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An Inside Perspective of A Liberal Arts Student Navigating the Engineering Licensure Without an ABET Certified Degree

These are my findings as a young professional studying for her FE exam in the state of Colorado. I am a graduate from Carleton College with a physics degree and math minor and I have a masters of science in architectural engineering. This is written to the best of my ability, but please do your own research based on your CV/Resume, state, and area of interest.

Acronyms

FE= fundamental of engineering exam

EIT= engineer in training or engineer intern (interchangeable)

PE exam= professional engineering exam

PE= professional engineer (license)

NCEES= National Council of Examiners for Engineering and Surveying

ABET= The Accreditation Board for Engineering and Technology

Why take the FE?

The FE allows you to apply to become an EIT. Sometimes, this is a prerequisite to getting a job at an engineering firm. Passing the FE is also a prerequisite to becoming a PE. Generally speaking, a PE allows you to oversee certain types of engineering tasks¹ and stamp plans². Due to this responsibility associated with stamping plans, achieving the credential of PE usually comes with a substantial job promotion and pay raise. Not all engineers need a PE to rise to management positions, but the 16 professions listed on <https://ncees.org/exams/pe-exam/> gives a good idea of who could benefit from this official, state-granted title.

Please note that passing the FE does NOT automatically make you an EIT and is NOT the only requisite to taking the PE exam. The requirements beyond the FE to become an EIT and the requirements beyond the FE to take the PE and then the requirements to become a PE vary state by state, according to the respective states' Board of Professional Licensure. For instance, in California, passing the FE is required to take the PE exam, but being an EIT is not required.

¹ These engineering tasks are typically ones that are regulated and overseen by the state in which the engineer is operating and directly relate to the public safety of the end product.

² Stamping plans indicates that as a professional, you have the knowledge to deem the designed product - whether it be a structure, an energy plant, or a machine – safe for the general public. In other words, the product meets state and federal regulations. Legally one cannot build, say a bridge or certain instruments, from an unstamped set of plans. Thus, with the power of stamping plans comes great responsibility.

Basics of FE

The FE is a 6 hr test, consisting of 110 questions to check knowledge in math, science, and engineering. There are 7 different tests to choose from: chemical, civil, electrical and computer, environmental, industrial and systems, mechanical, and other. Each topic has slightly varying subcategories. It does not matter which topic you choose - all FE exams can be used for EIT certification and taking the PE exam.³

The test is given and proctored by NCEES. It is given in person at a Pearson VUE test center on the computer, in any state, all year long. It does not matter what state you take the FE in, as it is universal by topic and automatically transferable to any state. It is typically encouraged to take it soon after graduation (whether it is undergrad or graduate school is at your discretion) as it reviews topics covered from algebra through ordinary differential equations, kinematics through upper-level courses.

How to study

The FE is just like any other exam where the student needs to know the material, as well as how to take the exam. The basics are outlined on the NCEES website, where the student signs up, submits credentials, and can find materials <https://ncees.org/exams/fe-exam/>. There are many study materials online - varying from prep books to courses to practice exams. Make sure you are gathering materials for the topic that you will be taking the exam in. For instance, while civil and mechanical overlap, they are not the same exam. The most important things to note are the division of subjects, depending on the topic (i.e. mechanical has 6-9 math questions, 4-6 probability questions, 9-14 materials questions, 10-15 fluids questions, and so on). In addition, every student will get access to a (searchable) online PDF of the FE Reference Handbook that they can use during the exam. Like any standardized test, about half of studying is reviewing the material, and half is learning how to take the exam. It is typically advised that a student study for 3-4 months before taking the exam.

Credentials

Each state has different requirements for both the FE and EIT. Some states allow you to sit for the FE without fulfilling the specific FE requirements beforehand. However, you must fulfill all requirements prior to applying for the EIT license. Each state has its own prerequisites, but generally, they are (1) complete a 4-year ABET-accredited degree OR (2) complete a science-based degree with a certain number of math and science credits and a certain number of years of experience. This is where it gets complicated if you went to a liberal arts college, as liberal arts colleges do not typically provide ABET accredited degrees (Carleton doesn't have any, whereas Swarthmore does)⁴. Masters programs are not typically ABET accredited either as the

³ Though topics have varying pass rates, it is advised from an ease of studying perspective that if you want a PE in a certain field, you take the FE in the same field.

⁴ You can quickly identify an undergraduate ABET accredited degree by noting whether the degree is a BS (*usually* ABET accredited) or BA (not ABET accredited). Since BS degrees are usually ABET accredited, you should double check to make sure if this is important for you post-graduation plans.

accreditations are expensive and program-specific, so universities focus their time, energy, and money on accrediting the bachelors programs. Most individuals who choose to pursue an engineering profession will get a bachelors of science from an ABET-accredited program.

Colorado and California Alternatives to ABET Accreditation⁵

In Colorado, the [Division of Professions and Occupations states on their website](#), that to become an EIT, you must graduate from a ABET-accredited curriculum OR “Graduate from an engineering curriculum of 4 years or more not approved by the Board OR from **a related science curriculum of 4 years or more and have 2 years of progressive engineering experience**. [The student] May take the FE exam after graduation prior to completion of experience. Engineer Intern enrollment will be awarded after the applicant possesses a total of 6 years of progressive engineering experience, of which educational study may be a part.” In addition, you must have at least “12 semester hours, or the equivalent of mathematics beyond trigonometry...” and “a minimum of eighteen semester hours, or the equivalent, of basic sciences and/or engineering sciences and/or engineering design” (source: [Colorado Revised Statutes section 12-120-211](#) and [Code of Colorado Regulations Section 1.4-G.f.](#))⁶ Please note that Carleton College has “6 credit” on their transcripts, but to compare apples to apples with other institutions, it is counted as 3 credit hours⁷.

Here is an example of how to I meet these credentials for the state of Colorado in terms of Carleton’s credits:

- **At least 12 semester hours (24 Carleton Credits), or the equivalent of mathematics beyond trigonometry:** Calculus 1, Calculus 2, Calculus 3, Math Structures (introduction to proofs), Linear Algebra, Ordinary differential equations, Partial differential equations
- **A minimum of eighteen semester hours (36 Carleton Credits), or the equivalent, of basic sciences and/or engineering sciences and/or engineering design:**
 - Introductory, Atomic and Nuclear (modern physics), Classical mechanics, Electricity and Magnetism, Electronics, Contemporary experiments, Sustainable energy and principles, Sustainable energy in practice, Thermodynamics, Quantum Mechanics, Comps, Independent research (7 trimesters)
 - Introductory Chemistry

My courses listed above exceed the minimum criteria of 12 semester hours in math and 18 semester hours in science. Then, for the two years of progressive engineering experience, I:

⁵ Other states have alternatives too. This section just provides 2 examples.

⁶ The course grades must be a C or better.

⁷ A full 10-week course at Carleton, counts as 6 credits on the Carleton transcript, but counts at 3.334 semester hours. For ease of calculation, the examples uses 6 credits = 3 semester credit hours.

- completed a masters of science in engineering, which is equivalent to 1 year of experience in the eyes of the board
- worked for 1 year at an engineering firm under the direction of someone with a PE license.

Alternatives to my path to achieve the EIT title include:

- continuing education with a PhD or post-masters (i.e., a masters degree with additional graduate credits beyond what is required) or a post-doctoral position, or
- foregoing the masters degree and working for a total of 2 years.

If a student decides that the official EIT title is not necessary for their career (or ego), they could take and pass the FE in another state (e.g. California). Then they could immediately take and pass the PE in California. Note that PEs are state-specific and must be transferred to another state to be able to practice professional engineering in that state. Note that California does not require the EIT title, and sets out this [flow chart of requirements for their PE](#). It states that one must pass the FE⁸, needs a masters or to work for 3 years if they don't have a BS, and then must have work experience on top of that.

Now, if a student is denied licensure by their state for lack of credentials, they have the option to either go to a different state, or appeal through NCEES. Note that the default is for the state board to grant licenses, and NCEES's primary role is to proctor the FE (and PE) exams. However, NCEES can rule on licensures in certain instances. See the email below for their criteria and note that my example above (representing a Carleton student), would not qualify through a NCEES ruling. I would not have enough undergrad science credits (even though I was a physics major), not enough chemistry or biology credits, not enough statistics credits, and not enough engineering credits (even though I have an engineering masters). Whew!

Good morning, <Carleton student>

This reply is likely more than you need to know at this time, but it will be helpful if you're seeking the NCEES Credentials Evaluation. Please find below more information about the education evaluation process. You are eligible to proceed once you can confirm all coursework is represented with school entries entered in your MyNCEES account, when those transcripts are verified, and when the descriptions are provided as described below. You sent full catalog books, but we'll need only descriptions of the courses you took.

If you need or wish to proceed with NCEES evaluation because your state board requires it, you may since you have the engineering master's/PhD in combination with the related science bachelor's. Please have your schools send the transcripts directly. Go to the Education page in your NCEES

⁸ Note that the California requirements for a PE do NOT require an ABET accredited (i.e., BS) degree.

account, click the blue 'verify' button, then look to the right for sending instructions. If you've already sent transcripts, no need to resend, but for any others where college work was obtained, e.g. any colleges where you earned transfer work, you need to add to your MyNCEES profile as 'non degree' and also request the transcripts (could be from community college, AP credit, dual enrollment, transfer work, CLEP, DSST credit, etc.). Diplomas are not needed for U.S. degrees (that applies primarily for international education), because the U.S. documents have the needed graduation information on them. We do need descriptions from your time of study, and you'll need to search for official, published by your school and copy/paste for only your courses, for all schools.

Please consolidate just the courses you took from each school's course bulletin/catalog from **your time of study**. You can organize them in a Word or Excel doc either alphabetically or chronologically and then send that condensed doc in (please include links for where the descriptions were sourced online). This should wind up being about 5-10 pages. I am not able to search entire course catalogs for your classes. More information is at the bottom about how most schools provide descriptions from further back and when they're not archived online at the school site. If you received AP credit and it appears you did, then we will need transcripts/exam results. AP exam results are available through the College Board (<https://apscore.collegeboard.org/scores/score-reporting>) if you do not have a copy of the results to send in. Be sure the descriptions include important details per course such as pre- or co-requisites, credit hours, department/faculty origination, content/keywords, etc.

Some boards can grant exam clearance or license you because they take other factors into consideration - advanced MS and/or PhD degree in engineering, numerous years of engineering practice, licensed in other states, etc. If a board does not though, and they require the 'equivalent' NCEES Credentials Evaluation wherein your education has met the NCEES Standard, I wanted you to understand sometimes the non-engineering BS + engineering MS/PhD combo does not equate. There is sometimes insufficient engineering coursework. We will include no more than 6 hours of thesis/research/independent study/special topics.

I recommend you consult with your state licensing board(s) about your exam or license eligibility. NCEES does not determine who is eligible to take the FE or PE exams, and we do not license. Therefore, when one is pursuing one of the exams and/or a professional license, (s)he must understand exactly what his board requires.

Sometimes boards will direct individuals with non-engineering educational backgrounds to NCEES to get the Credentials Evaluation. I can share more about that process below.

NCEES provides a course-by-course assessment of your education. We look at all college-level classes completed in a bachelor's, master's, PhD, as transfer credits, AP, IB, etc. Courses are placed in

each category (math/science, engineering science/design, general education, and elective/other) based on the course descriptions. Our assessment is not exclusive of a master's in engineering. It will involve all classes at all schools. You will need them all to be considered including any AP credits. If you've had a chance to thoroughly review the NCEES Engineering Standard, you likely understand what courses you need. We are determining if the combination of all your college studies can meet the NCEES Engineering Education Standard.

<https://ncees.org/engineering/ncees-engineering-education-standard/>

I can tell you that someone with a strong math/science undergrad will usually meet the general education (humanities/social sciences) and the math/science requirements. Even with a combined master's in engineering, often they do not meet the engineering science/design requirement. It is 48 semester credit hours, and the typical engineering master's has 30 hours. Eighteen hours or about 6 more classes are needed. If you took (or plan to take) several prerequisite, undergrad courses, you may be alright. Advanced science, programming, architecture, geology, engineering technology, natural resources, and other non-engineering classes are not categorized as engineering. So, no urban planning/affairs, physics, environmental science, agriculture, chemistry, geology, geography, biology, math/statistics, architecture, agriculture, or technology classes can be used towards the 48-hour engineering science/design requirement. Be sure you've earned at least 48 semester credits of qualifying, rigorous engineering science/design coursework. Before proceeding and so you have your own idea, I encourage you to take inventory to know how many engineering classes you've taken - what is the semester credit total? Some engineering-abbreviated courses are placed in the elective/other category and are not rigorous enough as engineering science/design (e.g., estimating, scheduling, surveying, project management, ethics, law, contracts, CAD/drawing).

The Standard will tell you what is acceptable or not. No math below calculus. Below is typically what an engineer completes in his/her undergrad degree.

Calculus I - 4 hours

Calculus II - 4 hours

Linear Algebra - 3 hours

Probability & Statistics - 3 hours

Differential Equations - 3 hours

Physics I (calc based) - 4 hours

Physics II (calc based) - 4 hours

Biology I OR Chemistry I - 4 hours

Biology II OR Chemistry II - 4 hours

You must have Calculus I & II (differential and integral calculus), and you must have one of the science combos below. Just one semester of each different science is needed, and just know that two physics won't be enough, because you must have 2 different sciences. In other words, you cannot fulfill the science requirement with only 2 physics, 2 biology, or 2 chemistry classes. Two of the three basic sciences are what you need. Beyond these two very specific curricular requirements, other math classes and sciences can be used to arrive at 32 semester credit hours (Calculus III/multivariable, Modern Geometry, Number or Group Theory/Abstract Algebra, Biochemistry, Genetics, Microbiology, Astronomy, Oceanography, Geology, Ecology, Physical Chemistry, Quantum Physics, Optics, Electromagnetism).

Biology + Chemistry

Biology + Calc-based Physics

Chemistry + Calc-based Physics

Prerequisite, undergrad engineering classes - the basics like statics, dynamics, fluid or soil mechanics, materials science, thermodynamics - are important. Usually this is necessary to combine with the graduate courses to attain the 48 hours in engineering science. If there are deficiencies, it is acceptable to take any needed math/science classes through community college, online at reputable/accredited schools, or through CLEP - <https://clep.collegeboard.org/exams>. CLEP exams that we accept for math/science - Calculus (1 semester), Chemistry (2 semesters), Biology (2 semesters). If additional engineering classes are needed, it is necessary to take them through an EAC/ABET program. You can earn them at the undergrad or grad levels. You can take classes only, and they do not have to be through a degree-seeking program of study. We include all passed classes - which includes some D's. It depends on the school, but if the school accepts D's, then NCEES does as well.

We do not provide a preliminary evaluation. The evaluation fee is \$350, and the reevaluation fee is \$100. Many proceed with the evaluation even when they know they do not have sufficient coursework to meet the Standard. This gives them a baseline to then go take the needed courses and return for the reevaluation. If you prefer to take more courses before applying for evaluation, that is fine as well.

Once all official transcripts and the course descriptions prepared in a Word or Excel doc are received, then your account will be enabled with the evaluation purchase option. We need all class descriptions please. To ensure the most favorable NCEES evaluation outcome, all descriptions are needed. Courses without course descriptions are placed in the elective/other category. We do not accept entire course catalogs, or descriptions from the present bulletin. You may need to contact the student records office for assistance if the bulletins from your time of attendance are unavailable online. Usually a staff or student worker can pull the respective hard copy catalogs to scan/email to you (and then you forward to us). A smaller doc can easily be attached and sent as a reply to this message. Applicants

routinely do this. Even with scanned hard copies, the PDF I usually receive is not too extensive because the major-specific courses within the same department typically fall on a couple of pages with a few more for math, science, gen ed.

Thank you,

<*Manager of Credentials and Records*>

If you have further questions, feel free to reach out to me, Emily Schwartz '19, at my personal email, emkschwartz@gmail.com.