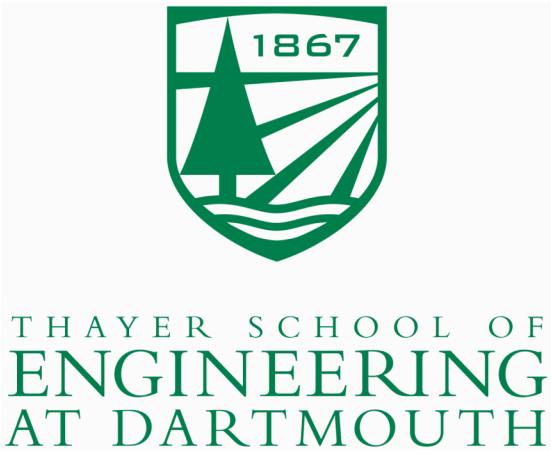
Handbook for Engineering Science Majors



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General Sylvanus Thayer founded the Thayer School of Engineering in 1867 with the goal of "prepar[ing] the most capable and faithful for the most responsible positions and the most difficult service." The engineer that General Thayer had in mind would be broadly educated in the liberal arts as well as thoroughly trained in technical subjects. Today, through our unique A.B.-B.E. program, we seek to continue Thayer's vision.

The central message of this handbook is *planning*. The Engineering Sciences major is rigorous (read: lots of challenging courses), but far more flexible than an engineering major at any other school. The numerous options you have for course selection and scheduling can enable you to participate in the full range of athletic, artistic, and intellectual activities offered by the college. But the way to pull this off is by planning ahead. We have seen Engs majors do some pretty incredible things, but we have also seen some who reach their senior year in a near state of panic because of things they didn't do soon enough. Our hope is that this handbook will enable you to make the most of your Dartmouth years, so that when you graduate you are not only well-prepared for graduate school or going to work, but can also look back with satisfaction and say "Wow, that was great."

I. General Considerations

The big picture

Your education as a Thayer engineer has several important components: the liberal arts, mathematics and natural science, engineering science, and engineering design. One way of viewing these is in terms of requirements to be met: to graduate from Dartmouth, to complete the Engineering Sciences major, and, if you desire to enter the engineering profession, to obtain the Bachelor of Engineering (B.E.) degree. This is a reasonable way to get an overview of how the program works.

Dartmouth A.B. degree **35 credits**

General education 10-14 credits
2 writing, 3 foreign language, 10 distributive (4 are fulfilled by prerequisites to the major), 3 world culture (may overlap distributives)

Math and science prerequisites to the major 7 credits
3 calculus, 2 physics, 1 chemistry, 1 computer science

Engineering Sciences major or modified major 9-10 credits

Free electives 4-8 credits

Thayer School B.E. degree **9-10 credits**

The B.E. requires up to three terms beyond the A.B. degree. The combined A.B.-B.E. must include at least: 9 credits of math and natural science, 13.5 credits of engineering science, of which 6 must have substantial design content (3 are prescribed, the other 3 are elective). In most cases, students will have 15 or more credits in engineering.

Beginning with the B.E. class of 2012 (A.B. class of 2011), the B.E. will require a total of 24.5 credits in mathematics, natural science, and engineering, including at least 9 credits of math and natural science and at least 13.5 credits of engineering science. Additional requirements are described later in this handbook.

Some students use their free electives for engineering courses, thus shortening the time required to complete the B.E. In recent years, twenty percent of our graduating seniors received the A.B. and B.E. degrees together. Many other students use the free electives to further broaden their liberal education, or to complete minors or second majors.

The A.B. in engineering science is an integral part of the program that leads to the B.E. Currently, about 75% of engineering sciences majors continue on for the B.E. after the A.B. Details about the B.E. program and how to make the transition from the A.B. to the B.E. are provided later. Variations on the basic program, such as modified majors and completing premed requirements also come later.

General education

Every Dartmouth student fulfills the same set of general education requirements. The combination of writing, foreign language, distributive, and world culture courses is intended to make every student an effective reader and writer, and to give every student some awareness of the principal areas of human culture and inquiry. For engineering

students, four distributive courses (QDS, SCI, SLA, and TAS) are covered by prerequisites to the major. The rest are in the humanities and social sciences.

As far as the engineering sciences major goes, you are free to pick whatever you want for your distribs. ABET, the organization that accredits engineering programs in the U.S., expects schools to provide "the broad education necessary to understand the impact of engineering solutions in a global and societal context."[1] In light of this, you may want to take some courses, *e.g.*, in economics, geography, and environmental studies,that address intersections of technology and society. On the other hand, you may equally well reserve your distribs for courses that are interesting to you, apart from your engineering studies. The choice is yours.

There is a temptation to think of the distributive requirements as something to be "gotten out of the way." This feeling can be especially acute if, say, you still have one distrib remaining in your senior spring and the only ones that don't conflict with your major courses aren't particularly interesting to you. The key to avoiding this situation is *planning*. In some liberal arts colleges, students are expected to complete their general education requirements by the end of the sophomore year, so that the junior and senior years can be focused on the major. This won't usually work for Dartmouth engineering majors, but the idea of leaving the senior year free for advanced courses in your major, completing an honors thesis, or accelerating the B.E. is a good one. On the other hand, some students prefer to reserve space in their senior years for liberal arts courses, to provide a break from a solid science and engineering schedule.

Our advice is this: plan your distributives with the same care that you plan your major courses. The more thinking you do up-front, the easier it will be to pick courses you really like. And be willing to be surprised by your pleasure in an area of study that you might have written off in high school.

Study abroad

Dartmouth has great study abroad programs, and engineering students are encouraged to take advantage of them. Planned properly, an LSA or FSP does not upset the flow of your major. The courses you take abroad frequently satisfy distributive requirements. Moreover, most of the courses available to sophomore engineering majors—in particular, 21-26 31, and 33—are offered twice a year. Here are two examples of second years, showing typical sets of core courses and an LSA:

F	W	S	X
Engs 21 D D	Chem 5 Language 2 D	LSA	Engs 22 Engs 25

F	W	S	X
Chem 5 Language 2 D	LSA	Engs 21 D D	Engs 22 Engs 33

[1] Criteria for Accrediting Engineering Programs (Baltimore, MD: ABET, Inc, 2003).

With both of these schedules, you finish the sophomore summer with three of the nine major courses and five distributives completed (2 from the LSA), and you still have seven terms left. Even if you plan to accelerate your B.E. program by taking extra engineering courses in your senior year, you're in good shape.

Thayer School sponsors two study abroad programs in engineering: for undergraduates in Bangkok, Thailand, and for B.E. students, in Hamburg, Germany. Additionally, several Thayer professors have colleagues at foreign universities who have helped our students arrange study terms at their schools. Other students have found study abroad programs on their own. Dartmouth and Thayer handle non-official foreign study programs like any domestic exchange program—there is a limit on how many courses can be transferred back, and the courses you plan to take must be approved before you go. If you want to explore this, pay a visit to the department chair.

The D-plan

The college registrar expects you to file an enrollment pattern by the spring term of your first year. However, they are also flexible about letting you change your enrollment plan at a later time, should you find that a different schedule works better for you. The rules about this are spelled out in the ORC.

With the mandatory sophomore summer, there will be a term sometime in your sophomore or junior year when you aren't here. If you do an LSA or FSP, you might want to take an off term to travel afterward. Industrial internships are also a great thing for an engineering student to do in an off term. Think of internships as part of your education, not just as ways to make money or contacts for future employment (which they certainly are). Generally, if you take the off term in your junior year you'll have more engineering classes under your belt and have more to offer a company. Some students take their junior spring off and combine it with the summer term, enabling a very substantial five-month internship with one company. The downside of this plan is six terms of classes in a row, from sophomore fall through junior winter.

Finding an advisor

As you go through the major you're likely to have questions about course selection and scheduling, about the engineering profession, and what to do after graduation (go to work or go to grad school?). A faculty advisor can be a valuable resource for getting answers to these questions. Your advisor can also sign your major cards.

The choice of an advisor is largely left up to individual students. Most first-year students who express interest in engineering are assigned first-year advisors in the engineering sciences department. Sometimes students stay with that professor beyond the first year. Some students enjoy a class with a certain professor and find that their conversations during office hours grow into a fruitful advising relationship. Or, as your interests develop, you may want to seek out a professor specializing in a particular branch of engineering to be your advisor. The department chair is always available for undergraduate advising, or to help you find an advisor matching your interests.

In your senior year, if you plan to continue on into the B.E. program, it will be important to meet with an advisor in your chosen specialty area. Together, you and your advisor will map out a plan for your additional courses, then fill out and sign the B.E. program form (analogous to a major card for the A.B.)

II. The Engineering Sciences Major

What kind of major?

The Engineering Sciences department offers both a standard major and several modified majors. All of our majors combine study in mathematics and natural science, engineering science, and design. Natural science is about how natural processes in the world operate. Mathematics provides a language for expressing many scientific principles, so that quantitative analyses and predictions can be made. *Engineering science* brings mathematics and natural science together with a focus on human-made systems. *Design* is the creative process of taking a human need, generating alternative solutions, evaluating them for scientific and economic practicality, and finally constructing the best one.

The regular Engs major is designed to equip you with a broad foundation in engineering sciences and experience with creative design. It is usually the best preparation for continuing on to a Bachelor of Engineering with a specialty in one of the traditional branches of engineering (electrical, mechanical, chemical, materials) and some interdisciplinary areas, like biomedical engineering.

The modified majors are for students whose academic and/or professional interests include engineering but not one of the traditional disciplines. With a modified major, you take a smaller and narrower set of six Engs courses, complemented by four courses in the modifying discipline. Engineering sciences can be modified with biology, chemistry, environmental science, computer science, economics, studio art, and public policy. Instead of a modified major with physics, we offer an engineering physics major jointly with the department of physics and astronomy, consisting of five Engs and five physics courses. And, for students interested in preparing for medical school or for graduate work in biomedical engineering, we offer a major in biomedical engineering sciences. The modified and engineering physics majors are suited to students with particular interests, as follows:

Biology	Biotechnology
Biomedical engs	Medical school, biomedical engineering
Chemistry	Chemical engineering
Environmental sciences	Environmental engineering
Computer science	Computer engineering
Engineering physics	Applied physics, also electrical or materials
Economics	Business, finance
Studio art	Architecture, product design
Public policy	Law, government

These majors are pre-approved and their requirements are spelled out in the ORC. Occasionally, a student will propose a major modified with some other subject to suit a special interest. One student, for example, modified with theatre because of a professional interest in lighting and set design. This type of modified major requires a proposal and approval of both departments, as described in the ORC.

All of the modified majors can segue into the Bachelor of Engineering program. Effective with the Dartmouth class of 2011, majors modified with non-science areas, *i.e.,*

Studio Art, Economics, and Policy, will need additional courses to complete the engineering and science requirements of the B.E.

Prerequisites

The prerequisites to the Engineering Sciences major are:

Three courses in mathematics (nominally 3, 8, and 13)

Two courses in physics (13, 14)

One course in chemistry (5)

One course in computer science (Engs 20 or CoSc 5)

Let's take these one at a time, because there are some variations.

If you have advanced placement credit in Calculus AB, then Math 3 is taken care of and you only need to take Math 8 and 13. If you have two AP credits (Calculus AB and BC), then both Math 3 and 8 are taken care of. The appropriate math course is not Math 13, but Math 11 (taken freshman fall), which includes topics from Math 8 that are not part of BC Calculus.

A couple of the calculus courses have honors sections (Math 9 for Math 8, and Math 12 for Math 13), which delve more deeply into the theoretical aspects of the calculus (*i.e.*, they are more "proofy"). As far as the engineering sciences major goes, it doesn't matter if you take the regular or honors courses. If you are invited to take honors calculus, make the choice based on your love for mathematics.

Physics 13-14 is the standard sequence for engineering majors. The physics department has determined that AP Physics credits do not substitute for these courses. The department offers an honors sequence, Physics 15-16, that covers the same material in greater depth. As with mathematics, the engineering sciences department doesn't care if you take 13-14 or 15-16. If you are invited to take honors physics, make the choice based on your love for physics.

Dartmouth has a two-course general chemistry sequence, Chem 5-6. Only Chem 5 is required for the Engs major. AP Chemistry can substitute for Chem 5. Chem 10 is the honors course, offered in the fall to students with AP credit. It is equivalent to Chem 6, perhaps with some topics drawn from Chem 5 that don't appear in the AP course.

There are two ways to satisfy the prerequisite in computer science. The Engs department offers Engs 20, "Introduction to Scientific Computing", and the Computer Science department offers CoSc 5, "Introduction to Computer Science." Both courses will teach you the fundamentals of thinking logically about computational problem solving and writing good code. They differ in the computer languages used and in the application emphases. Engs 20 uses the languages C and Matlab, which are widely employed in engineering. Matlab, in particular, is used in many Engs courses for number crunching and for graphics. It is also a standard tool in research and in industry. The application examples in Engs 20 are drawn from the kinds of computational problems you will encounter in Engs courses. CoSc 5 uses the Java language and introduces object-oriented programming, which is important in designing large software systems. The application

examples are typical of the kinds of problems encountered in subsequent computer science courses.

Both courses are offered twice a year, in fall and spring terms. Our preference is that you take Engs 20, unless you intend to pursue the modified major with computer science, in which case you must take CoSc 5.

Modified majors may have additional prerequisites for the courses in the modifying department.

The Engs core courses

The required courses for the regular Engs major can be divided into three categories.

Required core (take all 3)	term	prereq	lab/project
Engs 21, Introduction to Engineering	F, S	Math 3	P
Engs 22, Systems	W, X	Phys 14, Math 13 Engs 20 or CoSc 5	L
Engs 23, Distributed Systems and Fields	F, S	Engs 22 (Math 23 recommended)	
Elective core (choose 2)			
Engs 24, Science of Materials	W, S	Phys 14, Chem 5	P
Engs 25, Thermodynamics	S, X	Phys 13, Math 13 Engs 20 or CoSc 5	P
Engs 26, Control Theory	F, S	Engs 22	L, P
Engs 27, Discrete and Probabilistic Systems	W	Math 8 Engs 20 or CoSc 5	
Gateway courses (choose 2, from different groups)			
Engs 31, Digital Electronics	S, X	None	L, P
Engs 32, Electronics: Linear and Digital Circuits	W	Engs 22	L, P
Engs 33, Solid Mechanics	F, X	Phys 13, Math 13 Engs 20 or CoSc 5	L, P
Engs 34, Fluid Mechanics	W	Engs 23, 25	L
Engs 35, Biotechnology and Biochemical Engg	F	Math 3, Chem 5	L
Engs 36, Chemical Engineering	F	Engs 22, 25	
Engs 37, Intro to Environmental Engineering	F	Math 3, Chem 5	

The required core teaches methods and skills that we believe every engineer ought to know. Engs 21 will teach you how to take a project from initial idea to final prototype. Engs 22 and 23 teach mathematical and physical methods of modeling and analysis, and draw examples from multiple branches of engineering to illustrate common methods of solving problems.

The elective core consists of four courses that are narrower in scope than 22 and 23, but still applicable to more than one branch of engineering. You are required to choose two, but as your interests develop, you may find that you want to take more in order to have all the tools you need for your chosen field. A very good argument can be made for

taking all of them, but time will generally not permit that, so choices have to be made. Here are some examples:

- A mechanical engineering student will be sure to take 24 and 25, but 26 is also an excellent idea.
- A chemical engineer should take 25 and 26, but 24 is also a good choice.
- An electrical engineer will likely take 26 and 27, but 24 is important for understanding how semiconductor devices work, and 25 is necessary to understand energy conversion technologies.

The gateway courses are specialized to particular branches of engineering: 31 and 32 are electrical, 33 and 34 are mechanical, 35 and 36 are chemical, and 37 is environmental. You have to choose two from two different groups. Here are a few examples:

- If you don't know what kind of engineering appeals to you, then the gateway courses give you an opportunity to sample two different areas.
- If you're an aspiring chemical engineer you'll want to take 36. Engs 35 will also be a good course to take, but because you're already chosen 36, it cannot serve as your second gateway course. Instead, choose 34 or 37. The combination of Engs 36 and 37 is also good for prospective environmental engineers.
- If you're interested in mechanical engineering, you'll probably start with 33; for your second gateway course, 31 or 32 will be a good choice, because many mechanical systems have significant electronic elements.
- An electrical engineering student will choose 31 or 32. For the second gateway course, 33 or 36 is a good choice, because of the mechanical and chemical aspects of electronic manufacturing.

The modified majors each include a subset of the core and gateway courses, as shown below. For complete descriptions of the modified majors, see the ORC or Thayer bulletin.

Biology	22, 25, 35
Biomedical engs	21, 22, one from 23-27, one from 31-36
Chemistry	22, 25, 36
Environmental science	22, 25, 37
Computer science	22, 27, 31, and 23 or 24
Engineering physics	22, 23, 24
Economics	21, 22, and 23, 24, 25, or 33
Policy	21, 22, one from 23-27, one from 31-37
Studio art	21, 24, 33

Electives

Beyond the core and gateway courses, the regular Engs major includes two elective courses. One of these must be an Engs course. The other may be either an Engs course or a course in math or science.

- The Engs elective can be another course chosen from the core and gateway courses, a more advanced course in a particular area (numbered above the 20s and 30s), or the culminating experience (see more about this later).

- Recommended math and science courses for the other elective include Math 22 (linear algebra), Math 23 (differential equations), Chem 6 (second term of general chemistry), Phys 19 or 24 (modern physics), and Biol 11 and 12-16 (foundation courses is various branches of biology). In particular, many students take Math 23 either with or before Engs 22 or 23.

If you plan to stay on for the B.E., it is a very good idea to take a math or science course for the second elective. The combined A.B.-B.E. program requires nine courses in math or *natural* science (except for those computer science courses designated QDS, computer science doesn't count). The prerequisites to the Engs major supply six of the nine, and the B.E. program itself includes an applied math course. The second major elective can supply one of the remaining two.

Culminating experience

A so-called culminating experience in the major is a requirement for graduation from Dartmouth. There are three ways to meet this requirement in engineering sciences.

1. Complete the Bachelor of Engineering design project sequence, Engs 190/290.

2. Do an independent project, either an honors thesis (Engs 88) or a non-honors senior thesis (Engs 86).

3. Take a suitably advanced course that includes a research or design project. An up-to-date list of eligible courses may be found at the Thayer School website.

In the regular Engs major and most of the modified majors, the culminating experience may be counted as one of the engineering sciences electives. For example, the following courses are a valid program: 21, 22, 23, 24, 26, 32, 33, Math 23, Engs 190/290.

Engs 190/290

The B.E. project sequence, Engs 190/290 (F, W) is a popular culminating experience option among students who are trying to complete the B.E. in fewer than five years. The project is the main part of the course, but there are several lectures on topics related to the professional practice of engineering. The projects themselves are usually provided by industry, so in this respect you are working for an industrial client or, in some cases, for Thayer School as a client. Early in the fall term, after reading the descriptions of the projects and the technical expertise that each requires, you submit a list of your preferred projects as well as your qualifications. The faculty then form the final set of projects and teams with the right skill sets to work on them. There is a progress report in the middle and at the end of fall term, a third progress report in the middle of winter term, and a final presentation at the end of the winter term.

The prerequisites for Engs 190/290 are Engs 21 + five more Engs courses numbered between 22 and 76 (*i.e.*, we want you to have the bulk of the major under your belt before you attempt 190/290).

Honors thesis

For details of the honors program, consult the ORC or Thayer bulletin. The honors thesis is a two-term project, completed under the course number Engs 88. Unlike the B.E. project, the honors thesis is on a topic of your choosing, and you work on it by yourself, under the guidance of a faculty advisor.

Engs 88 may be counted as an elective in the plain Engs major and most of the modified majors. The first term of the project may optionally be taken under course

number Engs 87 (Undergraduate Investigations). Engs 87 can be counted as one of the 35 courses required for graduation from Dartmouth, and it can be counted as an elective in the B.E. program, but it does not carry credit as an elective in any Engs major (you may not put it on your major card).

Students usually do the honors project in the winter and spring of senior year, but this is not a hard-and-fast rule. All honors students write a final report and give a public presentation of their work in mid-May.

Non-honors senior project

A student who lacks the GPA required for honors may still complete a two-term independent project for the culminating experience, under the course number Engs 86 (Independent Project). Except for the non-honors distinction, it is in all respects like the honors thesis, Engs 88.

Combining honors with the B.E. project

It is possible, though not easy, to do both an honors thesis and a B.E. project in the same year. One way is to do 190/290 in the fall and winter, start the honors project in the winter (that's right, while you're finishing the B.E. project—we said it wasn't easy), and finish it in the spring. Another way is to take an aspect of the B.E. project and continue it as an independent research project in the spring. This must be planned in close consultation with the 190/290 faculty and your honors thesis advisor, to make sure that the honors project is a significant extension of the B.E. project work.

III. Staying on Track

The next topic is how to get it all done. A big advantage of the Engs major, relative to traditional engineering programs, is its flexibility. Your life is not determined by a fixed curriculum, starting with freshman fall. There are many ways to construct a successful course of study. For purposes of providing some general guidance, consider three models:

1. Complete the A.B. and B.E. in five full years. This is also the model for the student who wants to complete just the A.B. in four years and decide about the B.E. in the senior year.

2. Complete the A.B. and B.E. in fewer than five years, by taking some additional Engs courses in the senior year.

3. Complete the A.B. and B.E. in four years.

The tables on the following pages show good distributions of courses for each of these models (only math, science, and engineering courses shown). The general tables are accompanied by example programs for concentrations in electrical and mechanical engineering. These examples are given only to show how things might fit. You should plan your program in consultation with your advisor and the latest version of the Prospectus.

Five-year A.B.-B.E.

This plan maximizes the flexibility to pursue other interests besides engineering, *e.g.*, a minor in another subject. There is room for an LSA and an honors thesis. Relatively few terms require doubling up on engineering courses, until the fifth year, which is solid

engineering. The general plan is shown in the table below, followed by sample programs. No AP credits are used in these sample programs.

In the first year	Math, physics (or chemistry)
In the second year (including summer)	Finish prerequisites. Do LSA. Take Engs 21, 22, one or two other 20s or 30s or math/science elective.
In the junior year	Take 20s and 30s, math/science elective. Obtain a summer internship.
By the fall term of the senior year	Finish the 20s and 30s.
In the senior year	Complete the major: electives, culminating experience, prepare for completion of the B.E. program during the fifth year
In the fifth year	Complete the B.E. program: 190/290, applied math (91, 92, or 103), six Engs courses

Sample program: B.E. with EE concentration in five years, honors thesis

Summer	Fall	Winter	Spring
	MATH 3 WRIT 5 Distrib	MATH 8 PHYS 13 First-year seminar	ENGS 20 PHYS 14 Distrib
	ENGS 21 MATH 13 Language	CHEM 5 MATH 23 (elective) Language	LSA
ENGS 22 ENGS 31	Leave term	ENGS 27 ENGS 32 (elective) Distrib	ENGS 23 Distrib Distrib
Internship	ENGS 33 MATH 22 (pre-B.E.) Distrib	ENGS 87 ENGS 24 Distrib	ENGS 88 Distrib Distrib
Internship	ENGS 190 ENGS 92 ENGS 26	ENGS 290 ENGS 62 or 68 ENGS 120 or 122	ENGS 110 or 125/126 ENGS 145 ENGS elective

Sample program: B.E. with ME concentration in five years, honors thesis

Summer	Fall	Winter	Spring
	MATH 3 WRIT 5 Distrib	MATH 8 PHYS 13 First-year seminar	ENGS 20 PHYS 14 Distrib
	ENGS 21 MATH 13 Language	CHEM 5 MATH 23 (elective) Language	LSA
ENGS 22 ENGS 25	ENGS 23 ENGS 33 Distrib	Leave term	ENGS 24 Distrib Distrib
Internship	ENGS 76 (elective) MATH 22 (pre-B.E.) Distrib	ENGS 87 ENGS 32 Distrib	ENGS 88 Distrib Distrib
Internship	ENGS 190 ENGS 91 ENGS 130	ENGS 290 ENGS 140 ENGS 34 or 142	ENGS 26 ENGS 71 ENGG 146

A.B.-B.E. in fewer than five years

This plan moves three or more engineering courses from the B.E. program back into the senior year. The sample programs shown take fourteen rather than fifteen terms, and only one AP credit is required to make things fit reasonably well.

In the first year	Math, physics (or chemistry)
In the second year (including summer)	Finish prerequisites. Do LSA. Take Engs 21, 22, one or two other 20s or 30s or math/science elective.
By the fall term of the junior year	Finish Engs 21-23.
In the junior year	Take 20s and 30s, math/science elective. Obtain a summer internship.
By the fall term of the senior year	Finish the 20s and 30s, electives
In the senior year	Complete the major: culminating experience, BE applied math course, two spring-term BE courses
In the fifth year	Complete the B.E. program: 190/290, four Engs courses

These sample programs for EE and ME use the course option for the culminating experience, but an honors project will also fit just fine. Note how the spring term B.E. courses are shifted into the senior year. The more aggressive preparation in the senior year can either open up or close off options in the fifth year.

Sample program: B.E. with EE concentration in fourteen terms, no honors thesis

Summer	Fall	Winter	Spring
AP credit for MATH 3	MATH 8 PHYS 13 WRIT 5	MATH 13 PHYS 14 First-year seminar	ENGS 20 Distrib Distrib
	ENGS 21 ENGS 33 Language	CHEM 5 MATH 23 (elective) Language	LSA
ENGS 22 ENGS 31	ENGS 23 MATH 22 (pre-B.E.) Distrib	Leave term	ENGS 24 Distrib Distrib
Internship	ENGS 92 (BE) ENGS 61 (culm) Distrib	ENGS 32 (BE) ENGS 27 Distrib	ENGS 110 (BE) Distrib Distrib
Internship	ENGS 26 or 63 ENGS 129 ENGS 190	ENGS 62 or 68 ENGS 120 or 122 ENGS 290	

Sample program: B.E. with ME concentration in fourteen terms, no honors thesis

Summer	Fall	Winter	Spring
AP credit for MATH 3	MATH 8 PHYS 13 WRIT 5	MATH 13 PHYS 14 First-year seminar	ENGS 20 Distrib Distrib
	ENGS 21 Distrib Language	CHEM 5 MATH 23 (elective) Language	LSA
ENGS 22 ENGS 33	Leave term	ENGS 24 MATH 22 (pre-B.E.) Distrib	ENGS 23 ENGS 25 Distrib
Internship	ENGS 76 (culm) ENGS 26 (BE) Distrib	ENGS 32 ENGS 34 (BE) Distrib	ENGS 71 or 145 (BE) ENGG 146 (BE) Distrib
Internship	ENGS 190 ENGS 91 ENGS 130	ENGS 290 ENGS 140 ENGS 142	

A.B.-B.E. in four years

Each year, about twenty percent of the graduating Engs majors complete the B.E. simultaneously with the A.B. The more AP credits you have, the better. However, just to show what's possible, the sample programs below assume only two AP credits, in calculus. One calculus credit and one foreign language credit will work just as well. An LSA is still possible.

In the first year	Math (using AP), physics, Engs 20 or 21
In the second year (including summer)	Finish prerequisites. Do LSA. Take Engs 21, two other 20s or 30s, and math/science elective.
By the fall term of the junior year	Finish Engs 21-23.
In the junior year	Take 20s and 30s, math/science elective. Obtain a summer internship.
By the fall term of the senior year	Finish the 20s and 30s, electives
In the senior year	Complete the B.E. program: 190/290, four Engs courses

The following sample programs also assume that distributives are chosen that satisfy both distributive and world culture requirements (*e.g.*, LIT and W). To show how other science courses can be worked in, PHYS 19 (modern physics) is used instead of MATH 22 (linear algebra). Elective choices are limited compared to the longer programs. With more AP credits and/or by sacrificing the LSA, a greater variety of engineering electives can be used.

Sample program: B.E. with EE concentration in twelve terms

Summer	Fall	Winter	Spring
AP credit for MATH 3, 8	MATH 11 PHYS 13 WRIT 5	Distrib PHYS 14 First-year seminar	ENGS 20 PHYS 19 (elective) Distrib
	ENGS 21 CHEM 5 Language	ENGS 24 MATH 23 (pre-BE) Language	LSA (Lang + 2 Distrib)
ENGS 22 ENGS 33 Distrib	Leave term	ENGS 32 (BE) ENGS 27 Distrib	ENGS 23 ENGS 31 Distrib
Internship	ENGS 92 ENGS 61 or 63 ENGS 190	ENGS 62 or 68 ENGS 120 or 122 ENGS 290	ENGS 110 or 126 ENGS 26 Distrib

Sample program: B.E. with EE concentration in twelve terms, no LSA

Summer	Fall	Winter	Spring
AP credit for MATH 3, 8	MATH 11 PHYS 13 WRIT 5	Distrib PHYS 14 First-year seminar	ENGS 20 PHYS 19 (elective) Distrib
	ENGS 21 CHEM 5 Language	ENGS 22 MATH 23 (pre-BE) Language	ENGS 23 Distrib Language
ENGS 33 ENGS 31 Distrib	Leave term	ENGS 32 (elective) ENGS 27 Distrib	ENGS 26 Distrib Distrib
Internship	ENGS 92 ENGS 61 or 63 ENGS 190	ENGS 62 or 68 ENGS 120 or 122 ENGS 290	ENGS 110 or 126 ENGS 145 Distrib

Sample program: B.E. with ME concentration in twelve terms

Summer	Fall	Winter	Spring
AP credit for MATH 3, 8	MATH 11 PHYS 13 WRIT 5	Distrib PHYS 14 First-year seminar	ENGS 20 PHYS 19 (elective) Distrib
	ENGS 21 CHEM 5 Language	ENGS 24 MATH 23 (pre-BE) Language	LSA (Lang + 2 Distrib)
ENGS 22 ENGS 33 Distrib	ENGS 76 (elective) ENGS 26 (BE) Distrib	Leave term	ENGS 23 ENGS 25 Distrib
Internship	ENGS 190 ENGS 91 ENGS 130	ENGS 290 ENGS 140 or 142 ENGS 32	ENGS 71 or 75 ENGS 145 ENGS 146

Sample program: B.E. with ME concentration in twelve terms, no LSA

Summer	Fall	Winter	Spring
AP credit for MATH 3, 8	MATH 11 PHYS 13 WRIT 5	Distrib PHYS 14 First-year seminar	ENGS 20 PHYS 19 (elective) Distrib
	ENGS 21 CHEM 5 Language	ENGS 22 MATH 23 (pre-BE) Language	ENGS 23 ENGS 24 Language
ENGS 25 ENGS 33 Distrib	ENGS 76 (elective) ENGS 26 Distrib	Leave term	ENGS 31 ENGS 71 or 75 Distrib
Internship	ENGS 190 ENGS 91 ENGS 130	ENGS 290 ENGS 140 or 142 ENGS 34	ENGS 145 or 156 ENGS 146 Distrib

A student who chooses to stay on for the M.S. or M.E.M. after the B.E. regains some flexibility in scheduling advanced courses. Examples of combined A.B.-B.E.-M.E.M. programs will be shown later.

Which courses can be doubled up?

All of the sample programs include terms where two Engs courses are taken together. Some combinations are notably absent: Engs 20 and 21, or Engs 21 and 31. These particular courses require a lot of time, and it isn't considered wise to double them up (although every combination has probably been tried—once).

The table below is intended to provide you with a bit more guidance about what undergraduate courses make more or less sense together, in terms of workload. Virtually all classes have significant weekly problem sets. The table shows courses that have labs and/or term projects. Even within this table, there is variation as to the intensity of the project experience. Most students would say that the design experiences in Engs 21, 31, and 76 are very intense, while in the other classes, they are significant, but don't threaten to dominate your life at the end of the term.

Course	Lab, project	Course	Lab, project
Engs 20 Intro Scientific Computing	L	Engs 43 Environmental Transport & Fate	
Engs 21 Intro to Engineering	P	Engs 44 Sustainable Design	P
Engs 22 Systems	L	Engs 51 System Dynamics	P
Engs 23 Distributed Systems & Fields		Engs 52 Operations Research	
Engs 24 Science of Materials	L, P	Engs 56 Biomedical Engineering	P
Engs 25 Thermodynamics	L	Engs 61 Intermediate Electrical Circuits	L
Engs 26 Control Theory	L, P	Engs 62 Microprocessors in Engineered Systems	L, P
Engs 27 Discrete & Probabilistic Systems		Engs 63 VLSI Systems	P
Engs 31 Digital Electronics	L, P	Engs 68 Communication Systems	
Engs 32 Electronics	L, P	Engs 71 Structural Analysis	P
Engs 33 Solid Mechanics	L, P	Engs 73 Materials Processing & Selection	P
Engs 34 Fluid Mechanics	L	Engs 75 Product Design	P
Engs 35 Biotechnology & Biochem Engg	L	Engs 76 Machine Engineering	P
Engs 36 Chemical Engineering		Engs 91 Numerical Methods in Computation	L
Engs 37 Environmental Engineering		Engs 92 Fourier Transforms & Complex Variables	
Engs 41 Sustainablity & Natural Resource Mgmt	P		

Course evaluations

Another source of information about courses is the student evaluations. Evaluations for all engineering courses are kept on reserve in Feldberg library for your reference.

IV. Doing Research

This is a coming attraction

V. Life after the A.B.

Completing the B.E. program

Currently nearly three-fourths of Engs majors continue on to complete the Bachelor of Engineering degree. The B.E. requires a minimum of nine courses in math and natural science, nine in humanities and social sciences (including foreign language), and 13.5 in engineering sciences (six of which must have significant design content).

Effective with the Dartmouth class of 2011 (Thayer B.E. class of 2012), the requirements for the B.E. degree will be as follows:

(a) 13.5 credits in engineering sciences: Engs 20 (or CoSc 5), 21, 22, 23, two from 24-27, two from 31-37 (in different disciplines, except as noted below), Engs 190 and Engs 290 plus fourelectives. Six of these courses must have significant design content.

(b) 9 credits in mathematics and natural science, including Math 3, 8, 13; Physics 13-14; Chem 5; Engs 91, 92, or 103, and two electives.

(c) 2 additional credits in mathematics, natural science, or engineering science.

(d) 9 credits in humanities and social sciences (fulfilled by Dartmouth general education requirements).

These requirements apply to all engineering sciences students, including modified majors. In particular,

- There is no change for plain Engs majors. Requirement (c) is already normally fulfilled by engineering electives in the B.E. program.
- Students pursuing an Engs major modified with a natural science (including engineering physics and biomedical engineering science) will need to take a few additional Engs courses to fulfill all the core and gateway requirements (21, 22, 23, two from 24-27, and two from 31-37). Unlike plain Engs majors, they may take the two 30-level courses from the same engineering discipline. Requirement (c) is already fulfilled by the science courses in the modifying department.
- Students pursuing an Engs major modified with a non-science subject (*i.e.*, studio art, economics, or public policy) will need to take additional courses to fulfill the engineering core and gateway requirements as well as requirement (c). Like plain Engs majors, they must take the two 30-level courses from different engineering disciplines.

The planning point here is that you should make sure that, prior to the fifth year, you have fulfilled enough of the requirements so that you need no more than nine courses to finish the B.E. If you are a plain Engs major, you will take six of the math and natural science courses as prerequisites to the major. One more math course beyond the three required for the A.B. is included as part of the B.E. program proper (Engs 91, 92, or 103). That leaves two additional math and natural science courses that must be taken, usually prior to the fifth year. Because these courses are frequently valuable in your other Engs courses (*e.g.* Math 23), it is a good idea to take them sooner rather than later.

If there are courses you know you want to take in the fifth year, make sure that you have taken the prerequisites for those courses in your senior year. For example: Engs 61 and 129 are both taught in the fall term, and 61 is a prereq for 129; thus, 61 should be taken in the senior fall so you can take 129 in the. fall of the fifth year. Also, if several important courses are taught in the same term, take one or more of them in your senior year so that you don't have to choose one to drop in your fifth year. For example, Engs 34, 140 and 142 are all good mechanical engineering courses, offered in the winter; however, the required course Engs 290 is also offered during the winter and so one of these should be scheduled in the preceding year.

Preparing for the M.E.M. program

Upon completing the B.E., many students continue into the Master of Engineering Management (M.E.M.) program. The M.E.M. program requires fifteen graduate-level courses in engineering and management, but significant overlap is allowed between the B.E. and the M.E.M., so that the M.E.M. can be completed in one additional year beyond the B.E., or less. In particular:

- The M.E.M. requires Engs 103, which also satisfies the applied math requirement for the B.E.
- Any graduate-level engineering course taken as part of the B.E. program may also be counted as a graduate-level engineering course in the M.E.M. program.

As with combining the A.B. and B.E. in fewer than five years, efficiencies are obtained at the cost of reduced flexibility for choosing electives. For example, the ability to double-count Engs 103 for both the B.E. and M.E.M. makes it nearly irresistible to take Engs 103 as the applied math course for the B.E., even though Engs 91 or 92 might be better suited to your technical education. When planning the additional courses to satisfy the requirements for the B.E. and M.E.M., you need to balance carefully the program requirements, the amount of time you want to spend in school, and the technical preparation you want to have in your career. As we have said before, consulting with a faculty advisor is important as you make your plans.

The table below shows an example of how the B.E. and M.E.M. can be completed in two years beyond the A.B. It requires that the B.E. be "frontloaded" by taking enough extra courses in the senior year so that only seven remain to be taken in the fifth year to complete the B.E.

Summer	Fall	Winter	Spring
Internship	Senior year includes at least two additional. courses to meet B.E. requirements		
Internship	ENGS 190 (BE) ENGS elective (BE) ENGG 178 (MEM)	ENGS 290 (BE) ENGS 103 (BE/MEM) ENGS elective (BE)	ENGS elective (BE) ENGS elective (BE) ENGS elective (BE/MEM)
Internship (ENGG 390)	ENGM 181 (MEM) ENGM 184 (MEM) ENGG 177 (MEM)	ENGM 179 (MEM) MEM elective MEM elective	ENGM 180 ENGM 183 MEM elective

Applying to graduate programs outside Thayer

A coming attraction.

VI. Career Planning[2]

Thayer School Career Services focuses on providing career services and resources related to engineering. While we primarily serve Thayer School students, our office is open to all Dartmouth students and alumni/ae that might benefit from our services.

As an undergraduate student at Dartmouth, you are also welcome to utilize Dartmouth Career Services which offers additional career and graduate school planning resources. Dartmouth Career Services is located at 63 S. Main Street, on the 2nd Floor of the Bank of America Building. For more information, see their website: http://www.dartmouth.edu/~csrc/

Thayer Career Services Resources

Thayer Career Service's goal is to connect students with resources, tools and advice they need to explore and obtain "dream jobs." We offer individual customized assistance, facilitating connections with employers and alumni/ae. Whether through on-campus recruiting, career fairs or making connections we are here to help you, step-by-step, in pursuing your goals and dreams.

Below is a list of some of the resources you have access to:

Advising Appointments. From identifying your career interests and skills to accepting a job offer, a Career Services staff member is available to help you at each step of your career development. Schedule an appointment by dropping by the office (Cummings 135) or by calling 646-1490.

Resume & Cover Letter Reviews. Career Services is available to help you develop and revise resume and cover letters. If you choose to major in Engineering Sciences, your

resume should include details on your project experience from coursework.

Workshops/Programs. Each term we offer a variety of workshops and alumni talks on topics such as *Strategies for Finding an Internship*, *Networking* and *Careers in Climate Protection*, as well as mock interview programs. Check our online events calendar for dates, times, and locations.

Career Fairs. The Engineering and Technology Career Fair and Thayer Internship Fair are held annually in October and January, respectively. Attend both and explore the possibilities!

DartBoard. An online database of internships/entry-level job posting and on-campus interview opportunities with employers targeting Dartmouth and Thayer students. Log in at:
https://www.myinterfase.com/dartmouth-eng/student/

Graduate School.
We offer resources for researching grad schools, studying for GREs and managing the application process including a database of recent Thayer alums that have pursued graduate degrees immediately after completing their Bachelor of Engineering degree. Tap these alums for information on applying to specific programs.

Alumni Networking. Both Dartmouth and Thayer alumni/ae have volunteered to serve as career advisors to current students. Stop by our office or check out our website to learn how to access the network.

Library Resources. Searching for career information on "what you can do with a specific major" or general strategies about job hunting? Chances are good that we have what you're looking for...Whether you're looking for information on venture capital or biomedical engineering, applying for a job in China or to graduate school, we have great information!

Engineering Career Services Website
Visit the Thayer Career Services website for more resources:
http://engineering.dartmouth.edu/career/students/index.html

VII. Paperwork and Deadlines

The source and destination for most of the forms you need for the programs at Thayer School is the Academic and Student Affairs Office, Room M103 (MacLean Engineering Sciences Center). Just walk in and ask for help. Here are the main things we get asked questions about.

Major cards

You must file two copies of your major card: one with the College Registrar, and one with the Thayer School Academic and Student Affairs Office. If you are taking a plain Engs major, your card may be signed by almost any engineering sciences professor. If you are pursuing a modified or double major, your card must be signed by the department chair or by the designated advisor for the modified major (consult the ORC or the Thayer School Bulletin for the names of the modified major advisors). Modified majors must secure signatures from both departments, even for pre-approved modified programs.

In order to graduate from Dartmouth, your transcript must show all the courses listed on your major card. Thus, it is a good idea to check in with the Registrar no later than the beginning of senior spring to make sure that everything is in order.

Taking courses elsewhere and transferring credit to Dartmouth

If you want to take an engineering course at another university (*e.g.*, UCSD) and count it toward your A.B. program, you must get the course approved for transfer credit *before* you take it. Pick up a transfer credit form at the College Registrar's office in McNutt Hall. Fill out the course information on it and get each course signed off by the engineering department chair. Then return the form to the College Registrar by the transfer term deadline (consult the Registrar's website for these dates).

The College rules about transfer courses are spelled out in the ORC:

http://www.dartmouth.edu/~reg/regulations/undergrad/off-campus.html

Sometimes you cannot know if you can get into a particular course until you arrive on campus. Thus, it is prudent to get pre-approval for several courses, and make a final choice after you get there.

On the form, each transfer course will be marked as carrying major credit or not, and as being equivalent to an existing Dartmouth course or not. The call is made by the department chair. It is best if you work out your list in consultation with the chair, but if you don't, be sure to bring documentation about the course (*e.g.*, a syllabus from the course website) when you meet with the chair for signatures.

You can transfer a maximum of two courses for credit in the Engs major, and another two for credit towards the B.E.. Some of the core courses in the Engs major are taught in a unique way at Dartmouth (*e.g.*, Engs 21-23), and it is generally not possible to get transfer credit for them. Moreover, some universities organize their curricula into fall-spring or fall-winter-spring sequences, and it may be difficult to jump into the middle of a sequence (*e.g.*, the winter term at UCSD). Finally, at many universities course credits are variable, and some courses may not carry enough credit to be considered equivalent to a Dartmouth course. Read carefully and plan ahead.

Honors program

The application form for the honors program is available in the Thayer School Academic and Student Affairs Office. Your completed application will include a proposal for your project, approved by the professor who will be your advisor for the project. Honors program applications are normally completed in the fall term of the senior year. Ask in M103 for the specific date.

Applying to the B.E. program

Admission to the B.E. program is automatic for students who complete the Engs major with a major GPA of 2.0 or higher. However, in order to begin the program, you must file two forms with the Academic and Student Affairs Office:

- The Student Information Form
  Basically, this is just name and address information so that we can enroll you in our student database.
- The B.E. Program Form
  The B.E. program form is like a major card. You will list all the math, natural science, and engineering courses that comprise your B.E. program, both the ones you took as an A.B. and the additional courses you take as part of the B.E. program proper. You should work out your program with a faculty advisor, who will sign the form for you. Suggested programs of study for different branches of engineering may be found in the Thayer School Bulletin.

  After you turn the form back in to the Academic and Student Affairs Office, it goes to the B.E. Program Committee for approval. They will check to make sure your program fulfills the requirements for the degree, and that it is intellectually coherent.

  The B.E. program form can be changed, with the approval of your advisor and the B.E. Program Committee. Like the major card, in order to graduate your transcript must show all the courses that you list on the program form. It is a good idea to keep a copy of your current program form to remind you of the course of study that was approved.

  The new B.E. requirements that take effect with the Dartmouth class of 2011 (Thayer School B.E. class of 2012) will be reflected in a new version of the program form.

If you are requesting financial aid, information and application forms are available in the Academic and Student Affairs Office.

The deadline for filing the forms for enrollment in the B.E. program is two terms in advance of beginning the program. This gives us time to process your financial aid.

Forms and instructions are also available at the Thayer School website,

http://thayer.dartmouth.edu/thayer/academicsadmissions/be-admission.htm

http://thayer.dartmouth.edu/thayer/academicsadmissions/be-requirements.html

Applying to the M.S. & M.E.M. programs

Unlike the B.E. program, admission to the Master's degree programs, Master of Science (M.S.) and Master of Engineering Management (M.E.M.), is competitive. An exception is made for Engs majors with outstanding academic records, who are offered direct admission during the senior year.

Information about applying to the M.S. and M.E.M. programs is available at the Thayer School Website,

http://thayer.dartmouth.edu/thayer/academicsadmissions/graduate-ms.html

http://thayer.dartmouth.edu/thayer/academicsadmissions/graduate-mem.html

VIII. Getting Involved in the Thayer Community

Life at Thayer School is more than problem sets and term projects. Here are some ways to participate in the life of the school outside the classroom.

- Join a student organization. For a current list of active clubs, see the Thayer School website,

  http://thayer.dartmouth.edu/thayer/studentlife/societies.html

- Attend the weekly Jones Seminar. This a general-interest seminar on some aspect of engineering and technology, held every Friday at 3:30 PM in Spanos Auditorium (Room 100 Cummings).
- Volunteer to be a tour guide. Every day we host an information session and tour for prospective undergrads and their families. A faculty member meets with the family for a half hour, followed by a student-guided tour of the school.
- Volunteer to be a campus tour guide and help tell visiting families about the great stuff that goes on at the end of Tuck Drive.
- Take a professor to lunch. Sometimes the College subsidizes this.