Guide for Math Majors

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Four major programs, each with its own advantages

Our majors are not tied to a particular career. They develop qualities that appeal to a wide range of employers, such as quantitative reasoning, problem-solving, and strong work ethic. That said, there are several ways in which students can align their mathematical education with particular career goals:

- B.S. in Mathematics is the most rigorous degree and is the best choice for students planning on graduate studies in mathematics or any graduate program that requires GRE Mathematics subject test. See the *Graduate School* section.
- Either B.A. or B.S. Mathematics is required for dual program with School of Education leading to NY State teacher certification (they have additional course requirements).
- Students who more closely associate their future with engineering or physics will likely find Applied Mathematics programs a better fit.
- Students interested in the actuarial profession should plan ahead to align their coursework with preparation for actuarial exams and fulfilling the VEE requirements. See the *Actuarial* section.

Math Department in numbers (January 2018 data)

- 33 faculty members (tenured/tenure-track), 9 of them hired 2010–
- About 150 undergraduate majors, evenly split between Mathematics and Applied Mathematics. Many are double majors with Economics, Physics, Engineering/CS, etc.
- 27 courses that count toward Bachelor's degrees.

What our majors do after graduation

These are some recent example of career paths of our majors.

- **Graduate school**: Mathematics, Statistics, Computer Science, Mathematical / Quantitative Finance, Physics, Biostatistics, Data Science, Medicine.

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- **Software industry**: Google, Microsoft, GE Software, Boston Technologies, Wolverine Trading, other trading platform development. After M.S. degree, or directly if double majoring in Computer Science.
- **Education**: teaching or developing educational materials.
- **Actuarial careers**: Sun Life Financial, National Life Group, Deloitte Consulting, Conrad Siegel Actuaries.
- **Other financial services**: J.P. Morgan, OppenheimerFunds, Putnam Investments, Nomura Securities) after M.S. or directly if double majoring in Finance.
- **Other**: engineering, government, forensics.

Overview of programs

There are three kinds of requirements; their details are found in the program descriptions.

- **Preliminary**: five courses.
- **Advanced**: six courses for B.A., ten courses for B.S.
- **Extra-disciplinary** (for Applied Mathematics only): one computing course; four science courses or another major or minor.

Preliminary courses develop three distinct sets of skills:

1. Manipulation with continuous, flexible objects (Calculus)
2. Manipulation with discrete or rigid objects (Linear Algebra)
3. Formal mathematical reasoning (Introduction to Abstract Mathematics)

Advanced courses draw on all three of the above. They lead to a much deeper understanding of mathematical structures, at the expense of proportionally greater effort. While on the preliminary level students are mostly following instructions, in the advanced courses they develop independent mathematical thought.

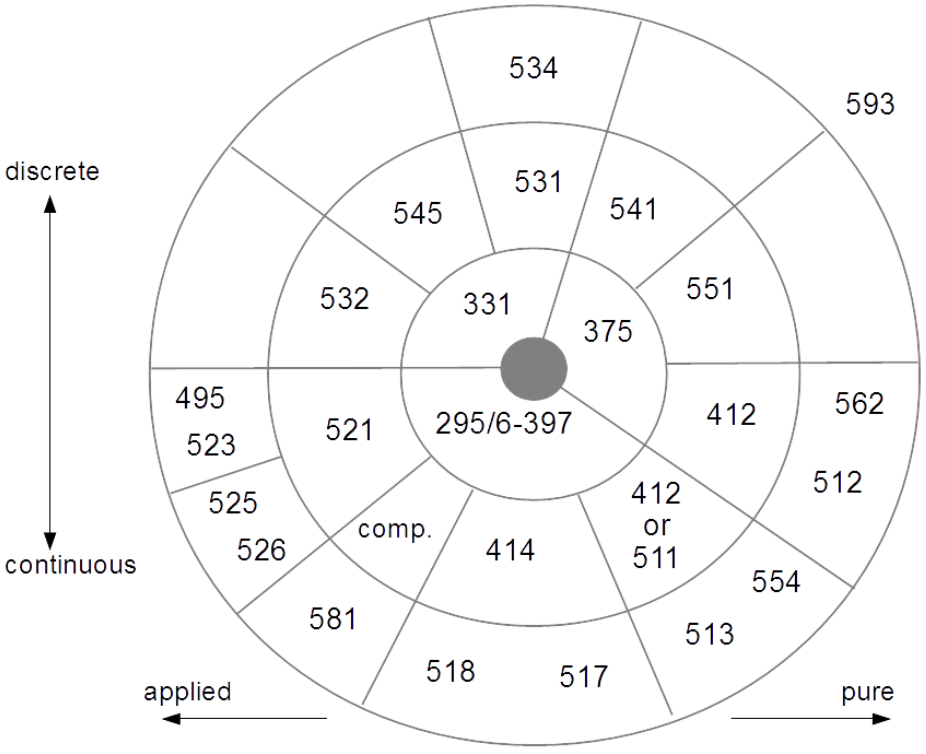
A schematic overview of our advanced courses (400 and 500 level) appears on the next page. It is important to realize that course numbers **do not** always represent the difficulty of courses: e.g., most students find 412 more challenging than 414 or 521.

Extra-disciplinary requirements are present in both Applied Mathematics programs. They consist of two parts: science courses and computing course. Most students in Applied Mathematics programs satisfy the science part without extra coursework, because they already pursue a qualifying major or minor. The computing requirement takes no extra coursework to Engineering students who already took ECS 102 or ECS 104. Non-Engineering computing courses include CPS 196, PHY 307, and EAR 402. Students with programming experience may want to take the more rigorous course CIS 252 instead. Advanced planning is important

because the availability of extra-disciplinary courses is not controlled by the Mathematics department, and some of these courses have prerequisites.

Advanced courses

No advanced prerequisites	**Some advanced prerequisites**
412 Real Analysis I	495 Fundamentals of Data Science (521)
414 Ordinary Differential Equations	512 Real Analysis II (412)
511 Advanced Calculus	513 Complex Analysis (412 or 511)
521 Probability	517 Partial Differential Equations (414 or 485)
531 Second Course in Linear Algebra	518 Fourier Series, Transforms & Wavelets (414)
532 Applied Linear Algebra	523 Statistical Methods for Data Science (521)
541 Number Theory	525 Mathematical Statistics (521)
545 Combinatorics	526 Stochastic Processes (521)
551 Fundamental Concepts of Geometry	534 Abstract Algebra (531)
581 Numerical Methods	554 Differential Geometry (412 or 511)
	562 Elementary Topology (412)
	593 History of Mathematics (two 500+ courses)



Getting involved

Mathematics is far from being a solitary activity. You should get to know the people of Math department, both students and professors. Some suggestions:

- Attend Math Club events: see math.syr.edu/PME You don't have to be a member (or even a math major) to attend.
- Participate in class discussions.
- Talk to professors during their office hours. Some of them will probably be writing recommendation letters for you. The better they know you, the more effective their letters will be.
- Add a photo (and a link to LinkedIn profile or personal webpage, if you have one) to the department's website: see math.syr.edu/majors
- The undergraduate section of Mathematics Department website has pointers to career resources and summer research programs.
- If you are spending time on Twitter or Facebook, you may as well follow @SUmathematics or facebook.com/SUmathdept

Setting your aim higher: Graduate school, etc

The best preparation for graduate school is B.S. in Mathematics, even if you are primarily interested in applied graduate programs. You should also strengthen your application file with activities that go beyond the standard curriculum. Some of them are sensible things to do even if you do not plan on going to graduate school:

- Apply for Pi Mu Epsilon membership, and consider serving as an officer of our chapter.
- Self-study and/or group-study for Putnam exam, which is a nationwide college-level mathematics contest. Pi Mu Epsilon organizes study sessions in Fall semesters; the contest is in December. This is an opportunity to develop your logical reasoning and problem-solving skills. Despite not having material past Calculus 3, the exam is very hard: the mean score is about 4 out of 120.
- Make sure you are familiar with most of the topics on GRE Mathematics Test, and try some practice problems.
- If you are a non-native speaker of English, be aware that many graduate school recommendation forms will explicitly ask the recommender about the applicant's mastery of spoken and written English. Do not shy away from conversations.

The following are more serious undertaking which should be discussed with your advisor in advance:

- Take the sequences 412-512 and 531-534 in the junior year. These are **hard** courses which emphasize proofs and abstract thinking. They are essential for graduate schools preparation, for REU applications, and for getting strong letters of recommendations. If you find that the regular homework in these classes is not challenging enough, talk to your professor, who may be able to suggest harder problems from the textbook or elsewhere.
- Apply to summer research programs (REU) during your junior year. Applications are due early in the Spring semester.
- Take Senior Seminar (599). Getting A or A- in the senior seminar, together with 3.4 overall GPA and 3.6 GPA in MAT 300+ courses qualify you to graduate with *Distinction in Mathematics*.
- Take graduate level classes in the senior year: 601 (after 412-512) or 631 (after 531-534). If you are interested in Statistics, consider 653 (after 521-525).
- Do independent study (490) on a subject outside of the standard curriculum. This is contingent on finding a professor who agrees to supervise the study.

Actuarial focus

There is no separate track for students interested in actuarial work. All four major programs in mathematics are compatible with the focus on future actuarial career.

You should be familiar with the website BeAnActuary.org which is jointly ran by two major actuarial societies. Pay particular attention to the description of the Probability Exam (1/P). Passing this challenging three-hour exam requires thorough command of probability and calculus. The calculus material is contained in our 295-296-397 sequence, but you will need to know more probability theory than is taught in 521. Thus, you should take 521 as early as practical, and follow it with intensive self-study for the exam. Other mathematics courses relevant to actuarial exams are MAT 525 (for Exam 4/C) and MAT 526 (part of which may be helpful with Exam 1/P).

Another introductory exam that can be passed during college year is Financial Mathematics, Exam 2/FM. Its mathematical content is not sophisticated by math major standards; this exam tests the knowledge of a large number of financial terms and associated formulas. Self-study, guided by the exam syllabus, is the best preparation for it. There are free online sample exams for both 1/P and 2/FM on the Society of Actuaries website soa.org.

VEE requirement in Applied Statistics can be fulfilled with the combination of MAT 525 and ECN 522. VEE in Economics can be fulfilled with ECN 302 and ECN 311. Given the number of relevant economics courses (and their prerequisites), consider obtaining at least a minor in Economics.

Some background in finance or accounting is an advantage in applications for actuarial internships, as well as in preparation for the Financial Mathematics exam 2/FM. If your schedule allows, consider a minor in finance.

You should also be proficient with spreadsheet software, such as MS Excel. A number of free tutorials are available online, including some directly from Microsoft. You should have some programming experience; consider CPS 196 Introduction to Computer Programming. Familiarity with database software and experience with writing SQL queries is also a plus.

Miscellaneous

Three major professional societies of U.S. mathematicians are MAA, AMS and SIAM: roughly speaking, they focus on teaching, research and applications, respectively. Each of them maintains a catalog of career resources, which reflects the emphasis of that society. Links can be found on math.syr.edu/ug

In addition to general computer proficiency, you may want to develop the skill of translating mathematical ideas into an algorithm solving a particular problem. A rich practice field is Project Euler (ProjectEuler.net). Many of these problems are more approachable for students who took 541 or 545 and/or have some computer science background.

Appendix 1: B.A. and B.S. in Mathematics

Preliminary Requirements. Complete 18 credits in the following classes with no grade below a C: MAT 295, 296, 331, 397, and MAT 375. These courses are prerequisites for most upper-division courses. The following sequence is recommended: MAT 295 in the first semester; MAT 296 in the second semester; MAT 331, 397 in the third semester; and MAT 375 when appropriate (as advised by a math major advisor). Computer science students (only) who have credit for CIS 375, and are pursuing a dual major in mathematics, need not take MAT 375.

B.A. Degree Requirements. In addition to the preliminary requirement described above, students are required to complete with an average of at least 2.0 and no grade below D, MAT 412 and 15 additional credits in upper division mathematics (MAT) courses numbered 400 or higher except 421, 485, and 503, at least two of which are from a single one of the groupings below.

- Analysis: 511, 512, 513, 554, 562
- Algebra: 531, 534, 541
- Finite Mathematics: 531, 541, 545, 551
- Applied analysis: 414, 517, 518, 581
- Probability and statistics: 521, 525, 526

With consent of the advisor, these groupings may be altered.

B.S. Degree Requirements. To complete a BS degree, in addition to the preliminary requirement described above, the student is required to complete the following courses with an average of at least 2.0 and no grade below a D:

- Analysis sequence: MAT 412, 512
- Algebra sequence: MAT 531, 534
- Probability: MAT 521
- at least one of MAT 414 (differential equations) or MAT 551 (geometry)
- 12 additional credits in MAT courses numbered 490 or higher, except MAT 503.

With the prior approval of the mathematics major advisor, a student may substitute another mathematics (MAT) course numbered 490 or higher for the MAT 412 requirement. Up to 6 credits in advanced courses in other departments that have been approved in advance by the student's mathematics major advisor may be included in the 12 credits.

Appendix 2: B.A. and B.S. in Applied Mathematics

Preliminary and extra-disciplinary requirements for both B.A and B.S. degrees

1. Complete 18 credits in the following classes with no grade below a C: MAT 295, 296, 331, 397, and MAT 375 or CIS 375. These courses are prerequisites for most upper-division courses. The following sequence is recommended: MAT 295 in the first semester; MAT 296 in the second semester; MAT 331, 397 in the third semester; and MAT 375/CIS 375 when appropriate (talk to your advisor about it).
2. Complete a course in computing such as CPS 196, PHY 307, ECS 102 or ECS 104 (for engineering majors). A similar course may be substituted with advisor's approval.
3. Complete two sequences of two approved science courses for a total of four different courses outside of the mathematics department, such as BIO 121-123, CHE 106(107)-116 (117), PHY 211(221)-212(222), ECN 203-302, ECN 203-311, ECS 221-222, ELE 231-232, or another, more advanced sequence with the approval of a mathematics major advisor. This requirement is waived if the student earns either (i) a minor in Applied Statistics, Biology, Chemistry, Computer Science, Economics, Engineering disciplines, Information Management & Technology, or Physics, or (ii) a major in one of natural sciences, engineering/technology disciplines, economics or finance.

B.A. Degree Requirements. In addition to the preliminary and extra-disciplinary requirements described above, the student must earn credit for the following courses, with a grade average of at least 2.0.

- Three required courses: MAT 414, MAT 532 (or 531), and MAT 581.
- Two courses chosen out of one of the following groups:
    - Differential and Linear Equations: MAT 511, 517, 518, 682
    - Analysis: MAT 412, 511, 512, 513, 554
    - Probability and Statistics: MAT 521, 525, 526

  With consent of the mathematics major advisor, these grouping may be altered.
- 3 credits of elective mathematics courses: MAT 412 or those MAT courses numbered 490 or higher, except MAT 503. With prior approval of the student's major advisor, a mathematically rich 500+ level course in another department may be substituted for the mathematics elective.

B.S. Degree Requirements. In addition to the preliminary and extra-disciplinary requirements described above, the student must earn credit for the following courses, with a grade average of at least 2.0.

- Differential Equations sequence: MAT 414 and MAT 517.
- Numerical Methods course: MAT 581.
- First course in **each** of the sequences in the table below.
- Second course in **one** of the sequences in the table below.

Sequence	**First course**	**Second course**
Linear Transforms	MAT 532 or 531	MAT 518 or 682
Analysis	MAT 412	MAT 511 or 512 or 513 or 554
Probability and Statistics	MAT 521	MAT 525 or 526

- 9 credits of elective mathematics courses numbered 490 or higher, except MAT 503. With prior approval of the student's major advisor, mathematically rich 500+ level courses in other departments may be substituted for the mathematics electives.