Mechanical Engineering

The Sc.B. program in Mechanical Engineering (ME) has a long tradition of excellence at Brown. ME is one of the most versatile engineering disciplines as it explores a wide range of systems spanning fluids and solids. Students from this concentration learn the science of motion, designing and analyzing systems that shape our world: From high-precision nanomechanical machines to large-scale aerospace systems. At Brown, ME students carve unique paths leveraging computational, analytical, or experimental methodologies with other areas of interest in the spirit of the open curriculum. They become distinguished scholars, engineering innovators, and management leaders.

The curriculum in ME is intended to provide students with a broad interdisciplinary foundation complemented by specialized training in mechanical systems and fluid/thermal systems.

The Mechanical Engineering program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. The Program Educational Objectives of the Mechanical Engineering program are to prepare the graduates: (1) to pursue careers as creative and innovative mechanical engineers in industry or academia; (2) to advance the frontiers of their field; and (3) to discharge their offices in a professional and responsible manner. The student outcomes of this program are the (1) - (7) Student Outcomes as defined by the "ABET Criteria for Accrediting Engineering Programs" available online at http://www.abet.org/accreditation-criteria-policies-documents/

Please note that all students concentrating in Engineering need to file a concentration declaration using the University's ASK advising system. This declaration must be first reviewed by the relevant Concentration Advisor and then approved by the Director of Undergraduate Studies after assuring compliance with all relevant program and accreditation requirements.

Standard Program for the Sc.B. degree

Mathematics Requirements

As mathematics is a cornerstone of all engineering programs, significant attention is given to early preparation in mathematics in engineering concentrations. It is recognized that students entering Brown will have different levels of mathematics preparation, and the following is offered as general guidance, though the actual choices of courses should be made in consultation with an exploratory advisor. MATH 0190 (or MATH 0100), followed by MATH 0200 (or MATH 0180) is the preferred sequence of courses to be taken in the freshman year. MATH 0100 and MATH 0180 offer content like that in MATH 0190 and MATH 0200, respectively, but the latter courses are highly recommended for future engineering students because they offer more examples of relevance to the field. Students who would prefer, or require, a more introductory level calculus course may start the sequence with MATH 0090. They may then take MATH 0200 (or MATH 0180) in the subsequent semester and in that case, would receive engineering concentration credit equivalent to that which they would have received having taken MATH 0190 and MATH 0200. However, students who find that the step up from MATH 0090 to MATH 0200 is too challenging, have a choice to take MATH 0190 (or MATH 0100) upon completion of MATH 0090, but in this case, MATH 0090 would not carry engineering concentration credit and the student would then need to take MATH 0200 (or MATH 0180) in the sophomore year.

Students who have taken Advanced Placement (AP) calculus courses in high school and/or have shown proficiency through AP examinations may start the calculus sequence at a higher level than that suggested above. If a student has AP credit and accepts to use it, it then allows the student to place out of MATH 0190 (or MATH 0100). These students should enroll in the appropriate higher-level math course, e.g., MATH 0200 (or MATH 0180) or possibly MATH 0350 (a more theoretical course that covers similar material). Although it is impossible to place out of MATH 0200 or MATH 0350 with AP credit, we recognize that some students enter with an even higher level of preparation. Those students are advised to enroll in MATH 0520 (Linear Algebra), or MATH 0540 (Honors Linear Algebra), and take their second freshman mathematics course at a higher level, for example, MATH 1460 (Complex Analysis), MATH 1210 (Probability), or MATH 1220 (Mathematical Statistics). Alternatively, for some engineering concentrations, this second MATH credit requirement may be satisfied by taking a course from the Applied Mathematics Department, such as APMA 0350 (Applied Ordinary Differential Equations), APMA 0360 (Applied Partial Differential Equations), APMA 1650 (Statistical Inference) or APMA 1210 (Operations Research: Deterministic Models) if one of those courses listed is not taken for two APMA concentration credits. Details regarding the mathematics requirement for each concentration are listed in the corresponding programs.

Advanced Placement

Courses that have been taken at the secondary school level are typically only used for placement into the appropriate course level at Brown. The examples of how this can be done in mathematics are given above, and there are other instances (such as in selection of the appropriate introductory chemistry course) where AP credit is considered. It should be noted, however, that advanced placement credits cannot be used to substitute for any Engineering concentration requirements; they are instead used to ensure that students are placed into the correct level of courses.

Transfer Credits

Some students will also complete courses at other universities during the time they are Brown students (sometimes during summers while they are not in residence at Brown; sometimes during a junior semester abroad). 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). In addition to the general rules governing such transfers, there are specific rules governing courses that will be offered as satisfying Engineering concentration requirements.

If the course proposed for transfer credit is offered by another department at Brown (i.e., that it carries a course number that does not start with ENGN), then the equivalent of the course must be established by that other department. This is done by submitting a formal request through the ASK system (https://ask.brown.edu/transfer_credits/information/index). Once this approval has been received from the other department, the student's internal transcript will show the equivalence and the course in question can be shown in the Engineering concentration declaration as having been completed elsewhere. If the equivalence to a Brown course is not approved, then there may still be "unassigned credit" given for the course. In this case, the situation relative to how it does or does not count for concentration credit needs to be discussed with the Concentration Advisor. In rare cases, students may petition the Engineering Concentration Committee to use courses that do not have an equivalent offered at Brown in order 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.

If the student wishes to transfer a course taken outside of Brown that would normally carry an Engineering course number, the sequence is a bit different. First, the student needs to fill out an Engineering Transfer Credit Approval Request (see https://engineering.brown.edu/undergraduate/concentrations/concentration-options/study-abroad (https://engineering.brown.edu/undergraduate/concentrations/concentration-options/study-abroad/)). This routes the request to the relevant Brown Engineering faculty member for approval. Once this has been obtained, then transfer approval is requested through the ASK system, as described above. This process ensures that the transcript will capture the equivalence of the externally completed course.

Substitutions for Required Courses

Students may petition the Engineering Concentration Committee to substitute a course in place of a defined concentration 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 needed 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 Advisor without requiring a formal petition to the Concentration Committee. (For courses taken elsewhere, the credit must be officially transferred as described above.) Students wishing to make substitutions of a broader nature should consult their Concentration Advisor for assistance in drafting their petition to the Engineering Concentration Committee. Such petitions may be approved by a majority vote of the Committee.

1. Core Courses:		
ENGN 0030	Introduction to Engineering	1
or ENGN 0032	Introduction to Engineering: Design	
ENGN 0040	Engineering Statics and Dynamics	1
ENGN 0310	Mechanics of Solids and Structures	1
ENGN 0410	Materials Science [1]	1
ENGN 0510	Electricity and Magnetism	1
ENGN 0520	Electrical Circuits and Signals	1
ENGN 0720	Thermodynamics	1
ENGN 0810	Fluid Mechanics	1
CHEM 0330	Equilibrium, Rate, and Structure	1
MATH 0190	Single Variable Calculus, Part II (Physics/ Engineering)	1
or MATH 0100	Single Variable Calculus, Part II	
MATH 0200	Multivariable Calculus (Physics/ Engineering)	1
or MATH 0180	Multivariable Calculus	
or MATH 0350	Multivariable Calculus With Theory	
APMA 0350	Applied Ordinary Differential Equations [2]	1
APMA 0360	Applied Partial Differential Equations I [2]	1
CSCI 0111	Computing Foundations: Data	1
or CSCI 0150	Introduction to Object-Oriented Programming and Computer Science	
or CSCI 0170	Computer Science: An Integrated Introduction	
or CSCI 0190	Accelerated Introduction to Computer Science	
or APMA 0160	Introduction to Scientific Computing	
2. Upper-Level Mechanical Engineering Curriculum: Complete at least 6 courses from the following groups:		**6**
Mechanical Systems: At least one course from:		
ENGN 1300	Structural Analysis	
ENGN 1370	Advanced Engineering Mechanics	
ENGN 1735	Vibration of Mechanical Systems	
ENGN 1750	Advanced Mechanics of Solids	
Fluids/Thermal Systems: At least one course from:		
ENGN 1860	Advanced Fluid Mechanics	
ENGN 1700	Fluid Mechanics of Aerospace and Energy Systems	
ENGN 1710	Principles of Heat and Mass Transfer	
Capstone: At least one course from the following must be taken in the final two semesters: [3]		
ENGN 1000	Projects in Engineering Design I	
or ENGN 1001	Projects in Engineering Design II	
ENGN 1931D	Design of Mechanical Assemblies	
ENGN 1760	Design of Space Systems	
Design Electives: Up to two courses from:		
ENGN 1230	Instrumentation Design	
ENGN 1740	Computer Aided Visualization and Design	
Bioengineering Electives: Up to two courses from:		
ENGN 1210	Biomechanics	
ENGN 1220	Neuroengineering	
ENGN 1490	Biomaterials	
Robotic and Control Systems Electives: Up to two courses from:		
ENGN 1931Y	Control Systems Engineering	
Engineering Analysis and Computation Electives: Up to two courses from:		
ENGN 1840	Numerical Methods in Engineering	
ENGN 1950	Advanced Numerical Methods for Data, Simulation, and Optimization	
Energy and Environmental Engineering Electives: Up to two courses from:		
ENGN 1932P	Sustainable Energy: Science and Technology	
ENGN 1931P	Energy and the Environment	
Interdisciplinary Electives: Up to one course from: [4]		
ENGN 1620	Analysis and Design of Electronic Circuits	
or ENGN 1340	Water Supply and Treatment Systems - Technology and Sustainability	
or ENGN 1440	Mechanical Properties of Materials	
or ENGN 1470	Composite Materials	
or ENGN 1570	Linear System Analysis	
or ENGN 1931F	Introduction to Power Engineering	
or ENGN 1931Z	Interfaces, Information and Automation	
3. Upper Level, Advanced Science Course: At least one course from: [5]		**1**
PHYS 0790	Physics of Matter	
or BIOL 0800	Principles of Physiology	
or CHEM 0350	Organic Chemistry I	
or CHEM 1140	Physical Chemistry: Quantum Chemistry	
or EEPS 1450	Structural Geology	
or EEPS 1370	Environmental Geochemistry	
4. General Education Requirement: At least four approved courses must be taken in humanities and social sciences		
Total Credits		**21**

1. ENGN 1490 may be substituted if taken in Sophomore year.
2. Students who completed APMA 0330 and/or APMA 0340 prior to academic year 2021-22 may count these as satisfying the APMA 0350 and/or APMA 0360 requirements. Other advanced courses in Mathematics or Applied Mathematics may be substituted with approval of the Concentration Advisor.
3. Subject to approval by the concentration advisor, an independent study course (ENGN 1972/ENGN 1973) 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 https://engineering.brown.edu/undergraduate/concentrations/concentration-options/independent-study (https://engineering.brown.edu/undergraduate/concentrations/concentration-options/independent-study/)
4. Other advanced alternative courses can be used with the approval of the Concentration Advisor.
5. Other non-introductory courses in physics, chemistry, neuroscience, geology, and biology are allowed.

Professional Track

The requirements for all undergraduate professional tracks within concentrations are standardized and additional information can be found here:

https://bulletin.brown.edu/undergradproftrack/

Degrees with Honors in Engineering

Honors are granted by the University to students whose work in a field of concentration has demonstrated superior quality and culminated in an 'Honors Thesis of Distinction.' Honors recipients in the School of Engineering must meet the following criteria: (1) Demonstrate a strong academic record (60% A's or "S with Distinction" in their concentration through the seventh semester); (2) Propose and execute an independent research project under the guidance of a faculty member; (3) Complete a written thesis to the satisfaction of the Honors Program Committee; (4) Give a scientific/technical presentation at the Undergraduate Research Symposium in the spring semester; and (5) Fulfill all deadlines for applying for or completing honors to the satisfaction of his/her research advisor and the Honors Program Committee.