To qualify for such approval, the independent study project must: (1) contain a significant and definable design component; (2) be based on the knowledge and skills acquired in earlier course work, (3) incorporate appropriate engineering standards; and (4) address multiple realistic constraints.

Electrical Engineering Track:

The Electrical Engineering program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. The education objectives of the Electrical Engineering program are to prepare graduates: (1) to pursue distinctive multidisciplinary scientific and technical careers beginning with either entry-level electrical engineering positions in industry or graduate study in electrical engineering and related fields; (2) to participate on multidisciplinary teams that cooperate in applying problem-solving skills and critical and independent thinking to a broad range of projects that can produce the technical innovations aimed at satisfying the future needs of society. The student outcomes of this program are the ABET (a) - (k) Student Outcomes as defined by the "ABET Criteria for Accrediting Engineering Programs" (available online at http://www.abet.org/accreditation-criteria-policies-documents/).

1. Core Courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGN 0030</td>
<td>Introduction to Engineering</td>
<td>1</td>
</tr>
<tr>
<td>or ENGN 0031</td>
<td>Honors Introduction to Engineering</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 0040</td>
<td>Dynamics and Vibrations</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 0410</td>
<td>Materials Science</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 0510</td>
<td>Electricity and Magnetism</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 0520</td>
<td>Electrical Circuits and Signals</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 0720</td>
<td>Thermodynamics</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 0310</td>
<td>Mechanics of Solids and Structures</td>
<td>1</td>
</tr>
<tr>
<td>or ENGN 0810</td>
<td>Fluid Mechanics</td>
<td>1</td>
</tr>
<tr>
<td>or CSCI 0160</td>
<td>Introduction to Algorithms and Data Structures</td>
<td>1</td>
</tr>
<tr>
<td>or CSCI 0180</td>
<td>Computer Science: An Integrated Introduction</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 0330</td>
<td>Equilibrium, Rate, and Structure</td>
<td>1</td>
</tr>
<tr>
<td>MATH 0190</td>
<td>Advanced Placement Calculus (Physics/Engineering)</td>
<td>1</td>
</tr>
<tr>
<td>or MATH 0170</td>
<td>Advanced Placement Calculus</td>
<td>1</td>
</tr>
<tr>
<td>or MATH 0100</td>
<td>Introductory Calculus, Part II</td>
<td>1</td>
</tr>
<tr>
<td>MATH 0200</td>
<td>Intermediate Calculus (Physics/Engineering)</td>
<td>1</td>
</tr>
<tr>
<td>or MATH 0180</td>
<td>Intermediate Calculus</td>
<td>1</td>
</tr>
<tr>
<td>or MATH 0350</td>
<td>Honors Calculus</td>
<td>1</td>
</tr>
<tr>
<td>APMA 0330</td>
<td>Methods of Applied Mathematics I, II</td>
<td>1</td>
</tr>
<tr>
<td>or APMA 0350</td>
<td>Applied Ordinary Differential Equations</td>
<td>1</td>
</tr>
<tr>
<td>APMA 0340</td>
<td>Methods of Applied Mathematics I, II</td>
<td>1</td>
</tr>
<tr>
<td>or APMA 0360</td>
<td>Applied Partial Differential Equations I</td>
<td>1</td>
</tr>
<tr>
<td>or APMA 1650</td>
<td>Statistical Inference I</td>
<td>1</td>
</tr>
<tr>
<td>or MATH 0520</td>
<td>Linear Algebra</td>
<td>1</td>
</tr>
<tr>
<td>or MATH 0540</td>
<td>Honors Linear Algebra</td>
<td>1</td>
</tr>
<tr>
<td>CSCI 0150</td>
<td>Introduction to Object-Oriented Programming and Computer Science</td>
<td>1</td>
</tr>
<tr>
<td>or CSCI 0040</td>
<td>Introduction to Scientific Computing and Problem Solving</td>
<td>1</td>
</tr>
<tr>
<td>or CSCI 0170</td>
<td>Computer Science: An Integrated Introduction</td>
<td>1</td>
</tr>
<tr>
<td>or CSCI 0190</td>
<td>Accelerated Introduction to Computer Science</td>
<td>1</td>
</tr>
</tbody>
</table>

2. Upper-Level Electrical Engineering Curriculum

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGN 1570</td>
<td>Linear System Analysis</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1620</td>
<td>Analysis and Design of Electronic Circuits</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1630</td>
<td>Digital Electronics Systems Design</td>
<td>1</td>
</tr>
<tr>
<td>PHYS 0790</td>
<td>Physics of Matter</td>
<td>1</td>
</tr>
<tr>
<td>or PHYS 1410</td>
<td>Quantum Mechanics A</td>
<td>1</td>
</tr>
</tbody>
</table>

3. Electrical Engineering Specialization - Complete at least three courses from the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGN 1230</td>
<td>Instrumentation Design</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1580</td>
<td>Communication Systems</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1590</td>
<td>Introduction to Semiconductors and Semiconductor Electronics</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1600</td>
<td>Design and Implementation of Very Large-Scale Integrated Systems</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1610</td>
<td>Image Understanding</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1640</td>
<td>Design of Computing Systems</td>
<td>1</td>
</tr>
</tbody>
</table>

Up to two other Electrical Engineering Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGN 1220</td>
<td>Neuroengineering</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1560</td>
<td>Optics</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1650</td>
<td>Embedded Microprocessor Design</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1680</td>
<td>Design and Fabrication of Semiconductor Devices</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1690</td>
<td>Photonics and Applications</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1930B</td>
<td>Biomedical Optics</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1931A</td>
<td>Photovoltaics Engineering</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1931F</td>
<td>Introduction to Power Engineering</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1931I</td>
<td>Design of Robotic Systems</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1931Y</td>
<td>Control Systems Engineering</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1931Z</td>
<td>Interfaces, Information + Automation</td>
<td>1</td>
</tr>
</tbody>
</table>

Up to two interdisciplinary engineering science course:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLPS 1491</td>
<td>Neural Modeling Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>CLPS 1520</td>
<td>Computational Vision</td>
<td>1</td>
</tr>
<tr>
<td>CSCI 0330</td>
<td>Introduction to Computer Systems</td>
<td>4</td>
</tr>
<tr>
<td>ENGN 1370</td>
<td>Advanced Engineering Mechanics</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1450</td>
<td>Properties and Processing of Electronic Materials</td>
<td>1</td>
</tr>
<tr>
<td>NEUR 1680</td>
<td>Computational Neuroscience</td>
<td>1</td>
</tr>
<tr>
<td>NEUR 2110</td>
<td>Statistical Neuroscience</td>
<td>1</td>
</tr>
<tr>
<td>PHYS 1420</td>
<td>Quantum Mechanics B</td>
<td>1</td>
</tr>
</tbody>
</table>

4. Capstone Design: At least one course from the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGN 1650</td>
<td>Embedded Microprocessor Design</td>
<td>1</td>
</tr>
<tr>
<td>or ENGN 1000</td>
<td>Projects in Engineering Design I</td>
<td>1</td>
</tr>
</tbody>
</table>

5. General Education Requirement: At least four approved courses must be taken in humanities and social sciences

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
</table>

Total Credits = 21

1. Or 1000-level Applied Mathematics or Mathematics course subject to Concentration Advisor Approval
2. Or 1000-level Physics course subject to Concentration Advisor approval.
3. Or 2000-level Electrical Engineering graduate course (such as ENGN 2500, ENGN 2520, ENGN 2530, ENGN 2560, ENGN 2912K).
4. Or Computer Science course beyond CSCI 0150/CSCI 0170 subject to Concentration Advisor approval.
5. Subject to approval by the concentration advisor, an independent study course (ENG 1970/ENG 1971) may be used to fulfill the Engineering Capstone Design requirement. To qualify for such approval, the independent study project must: (1) contain a significant and definable design component; (2) be based on the knowledge and skills acquired in earlier course work, (3) incorporate appropriate engineering standards; and (4) address multiple realistic constraints.

Environmental Engineering Track:

The Environmental Engineering program began in 2013. The program has not been reviewed by ABET and is not ABET-accredited. The education objectives of the Environmental Engineering program are to prepare graduates: (1) to apply in practice the knowledge obtained...
in school within industry, government, or private practice; (2) to work toward sustainable solutions in a wide array of technical specialties; (3) to pursue lifelong learning through continuing education and/or advanced degrees in environmental engineering. The student outcomes of this program are the (a) - (k) Student Outcomes as defined by the "ABET Criteria for Accrediting Engineering Programs" (available online at http://www.abet.org/accreditation-criteria-policies-documents/).

1. Core Courses:
   - ENGN 0030 Introduction to Engineering 1
   - or ENGN 0031 Honors Introduction to Engineering 1
   - ENGN 0040 Dynamics and Vibrations 1
   - ENGN 0410 Materials Science 1
   - ENGN 0490 Fundamentals of Environmental Engineering 1
   - ENGN 0510 Electricity and Magnetism 1
   - ENGN 0720 Thermodynamics 1
   - ENGN 0810 Fluid Mechanics 1
   - BIOL 0200 The Foundation of Living Systems 1
   - CHEM 0330 Equilibrium, Rate, and Structure 1
   - MATH 0190 Advanced Placement Calculus (Physics/Engineering) 1
   - or MATH 0170 Advanced Placement Calculus 1
   - MATH 0200 Intermediate Calculus (Physics/Engineering) 1
   - or MATH 0180 Intermediate Calculus 1
   - or MATH 0350 Honors Calculus 1
   - APMA 0330 Methods of Applied Mathematics I, II 1
   - or APMA 0350 Applied Ordinary Differential Equations 1
   - APMA 0650 Essential Statistics 1
   - or APMA 1650 Statistical Inference I 1
   - GEOL 1370 Environmental Geochemistry 1
   - or GEOL 1580 Quantitative Elements of Physical Hydrology 1
   - BIOL 0415 Microbes in the Environment (or an approved alternative Natural Science Course) 1
   - or BIOL 0420 Principles of Ecology 1
   - ENGN 1860 Advanced Fluid Mechanics 1

2. Advance Science Courses
   - MATH 0200 Intermediate Calculus (Physics/Engineering) 1
   - or MATH 0180 Intermediate Calculus 1
   - or MATH 0350 Honors Calculus 1
   - CHEM 0330 Equilibrium, Rate, and Structure 1
   - or CHEM 0331 Honors Calculus 1
   - BIOL 0415 Microbes in the Environment (or an approved alternative Natural Science Course) 1
   - or BIOL 0420 Principles of Ecology 1
   - APMA 0650 Essential Statistics 1
   - or APMA 1650 Statistical Inference I 1
   - GEOL 1370 Environmental Geochemistry 1
   - or GEOL 1580 Quantitative Elements of Physical Hydrology 1
   - BIOL 0415 Microbes in the Environment (or an approved alternative Natural Science Course) 1

3. Environmental Engineering Specialty Options (Complete one of the following five course sequences)
   - 3a. Chemistry Specialty
     At least three of the following:
     - ENGN 1110 Transport and Biotransport Processes
     - ENGN 1340 Phase and Chemical Equilibria
     - ENGN 1340 Water Supply and Wastewater Treatment
     - ENGN 1710 Heat and Mass Transfer
     - ENGN 1931P Fuels, Energy, and the Environment
     - ENGN 1930U Renewable Energy Technologies

   - 3b. Energy Specialty
     At least three of the following:
     - ENGN 1340 Water Supply and Wastewater Treatment
     - ENGN 1710 Heat and Mass Transfer
     - ENGN 1860 Advanced Fluid Mechanics
     - ENGN 1930U Renewable Energy Technologies
     - ENGN 1931F Introduction to Power Engineering
     - ENGN 1931A Photovoltaics Engineering
     - ENGN 1931P Fuels, Energy, and the Environment

   - 4. Capstone Design 1
     - ENGN 1000 Projects in Engineering Design I
     - or ENGN 1140 Chemical Process Design

   5. Total Credits 21

   1 Subject to approval by the concentration advisor, an independent study course (ENGN970/971) may be used to fulfill the Engineering Capstone Design requirement. To qualify for such approval, the independent study project must: (1) contain a significant and definable design component; (2) be based on the knowledge and skills acquired in earlier course work, (3) incorporate appropriate engineering standards; and (4) address multiple realistic constraints. To request approval, please complete the online form available at: http://www.brown.edu/academics/engineering/undergraduate-study

Materials Engineering Track:
The Materials Engineering program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. The education objectives of the Materials Engineering program are to prepare graduates: (1) to pursue multidisciplinary scientific and technical careers beginning with entry-level engineering positions in industry or graduate study in materials science and engineering and related fields; (2) to apply an engineering problem-solving approach combined with a broad appreciation for the liberal arts to inform and develop their understanding of current societal needs and values to achieve leadership positions in their chosen fields of endeavor. The student outcomes of this program are the (a) - (k) Student Outcomes as defined by the "ABET Criteria for Accrediting Engineering Programs" (available online at http://www.abet.org/accreditation-criteria-policies-documents/).

1. Core Courses:
   - ENGN 0030 Introduction to Engineering 1
   - or ENGN 0031 Honors Introduction to Engineering 1
   - ENGN 0040 Dynamics and Vibrations 1
   - ENGN 0410 Materials Science 1
   - ENGN 0510 Electricity and Magnetism 1
   - ENGN 0720 Thermodynamics 1
   - ENGN 0810 Fluid Mechanics 1
   - BIOL 0200 The Foundation of Living Systems 1
   - CHEM 0330 Equilibrium, Rate, and Structure 1
   - MATH 0190 Advanced Placement Calculus (Physics/Engineering) 1
   - or MATH 0170 Advanced Placement Calculus 1
   - MATH 0200 Intermediate Calculus (Physics/Engineering) 1
   - or MATH 0180 Intermediate Calculus 1
   - or MATH 0350 Honors Calculus 1
   - APMA 0330 Methods of Applied Mathematics I, II 1
   - or APMA 0350 Applied Ordinary Differential Equations 1
   - APMA 0650 Essential Statistics 1
   - or APMA 1650 Statistical Inference I 1
   - GEOL 1370 Environmental Geochemistry 1
   - or GEOL 1580 Quantitative Elements of Physical Hydrology 1
   - BIOL 0415 Microbes in the Environment (or an approved alternative Natural Science Course) 1
   - or BIOL 0420 Principles of Ecology 1
   - ENGN 1860 Advanced Fluid Mechanics 1
   - or ENGN 0040 Dynamics and Vibrations 1
   - or ENGN 0410 Materials Science 1
   - or ENGN 0510 Electricity and Magnetism 1
   - or ENGN 0520 Electrical Circuits and Signals 1
   - or ENGN 0720 Thermodynamics 1
   - or ENGN 0810 Fluid Mechanics 1
   - CHEM 0330 Equilibrium, Rate, and Structure 1
   - or CHEM 0331 Honors Calculus 1
   - MATH 0190 Advanced Placement Calculus (Physics/Engineering) 1
   - or MATH 0170 Advanced Placement Calculus 1
   - MATH 0200 Intermediate Calculus (Physics/Engineering) 1
   - or MATH 0180 Intermediate Calculus 1
   - or MATH 0350 Honors Calculus 1
   - APMA 0330 Methods of Applied Mathematics I, II 1
   - or APMA 0350 Applied Ordinary Differential Equations 1
### Mechanical Engineering Track:

The Mechanical Engineering program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. The education objectives of the Mechanical Engineering program are to prepare graduates: (1) to pursue scientific and technical careers beginning with either graduate study in mechanical engineering and related fields or mechanical engineering positions in industry; (2) to work on interdisciplinary teams that make use of the engineering problem solving method and a broad background in the liberal arts to address societal needs. The student outcomes of this program are the (a) - (k) Student Learning Outcomes as defined by the "ABET Criteria for Accrediting Engineering Programs" (available online at http://www.abet.org/accreditation-criteria-policies-documents/).

#### 1. Core Courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGN 0030</td>
<td>Introduction to Engineering</td>
<td>1</td>
</tr>
<tr>
<td>or ENGN 0031</td>
<td>Honors Introduction to Engineering</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 0040</td>
<td>Dynamics and Vibrations</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 0041</td>
<td>Mechanics of Solids and Structures</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 0050</td>
<td>Materials Science</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 0051</td>
<td>Electricity and Magnetism</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 0052</td>
<td>Electrical Circuits and Signals</td>
<td>1</td>
</tr>
</tbody>
</table>

#### 2. Upper-Level Materials Engineering Curriculum

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGN 1410</td>
<td>Physical Chemistry of Solids</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1420</td>
<td>Kinetics Processes in Materials Science and Engineering</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1440</td>
<td>Mechanical Properties of Materials</td>
<td>1</td>
</tr>
<tr>
<td>PHYS 0790</td>
<td>Physics of Matter</td>
<td>1</td>
</tr>
<tr>
<td>or CHEM 1140</td>
<td>Physical Chemistry: Quantum Chemistry</td>
<td>1</td>
</tr>
</tbody>
</table>

Three of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGN 1450</td>
<td>Properties and Processing of Electronic Materials</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1470</td>
<td>Structure and Properties of Nonmetallic Materials</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1480</td>
<td>Metallic Materials</td>
<td>1</td>
</tr>
<tr>
<td>ENGN 1490</td>
<td>Biomaterials</td>
<td>1</td>
</tr>
</tbody>
</table>

#### 3. Capstone Design

- ENGN 1000 Projects in Engineering Design I 1

* In addition to program requirements above, students must take four courses in the humanities and social sciences.

#### Total Credits

21

1. These courses are taken in either the junior or senior year. Note that ENGN 1470 is offered on a rotating basis in the fall semester of alternate years, and ENGN 1480 and ENGN 1450 are offered in the spring semester of alternate years.

2. Subject to approval by the concentration advisor, an independent study course (ENGN1970/1971) may be used to fulfill the Engineering Capstone Design requirement. To qualify for such approval, the independent study project must: (1) contain a significant and definable design component; (2) be based on the knowledge and skills acquired in earlier course work, (3) incorporate appropriate engineering standards; and (4) address multiple realistic constraints. To request approval, please complete the online form available at: http://www.brown.edu/academics/engineering/undergraduate-study
or ENGN 1340 Water Supply and Wastewater Treatment
or ENGN 1440 Mechanical Properties of Materials
or ENGN 1470 Structure and Properties of Nonmetallic Materials

ENGN 1570 Linear System Analysis
or ENGN 1931F Introduction to Power Engineering
or ENGN 1931X Instrumentation for Research: A Biomaterials/Materials Project Laboratory
or ENGN 1931Z Interfaces, Information + Automation

3. **Upper Level, Advanced Science Course: at least one course from:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 0790</td>
<td>Physics of Matter</td>
</tr>
<tr>
<td>or BIOL 0800</td>
<td>Principles of Physiology</td>
</tr>
<tr>
<td>or CHEM 0350</td>
<td>Organic Chemistry</td>
</tr>
<tr>
<td>or CHEM 1140</td>
<td>Physical Chemistry: Quantum Chemistry</td>
</tr>
<tr>
<td>or GEOL 1450</td>
<td>Structural Geology</td>
</tr>
<tr>
<td>or GEOL 1370</td>
<td>Environmental Geochemistry</td>
</tr>
</tbody>
</table>

4. **General Education Requirement:** At least four approved courses must be taken in humanities and social sciences

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Credits</td>
<td>21</td>
</tr>
</tbody>
</table>

---

1. Subject to approval by the concentration advisor, an independent study course (ENGN 1970/ENGN 1971) may be used to fulfill the Engineering Capstone Design requirement. To qualify for such approval, the independent study project must: (1) contain a significant and definable design component; (2) be based on the knowledge and skills acquired in earlier course work, (3) incorporate appropriate engineering standards; and (4) address multiple realistic constraints.

2. Or another advanced science course, subject to concentration advisor approval.
Font Notice

This document should contain certain fonts with restrictive licenses. For this draft, substitutions were made using less legally restrictive fonts. Specifically:

- Helvetica was used instead of Arial.

The editor may contact Leepfrog for a draft with the correct fonts in place.