The Graduate School Option

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This document provides information on the graduate school option. It describes what graduate school is conceptually, the options available, the financial requirements, how one selects the schools and prepares the applications, the key application requirements and things to consider when applying. The items discussed here applies to majority of applicants typically at the end of their junior year considering a graduate career (masters or a PhD) beyond graduation. Beyond referring to this document, it is recommended you consult your faculty mentors for advice specific to your case.

1 Graduate School Primer

1.1 Graduate school versus undergraduate school.

Graduate school is NOT just undergraduate experience with more difficult classes. The goal of an undergraduate institution is to provide you with fundamentals in your field of study, and not to become an expert at something specific. Graduate school, on the other hand, offers the chance to become an expert on a particular field. This is not just by taking higher level courses but also by researching and solving problems that have not been addressed before.

1.2 Graduate school degrees.

The end goal for a graduate career may be to go for a masters in your field or continue and earn a PhD. The choice may depend on several factors such as your personal interest, passion towards your field of research, your career destination (consulting, academics, industrial engineering, technician oriented jobs etc.), and also relationship with your graduate advisor.

1.3 Size.

Graduate schools are typically very large institutions with large student bodies and large departments. University of Michigan for example has over 40,000 students. The mechanical engineering department has 50 faculty members each with their own area of specialty and graduate students working with them. Due to the large sizes, most of the responsibilities on your career path lies with you.

1.4 Timeframes.

A masters degree may take 1.5 to 2 years to complete depending on the particular option. While a PhD generally takes between 5 and 6 years to complete. A PhD degree includes a masters portion and therefore students may go in for masters and continue with their work to end up with a PhD degree by staying at the institution for additional 3-4 years.

2 Master of Science Degree

2.1 Masters degree.

A masters degree typically has two options: a coursework masters or a project-based masters. A coursework master involves taking courses in a narrow field of your choice. For instance, thermal-fluid sciences, mechanics, controls and dynamics, etc. At some schools the 'purely courses' option may garner a Masters in Engineering degree rather than a Masters in Science degree. A project-based masters (masters thesis route) involves working on a research project with an advisor. At the end you will be required to defend your masters thesis in front of a faculty committee. Projects for a masters thesis route are selected such that they can be completed within the 2 year time frame.

2.2 Coursework or thesis option.

Generally terminal PhD candidates opt for the coursework option so that they do not have to break their research into parts to defend a masters thesis in between their graduate career. Therefore, while taking courses for their masters they continue working with a faculty advisor on their respective PhD projects. It is recommended that terminal masters student choose the thesis option in order to gain experience in research, however, this is a personal choice. A masters thesis does look attractive on a resume, especially with a journal or a conference publication or two.

3 Doctor of Philosophy Degree

3.1 PhD options.

There are no options in your PhD. All PhD candidates work on a research project that is guided by their respective faculty advisors. Typically they work closely with other PhD students under the same advisor having regular meetings at individual and group settings to discuss the different projects. The end goal of a PhD degree is for a student to become an independent researcher and therefore with time the faculty advisor's role becomes of a passive one, as opposed to actively deciding the direction of the project. Therefore the core of a PhD degree is research and not courses.

3.2 PhD success.

How does one judge the success of a PhD (since grades work wonderfully for coursework-based degrees)? The aim of a PhD is to produce new knowledge with the intention of sharing it with other researchers. Therefore success of a PhD is judged by the journal and conference papers that the PhD candidate produces over the course of their graduate career. The number depends on the type of project and your field.

4 Financing the Degrees

4.1 Financing.

Generally, PhD degrees are fully funded by the advisor that a student ends up choosing. The funding includes full tuition as well as a stipend to cover the living expenses. The source of the funding is typically government grants that the faculty advisor has acquired by proposal research projects. Masters students are rarely funded however a faculty advisor may choose to fund a student working on a masters thesis project. Coursework based terminal masters degree is never funded leaving the student responsible for the tuition.

4.2 Reason for funding PhD students.

The advisors acquire grants from funding agencies to work on a research area of their interests. Since the advisors themselves can not be working in the laboratories conducting the research they hire graduate students (paying them a stipend). Together, the graduate students and the faculty advisors publish their findings in journals or conferences. Therefore, both students and advisor benefit upon completion of a PhD. In a coursework-based masters degree, only the student benefits.

4.3 Teaching assistantship.

Funding for PhD-track students may include a teaching assistantship where the student helps a faculty (not necessarily the faculty advisor) teach a class by either lecturing or grading. Several universities offer teaching assistantship to first year PhD students since they have yet to pick a faculty advisor for their PhD thesis. This can be established during admission or post starting your graduate school.

5 Applying to Graduate School

5.1 School selection.

Just like applying to undergraduate institutions you may want to use rankings as your initial guide to picking out the best schools for your field. USNews publishes rankings every year for various fields. These rankings depend on publications, the quality of education, research grants etc. This should give one an idea of the top 30-40 schools in your area of interest. Figure 1 provides a list generated for engineering schools by USNews - notice they also list average GRE scores that you need to be aiming for.

SCHOOLS OF ENGINEERING

THE TOP SCHOOLS

Rank/School	Overall score	Peer assessment score (5.0 highest)	Recruiter assessment score (5.0 highest)	'01 average quantitative GRE score	'01 average analytical GRE score	'01 acceptance rate	'01 Ph.D. students/ faculty	'01 faculty membership in National Academy of Engineering	'01 engineering school research expenditures (in millions)	'01 research expenditures per faculty member (in thousands)	Ph.D.'s granted 2000-01
1. Massachusetts Institute of Technology	100	4.9	4.7	767	697	29.4%	3.7	13.9%	$189.7	$556.3	243
2. Stanford University (CA)	91	4.9	4.6	770	710	35.5%	4.3	14.7%	$88.4	$559.5	195
University of California–Berkeley	91	4.8	4.5	761	719	24.3%	4.9	20.6%	$118.6	$541.7	179
4. Georgia Institute of Technology	83	4.5	4.2	760	696	40.9%	3.4	4.6%	$187.6	$434.3	194
5. University of Illinois–Urbana-Champaign	81	4.6	4.4	771	722	16.7%	3.4	3.7%	$140.3	$389.7	217
6. University of Michigan–Ann Arbor	80	4.6	4.1	768	709	33.6%	3.4	2.9%	$135.0	$600.2	184
7. California Institute of Technology	79	4.8	4.5	776	717	14.8%	4.7	17.0%	$46.0	$523.1	80
8. Cornell University (NY)	74	4.3	4.2	771	726	27.0%	3.8	7.0%	$88.3	$689.5	104
University of Southern California	74	3.6	3.7	756	659	40.0%	4.8	11.3%	$107.5	$903.1	81
10. Carnegie Mellon University (PA)	73	4.3	4.2	770	730	21.1%	3.5	8.8%	$86.2	$495.4	97
University of Texas–Austin	73	4.3	4.0	763	698	26.6%	3.1	9.7%	$97.8	$537.6	140
12. Purdue University–West Lafayette (IN)	70	4.3	4.3	760	692	33.2%	2.7	2.7%	$103.3	$461.2	150
Texas A&M University–College Station	70	3.9	3.8	747	646	35.5%	2.9	3.9%	$139.9	$692.4	125
14. University of California–San Diego	69	3.7	3.7	766	708	22.1%	3.8	11.4%	$112.5	$846.1	53
15. Penn State University–University Park	66	3.9	3.9	754	698	41.2%	2.0	2.1%	$117.5	$354.9	137
University of Wisconsin–Madison	66	4.1	3.9	771	736	31.1%	2.8	5.1%	$98.2	$471.9	99
17. Harvard University (MA)	65	3.7	4.2	771	722	14.3%	3.6	16.3%	$24.4	$737.9	23
18. Princeton University (NJ)	64	4.2	4.0	778	743	17.5%	3.8	11.6%	$45.0	$405.4	53
19. University of Maryland–College Park	62	3.7	3.7	766	700	23.4%	3.6	3.0%	$103.9	$535.8	120
20. Northwestern University (IL)	60	4.0	3.8	762	730	28.9%	3.4	7.0%	$49.0	$415.4	106
21. University of California–Los Angeles	58	3.8	3.8	780	680	36.8%	4.7	2.2%	$50.7	$378.2	100
University of Minnesota–Twin Cities	58	3.8	4.0	750	696	39.1%	2.7	4.6%	$55.9	$274.0	118
23. Virginia Tech	57	3.8	3.9	746	673	35.8%	1.3	2.3%	$98.3	$555.2	103
24. Johns Hopkins University (MD)	55	4.0	3.9	764	712	17.9%	3.4	0.8%	$47.8	$408.8	54
University of California–Santa Barbara	55	3.4	3.5	769	717	15.8%	4.1	12.7%	$39.4	$339.5	64
26. Columbia University (Fu Foundation) (NY)	53	3.6	3.6	759	700	31.0%	2.9	7.3%	$44.7	$480.6	53
Ohio State University	53	3.6	3.7	757	697	16.9%	2.5	1.6%	$78.9	$350.7	99
28. University of Pennsylvania	52	3.5	3.8	753	699	32.3%	3.0	7.8%	$42.1	$501.2	41
29. North Carolina State University	51	3.5	3.5	758	686	31.3%	2.5	4.0%	$69.9	$364.2	87
University of Florida	51	3.5	3.7	746	635	13.3%	3.1	1.1%	$70.0	$370.6	95
31. Rensselaer Polytechnic Institute (NY)	50	3.7	3.8	740	669	33.3%	3.1	4.5%	$30.2	$293.0	67
32. Rice University (TX)	49	3.7	3.7	780	720	15.8%	3.5	5.1%	$22.0	$271.2	33
University of Washington	49	3.7	3.7	755	689	36.0%	2.6	3.2%	$53.6	$273.6	81
34. Duke University (NC)	46	3.5	3.7	730	711	19.8%	3.3	2.2%	$28.2	$375.7	45
35. University of Colorado–Boulder	45	3.5	3.3	752	683	35.1%	1.9	4.2%	$46.3	$306.6	82
University of Virginia	45	3.3	3.4	757	696	24.2%	2.8	4.0%	$40.8	$384.7	55
Washington University in St. Louis	45	3.2	3.5	770	720	31.2%	2.6	3.7%	$30.5	$442.2	30
38. Iowa State University	44	3.3	3.7	774	704	19.7%	1.4	0.0%	$47.6	$294.1	52
39. University of California–Davis	42	3.5	3.3	751	689	39.6%	2.4	4.5%	$36.4	$220.5	71
Yale University (CT)	42	3.4	3.8	736	709	13.4%	2.4	4.7%	$15.5	$293.2	18
41. Michigan State University	40	3.4	3.4	771	713	23.6%	1.9	0.0%	$27.5	$219.8	51
Rutgers State University–New Brunswick (NJ)	40	3.1	3.3	745	661	23.3%	1.4	3.2%	$66.1	$375.6	63
University of Delaware	40	3.1	3.5	756	690	26.9%	3.6	2.3%	$24.8	$281.9	43
44. Case Western Reserve University (OH)	39	3.3	3.4	711	712	26.2%	1.9	4.6%	$26.6	$282.5	51
University of Arizona	39	3.3	3.5	738	657	50.5%	2.2	5.7%	$25.0	$171.6	49
46. Dartmouth College (Thayer) (NH)	38	3.2	3.3	767	704	20.7%	2.3	2.6%	$17.3	$454.5	8
University of Massachusetts–Amherst	38	3.1	3.4	753	701	16.7%	3.3	0.7%	$29.3	$242.2	47
University of New Mexico	38	2.7	3.2	740	656	39.9%	2.3	1.0%	$41.6	$519.7	25
Vanderbilt University (TN)	38	3.2	3.5	757	697	36.9%	2.2	1.3%	$19.7	$323.3	20
50. Lehigh University (PA)	37	3.1	3.3	762	662	27.5%	2.1	5.3%	$20.7	$299.8	43

Figure 1: USNews ranking for Engineering Schools

5.2 Research schools.

You may want to narrow down the list based on criteria important to you. The most important criterion would be to select faculty members who are working on areas that interest you. Not all schools have all areas that appeal to you. Some schools are famous for their work on material science while some schools are famous for their robotics work. Determine which faculty members work in areas that fascinate you. You will be spending 4-5 years on a project - you better make sure you will enjoy it. You may want to read some journal papers published by a particular lab or a faculty. Cross-off schools where you do not find at least two faculty members you see

yourself working with. Figure 2 presents a sample table that shows a finalized list of school with their locations and chemistry rankings - or any other criteria that is important to you.

Ranks		University	State	safe schools		website URLs	app.	app.
Eng	Chem			Eng	Chem		deadline	fee
1	2	5 Standford University	CA			www.standford.edu	5-Dec	$95.00
2	3	1 University of California - Berkeley	CA			www.berkeley.edu	-	$60.00
3	5	7 University of Illinois - Urbana Champaign	IL			www.uiuc.edu	15-Feb	$50.00
4	6	21 University of Michigan - Ann Arbor	MI			www.umich.edu	1-Feb	$55.00
5	15	18 Pennsylvania State University - University Park	PA			www.psu.edu	15-Feb	$45.00
6	45	38 University of Arizona	AZ	x	x	www.arizona.edu	1-Feb	$50.00
7	16	10 University of Wisconin-Madison	WI			www.wisc.edu	31-Dec	$45.00
8	14	16 University of California-San Diego	CA			www.ucsd.edu	17-Jan	$60.00
9	11	13 University of Texas-Austin	TX			www.utexas.edu	15-Jan	$75.00
10	26	8 Columbia University	NY	x		www.columbia.edu	5-Jan	$65.00
11	22	26 University of Minnesota - Twin Cities	MN	x	x	www.umn.edu	15-Mar	$75.00
12	35	25 University of Colorado - Boulder	CO	x	x	www.colorado.edu	1-Dec	$60.00

Figure 2: A sample narrowed down list based on your selection criteria. Here both Chemistry and Engineering rankings are listed. Be methodical about your selection.

5.3 Diversify your schools.

You may want to apply to 10-15 schools to maximize your chances of admission as well as funding. Not all schools that you get admitted to will offer funding. This is the sad reality for engineers since natural science graduate departments typically guarantee funding upon admission.

5.4 Types of schools.

Do not apply to all the top rank schools. Apply to few top ranked schools as well as lower ranked schools which have faculty members working on projects that sound exciting to you and are active in that area. You can see how active a faculty member is by looking at their publication record - number of papers and year of publication. Most importantly, discuss your choices with your current undergraduate faculty mentors.

5.5 Cost of application.

Applications are not free. In fact, the total cost of applying to graduate school can range between $1000 - $1500, which includes the application fees, the GRE exam fees, etc., if you plan to apply to over 10 schools. Budget for this beforehand. Figure 3 presents a list of expenses incurred for a typical graduate school application process. You may want to even fly or drive out and visit a laboratory if you are very keen on working with a particular professor. Getting a personal connection established helps tremendously.

5.6 Time investment.

Applying to graduate school is a time consuming venture. Between researching, preparing application packets, sending out applications and, if you are lucky, visiting the schools can amount to significant amount of time during the last year of your senior year. So unless you are disciplined and organized, this can be a daunting process. The trick is to plan ahead and spend time working on your applications over a period of few months dedicating few hours every week.

Date	Description	Cost
15-Jul	GRE Books	$ 20.00
19-Aug	General GRE test	$ 105.00
	Ticket	$ 258.00
	Other costs	$ 50.00
9-Sep	General GRE test	$ 105.00
3-Oct	Envelopes, Folders, Clips	$ 5.24
4-Oct	40 stamps	$ 14.80
	GRE Score reports to schools	$ 78.00
4-Nov	App: Arizona	$ 50.00
	App: Berkeley	$ 60.00
	App: Columbia	$ 45.00
	App: Illinois	$ 50.00
	App: Michigan	$ 55.00
	App: Penn State	$ 60.00
	App: San Diego	$ 60.00
	App: Stanford	$ 95.00
	App: Texas	$ 75.00
	App: Wisconsin	$ 45.00
4-Nov	Official Transcripts	$ 30.00
	extra transcripts	$ 15.00
5-Nov	Envelopes for supplimental forms	$ 5.00
	Stamps	$ 10.00
	Total	$ 1,291.04

Figure 3: An example of expenses that includes the application fees, ordering transcripts, GRE expenses etc.

6 Application Process

6.1 Graduate Record Exam (GRE).

Just like SATs you are required to take the GREs possibly in the late summer after your junior year. You can take it twice if you are not satisfied with your scores. This involves a verbal, quantitative (math) and analytical writing sections. The GRE math is very basic however it may still require practice to be quick at answering the questions. Engineering departments pay close attention especially to the GRE math scores.

6.2 Recommendation Letters.

All schools require recommendation letters to be written by your current undergraduate faculty members. You want to make sure you pick members who know you best and can write something that describes your uniqueness. So try to get to know your faculty members early on. Recommendation letters carry a significant weight. Make sure you inform your recommenders or referees ahead of time and provide an up-to-date resume listing your accomplishments and highlighting ones that you want the recommender to stress in the letter. For example, English as a second language and your low verbal score. Provide addresses and stamped envelopes to mail for the faculty member rather than letting the faculty do your work. A faculty member may be writing recommendation letters for a number of students in your class year.

6.3 Personal Statement.

Personal statements help admission officers distinguish between candidates. They are primarily looking for how enthusiastic you are for attending graduate school and how prepared you are to take this responsibility. If you are going for a PhD degree, do stress on your research experience. A conference or a journal publication is a major plus in terms of demonstrating your research experience. Most schools require a personal statement that includes the following:

- Purpose of applying to grad-school.
- Professional plans and career goals.
- Research interests and experience.
- Personal goals and development to date.
- Area of specialization.
- Personal characteristics conducive to completing a graduate degree program.

6.4 Application packet.

Make sure you note down when the deadlines are in your Excel sheet of narrowed down school list. You may want to send out applications ahead of the deadlines as they may start reviewing the applications before the deadline. This is particularly the case when schools are deciding who to fund - this is on first-come-first-serve basis. You also do not want to get lost in the pile that gets in at the last moment. Make sure you have the right documents going to the correct institution!

7 Post Application

7.1 Reach out.

You may want to email faculty members at the various institutions you applied and mention that you are very interested in their university and particularly in joining their labs. Be truthful and therefore thoroughly research each faculty beforehand. Majority of these emails will be ignored but it may be worth sending them out in case they do respond and/or are part of the admission committee.

7.2 Visiting campus.

Majority of the schools will invite you to campus if you are admitted to visit and meet the faculty and students. You will want to indicate which faculty members you are interested in meeting. These faculty members may be the ones you are interested in working with. Make certain you talk to the current graduate students and get their feel for the campus, program, a particular faculty member for their reputation or a project. For some cases, it may be worth covering for the visit yourself if the school does not invite.

8 Questions to ask

The following are some of the questions that may help you decide on the school. Decide what is important you. The questions were published in "Making a Reasonable Choice" by Thomas H. Benton - pen name of William Pannapacker, an associate professor of English at Hope College, in Holland, Mich.

Admissions. How many applications does your program receive each year? How many students are accepted? How many enroll?

Student aid. What kind of financial support can a student expect to receive during the entire course of the program? In each year? What is the cost of living in the area? How much educational debt have students accumulated, on average, by the time they graduate?

Teaching. How many discussion sections and courses are graduate students required to teach in order to receive a stipend in each year of the program? What is the average teaching load in each year of the program?

Attrition. What percentage of students enrolled in the program eventually earn doctorates? How many leave with master's degrees? At what point do most drop out? What are the reasons given, if any (i.e., money, concerns about job market, seeking other opportunities, family responsibilities, etc.)?

Time to degree How many years does it take to graduate on average (not ideally, but in reality)?

Placement How long are graduates on the academic job market? Where, exactly, is every graduate employed in academe (and in what kinds of positions: tenure track, visiting, adjunct, etc.)? Who was their dissertation adviser? What were their subfields? Where are graduates working, if not in academe? Does the program also lead to appealing career paths outside of academe?

9 Graduate School Survival Skills

The following are some recommendations to make the most of your time at graduate school.

- For courses, read the textbook, join a study groups and use the office hours
- Embrace the multicultural aspect of the graduate school
- Make reading journal articles a weekly routine
- Adopt a journal management tool and use it religiously
- Learn the following tools: illustration software for technical drawings, data analysis package like MATLAB, advanced graphing package beyond MS Excel, advanced word processor like LaTeX.
- Attend research seminars and ask questions
- Pursue personal interests not related to graduate work
- Identify your support person/group and stay connected
- Always ask yourself: how is this helping me advance my graduate work?
- Make connections with students and faculty.
- Manage your finances ruthlessly - limit expenses
- Inquire and apply for scholarships large and small
- Take every opportunity to present your work.
- Setup short- and long-term goals for your lab activities
- Take notes profusely of seminars, meetings, talks, lab experiments, etc.
- Use every advisor meeting wisely, prepare an agenda and leave with action items.
- Positively contribute to your lab group (beyond thesis)