Azusa Pacific University
Mathematics Program Handbook
2015-2016

Program Learning Objectives

1. Master fundamental **computational procedures** and **problem-solving strategies**.

2. Employ **logical reasoning** and standard **proof techniques** to construct rigorous mathematical arguments.

3. **Communicate mathematical ideas** in speech and writing, combining precise language and notation with insightful explanation.

4. Apply analytical approaches to a range of **cross-disciplinary problems**.

5. Demonstrate appropriate use of **technology** specific to mathematics.

6. Articulate how **Christian perspectives** and the study of mathematics mutually inform and enhance each other.

Department of Mathematics and Physics
Segerstrom Science Center 100
(626) 815-6470
www.apu.edu/clas/mathphysics

Welcome

Welcome to the APU Mathematics Program! We are thankful to have you as a part of our community. We trust that during your time in the Mathematics Major or Minor you will:

- learn a ton of beautiful and useful mathematics,
- develop and refine your analytical thinking skills,
- make lasting friendships and have a lot of fun together, and
- be further prepared for a lifetime of faithful service to God.

This handbook gathers in one place the information that you will need to succeed during your time with us and beyond. Consult it early and often!

We look forward to learning more about you, your interests, and your insights, in the classroom, during office hours and advising, during Department Barbeques, Game Nights, Putnam practice sessions, and everywhere in between. May God bless your time with us.

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Kim Bartlett, Administrative Assistant

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M.A., Azusa Pacific University
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B.A., Rice University

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Gary Wood
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B.A., Anderson College

Lecturers

Elizabeth Rivas
M.A., University of Southern California
B.S., Azusa Pacific University

Contents

Top 10 Reasons to Study Math at APU

1. Caring Professors

Our faculty take pride in being as approachable and helpful as we can. We love to go the extra mile for our students, whether that means posting extra example videos on YouTube, helping students to map out their future plans, or hosting dinners in our homes.

2. A Rigorous Curriculum

We continually evaluate our curriculum to ensure that we stay on the cutting edge, both with content and with pedagogical strategies. We have recently introduced a new "bridge course," Discrete Mathematics and Proof, to help ease the transition from calculus to the challenging upper-division courses. Our new Topology course provides a solid foundation for graduate-level mathematics, weaving together ideas and methods from analysis, algebra, and geometry. Technology provides important tools in many courses, whether for computation, visualization, or typesetting.

3. Great Careers

Rankings of the best jobs usually include mathematician, actuary, and statistician in the top five. A mathematics major can prepare you for a variety of careers (see pp. 13-15). According to the Mathematical Association of America, "Math gives students a structured and logical perspective while still encouraging creativity. This balanced thought process can really pay off. Mathematicians are prized for their ability to think in this manner." www.maa.org/maa-parent-page Math majors even post some of the highest average scores on the entrance exams for Medical School, Law School, and Business School!

4. Research and Internships

We encourage all of our students to spend a summer or two experiencing a research project or an internship, whether at APU or elsewhere. Our faculty will hire you to assist with our research, or we will help you apply to the many Research Experience for Undergraduates (REU) programs at universities around the country. We will also provide guidance and contacts to assist you in your search for an internship.

5. Segerstrom Science Center

Our department is located in the Segerstrom Science Center, which opened in 2009. This state-of-the-art structure houses the department offices and lounge, smart classrooms, computer labs, and plenty of student study space, not to mention the many physics, chemistry, and biology labs.

6. The Math Center

Segerstrom 170 becomes the Math Center from 2-8 p.m. Monday-Thursday, providing free tutoring and group study space for all math students at APU. Come study with your friends, get help from our talented tutors, and then apply to be a tutor yourself!

7. The Putnam Team

APU competes each December in the William Lowell Putnam Mathematical Competition, along with over 4000 students from over 500 colleges and universities in the United States and Canada. This six-hour, twelve-problem examination challenges students to apply college mathematics in creative ways. Our APU Putnam Team practices weekly during Fall Semester. All participants benefit from learning to integrate concepts, problem-solving skills, and proof techniques from the various math courses they have taken.

8. Friday Night Math

Our Math and Physics Fellow students lead these discussions on the deep questions at the intersection of faith and mathematics several times a year with both faculty and students. One resource which informs the conversations is the book *Mathematics Through the Eyes of Faith* (HarperOne, 2011).

9. Study Abroad

There are several excellent study abroad (or away) options for mathematics majors. While none are officially affiliated with APU, our department will be happy to help you to plan your course schedule around a semester abroad. The most famous program (attended by our own Dr. McCathern when she was a student) is Budapest Semesters in Mathematics. Others include Math in Moscow, Mathematics Advanced Study Semesters (MASS) at Penn State, and the Junior Program at the Center for Women in Mathematics at Smith College (see p. 20 for details.)

10. Teach for America/Math for America

Quite a few of our mathematics majors on the secondary education track have been accepted into the highly competitive Teach for America and Math for America programs, which place new graduates as teachers in underserved school districts. Math for America's program is especially appealing, providing a full-tuition scholarship toward a masters degree or credentialing program, a mentoring network, and $100,000 in stipends, on top of a full-time teacher's salary, in return for a five-year commitment. www.mathforamerica.org

The Curriculum

1. THE FOUNDATION Calculus I, Calculus II, Discrete Mathematics and Proof

Calculus I and II explore the mathematics of continuous change using limits, derivatives, integrals, and series. Discrete Mathematics introduces mathematical logic, set theory, and proof techniques, and then applies them to study functions, relations, and cardinality.

All three courses are foundational for the Math Major and Minor. For this reason, a C- or higher in Calculus I is strongly recommended before taking Calculus II, and a C- or higher in Discrete Mathematics is required as a prerequisite for several upper-division courses involving proof writing.

2. THE THREE BRANCHES OF MATHEMATICS

After building your foundation, it is time to explore the three traditional branches of mathematics, analysis (growing out of calculus), algebra (the study of number systems, patterns, and symmetry), and geometry (the study of shape). In these courses, you'll learn the key methodologies and concepts that animate mathematical inquiry.

Analysis	**Algebra**	**Geometry**
Multivariable Calculus	Linear Algebra	Geometry
Differential Equations	History of Mathematics	Topology
Real Analysis	and Number Theory	
Complex Analysis	Abstract Algebra	

3. APPLICATIONS

You will encounter plenty of applications of mathematics in the courses listed above, but other courses in the major and minor are specifically devoted to applications.

Probability and Statistics	Advanced Topics in Mathematics
Mathematical Physics	Physics for Science and Engineering I
Numerical Analysis	Physics for Science and Engineering II
Mathematical Reading, Writing & Presentation	Introduction to Computer Science

4. TEACHING

Students can prepare for a career in secondary education with the following two courses.

Mathematics for Secondary Education	Introduction to Teaching as a Profession

MATHEMATICS MAJOR

The requirements for the Bachelor of Arts (B.A.) in Mathematics are:

REQUIRED COURSES (41 units)**:**

MATH161	Calculus I (5)	MATH360	Probability and Statistics (3)
MATH162	Calculus II (4)	MATH400	Abstract Algebra (3)
MATH263	Multivariable Calculus (4)	MATH450	Real Analysis (3)
MATH270	Differential Equations (4)	PHYC161	Physics for Science and Engineering I (5)
MATH280	Discrete Mathematics & Proof (3)	CS220	Introduction to Computer Science I (4)
MATH290	Linear Algebra (3)		

ELECTIVES (at least 10 units, including at least 6 units of MATH):

MATH340	Geometry (3)	MATH470	Complex Analysis (3)
MATH390	Hist. of Math & Number Theory (3)	MATH480	Math Reading, Writing & Present. (3)
MATH430	Mathematical Physics (3)	PHYC162	Physics for Science and Engineering II (5)
MATH455	Numerical Analysis (3)	CS225	Introduction to Computer Science II (4)
MATH460	Topology (3)		

To complete the Bachelor of Science (B.S.) degree, the above requirements must be met in addition to a minor in physics, chemistry, or computer science.

The following information can help to guide your choice of electives:

Pure Mathematics Courses

MATH340	Geometry (3)
MATH390	Hist. of Math & Number Theory (3)
MATH460	Topology (3)
MATH470	Complex Analysis (3)

Applied Mathematics Courses

MATH430	Mathematical Physics (3)
MATH455	Numerical Analysis (3)
MATH470	Complex Analysis (3)

Secondary Math Education Track (CTC-approved Single Subject Waiver program)
Completion of all courses below waives the CSET exam for entrance into a credentialing program.

MATH301	Math for Secondary Teachers (3)	MATH480	Math Reading, Writing & Present. (3)
MATH340	Geometry (3)	EDLS300 or 302	Intro to Teaching as a Profession (4)
MATH390	Hist. of Math & Number Theory (3)	one more course from the above list of electives	

Prerequisites for the APU Teacher Credentialing Program:
PSYC290 Human Growth and Development, POLI150 American Government, and EDLS405 Diversity in the Classroom.

To satisfy the General Education Senior Seminar requirement, we recommend MATH496.

Mathematics Minor Requirements

REQUIRED COURSES (9 units)

MATH161 Calculus I (5)
MATH162 Calculus II (4)

ELECTIVES (12-14 units)

Select at least 4 of the following courses. At least 2 of the 4 courses must be chosen at the 200 level.

MATH 263 Multivariable Calculus (4)
MATH 270 Differential Equations (4)
MATH 280 Discrete Mathematics and Proof (3)
MATH 290 Linear Algebra (3)
MATH 340 Geometry (3)
MATH 360 Probability and Statistics (3)
MATH 390 History of Mathematics and Number Theory (3)
MATH 400 Abstract Algebra (3)
MATH 430/PHYC 430 Mathematical Physics (3)
MATH 450 Real Analysis (3)
MATH 455/CS 455 Numerical Analysis (3)
MATH 460 Topology (3)
MATH 470 Complex Analysis (3)
MATH 495 Advanced Topics in Mathematics (3)

Course Placement Policies

SAT Math	ACT	AP	Placement
		4 or 5 on Calculus BC	Multivariable Calculus
		3-5 on Calculus AB or 3 on Calculus BC	Calculus II
see below			Calculus I
600 or higher	26 or higher		Precalculus
540-590	23-25		College Algebra
500-530	21-22		Intermediate Algebra
430-490	18-20		Elementary Algebra
420 or lower	17 or lower		Prealgebra (community college)

If you believe you may belong in a higher-level course than the one in which you place, you are encouraged to take a free placement test in the **Learning Enrichment Center (LEC)**. Students desiring placement in Calculus I should take the **Advanced Math Placement Test**, while students desiring placement in a course below Calculus I should take the **Math Placement Test**.

Learning Enrichment Center
(626) 815-3849
www.apu.edu/lec

APU

DEPARTMENT OF MATHEMATICS & PHYSICS

Proposed Schedule of Offerings

Fall 2015	MATH150	Precalculus
	MATH161	Calculus I
	MATH162	Calculus II
	MATH263	Multivariable Calculus
	MATH280	Discrete Mathematics & Proof
	MATH301	Math for Secondary Teachers
	MATH340	Geometry
	MATH390	Hist. of Math & Number Theory
	MATH450	Real Analysis
	MATH480	Math Reading, Writing & Pres.
Fall 2016	MATH150	Precalculus
	MATH161	Calculus I
	MATH162	Calculus II
	MATH263	Multivariable Calculus
	MATH280	Discrete Mathematics & Proof
	MATH340	Geometry
	MATH390	Hist. of Math & Number Theory
	MATH430	Mathematical Physics
	MATH450	Real Analysis
	MATH480	Math Reading, Writing & Pres.
Fall 2017	MATH150	Precalculus
	MATH161	Calculus I
	MATH162	Calculus II
	MATH263	Multivariable Calculus
	MATH280	Discrete Mathematics & Proof
	MATH301	Math for Secondary Teachers
	MATH340	Geometry
	MATH390	Hist. of Math & Number Theory
	MATH450	Real Analysis
	MATH480	Math Reading, Writing & Pres.
Fall 2018	MATH150	Precalculus
	MATH161	Calculus I
	MATH162	Calculus II
	MATH263	Multivariable Calculus
	MATH280	Discrete Mathematics & Proof
	MATH340	Geometry
	MATH390	Hist. of Math & Number Theory
	MATH430	Mathematical Physics
	MATH450	Real Analysis
	MATH480	Math Reading, Writing & Pres.

Spring 2016	MATH161	Calculus I
	MATH162	Calculus II
	MATH270	Differential Equations
	MATH280	Discrete Mathematics & Proof
	MATH290	Linear Algebra
	MATH360	Probability & Statistics
	MATH400	Abstract Algebra
	MATH455	Numerical Analysis
	MATH460	Topology
	MATH496	Senior Seminar
Spring 2017	MATH161	Calculus I
	MATH162	Calculus II
	MATH270	Differential Equations
	MATH280	Discrete Mathematics & Proof
	MATH290	Linear Algebra
	MATH360	Probability and Statistics
	MATH400	Abstract Algebra
	MATH455	Numerical Analysis
	MATH470	Complex Analysis
	MATH496	Senior Seminar
Spring 2018	MATH161	Calculus I
	MATH162	Calculus II
	MATH270	Differential Equations
	MATH280	Discrete Mathematics & Proof
	MATH290	Linear Algebra
	MATH360	Probability and Statistics
	MATH400	Abstract Algebra
	MATH455	Numerical Analysis
	MATH460	Topology
	MATH496	Senior Seminar
Spring 2019	MATH161	Calculus I
	MATH162	Calculus II
	MATH270	Differential Equations
	MATH280	Discrete Mathematics & Proof
	MATH290	Linear Algebra
	MATH360	Probability and Statistics
	MATH400	Abstract Algebra
	MATH455	Numerical Analysis
	MATH470	Complex Analysis
	MATH496	Senior Seminar

4-YEAR PLANS: Pure Mathematics and Applied Mathematics Tracks

	Students beginning in MATH150 Precalculus	Students beginning in MATH 161 Calculus I	Students beginning in MATH 162 Calculus II	Students beginning in MATH 263 Multivariable Calculus
Fall '15	MATH150 Precalculus LDRS100 First-Year Seminar GE (recommended ENGL110) GE (recommended MIN108)	MATH161 Calculus I PHYC161 Phys. Sci. Eng. I LDRS100 First-Year Seminar GE (recommend ENGL110 or MIN108)	MATH162 Calculus II PHYC161 Phys. Sci. Eng. I LDRS100 First-Year Seminar GE (recommend ENGL110 or MIN108)	MATH263 Multivariable Calc. PHYC161 Phys. Sci. Eng. I LDRS100 First-Year Seminar GE (recommend ENGL110 or MIN108)
Spring '16	MATH161 Calculus I CS220 Intro. to Comp. Sci. I GE (recommended COMM111) GE (recommended UBBL100)	MATH162 Calculus II *PHYC162 Phys. Sci. Eng. II* GE (rec. ENGL110 or MIN108) GE (rec. COMM111 or UBBL100)	MATH280 Disc. Math & Proof *PHYC162 Phys. Sci Eng. II* GE (rec. ENGL110 or MIN108) GE (rec. COMM111 or UBBL100)	MATH280 Disc. Math & Proof *PHYC162 Phys. Sci Eng. II* GE (rec. ENGL110 or MIN108) GE (rec. COMM111 or UBBL100)
Fall '16	MATH162 Calculus II MATH280 Disc. Math & Proof	MATH263 Multivariable Calc. MATH280 Disc. Math & Proof	MATH263 Multivariable Calc. CS220 Intro. to Comp. Sci. I	*MATH390 Hist & Numb. Th.* CS220 Intro. to Comp. Sci. I
Spring '17	MATH290 Linear Algebra MATH360 Prob. & Stat.	MATH290 Linear Algebra CS220 Intro. to Comp. Sci. I	MATH270 Diff. Equations MATH290 Linear Algebra *CS225 Intro to Comp. Sci. II*	MATH270 Diff. Equations MATH290 Linear Algebra *CS225 Intro to Comp. Sci. II*
Fall '17	MATH263 Multivariable Calc. *MATH340 Geometry* *MATH390 Hist. & Number Th.* PHYC161 Phys. Sci. Eng. I	*MATH340 Geometry* *MATH390 Hist & Numb. Th.* MATH450 Real Analysis *CS225 Intro to Comp. Sci. II*	*MATH340 Geometry* *MATH390 Hist & Numb. Th.* MATH450 Real Analysis	*MATH340 Geometry* MATH450 Real Analysis
Spring '18	MATH270 Diff. Equations *MATH455 Num. Analysis* *PHYC162 Phys. Sci. Eng. II*	MATH270 Diff. Equations MATH360 Prob. & Stat. *MATH455 Num. Analysis* ***MATH460 Topology***	MATH360 Prob. & Stat. MATH400 Abstract Algebra ***MATH460 Topology***	MATH360 Prob. & Stat. MATH400 Abstract Algebra ***MATH460 Topology***
Fall '18	***MATH430 Math. Physics*** MATH450 Real Analysis *MATH480 Math R. W. & P.*	***MATH430 Math. Physics*** *MATH480 Math R. W. & P.*	***MATH430 Math. Physics*** *MATH480 Math R. W. & P.*	***MATH430 Math. Physics*** *MATH480 Math R. W. & P.*
Spring '19	MATH400 Abstract Algebra ***MATH470 Complex Analysis*** MATH496 Senior Seminar	MATH400 Abstract Algebra ***MATH470 Complex Analysis*** MATH496 Senior Seminar	*MATH455 Num. Analysis* ***MATH470 Complex Analysis*** MATH496 Senior Seminar	*MATH455 Num. Analysis* ***MATH470 Complex Analysis*** MATH496 Senior Seminar

Electives: Choose at least 10 units, including at least 6 MATH units

Bold: Offered every other year

MATHEMATICS MAJOR 4-YEAR PLANS

4-YEAR PLANS: Secondary Math Education Track

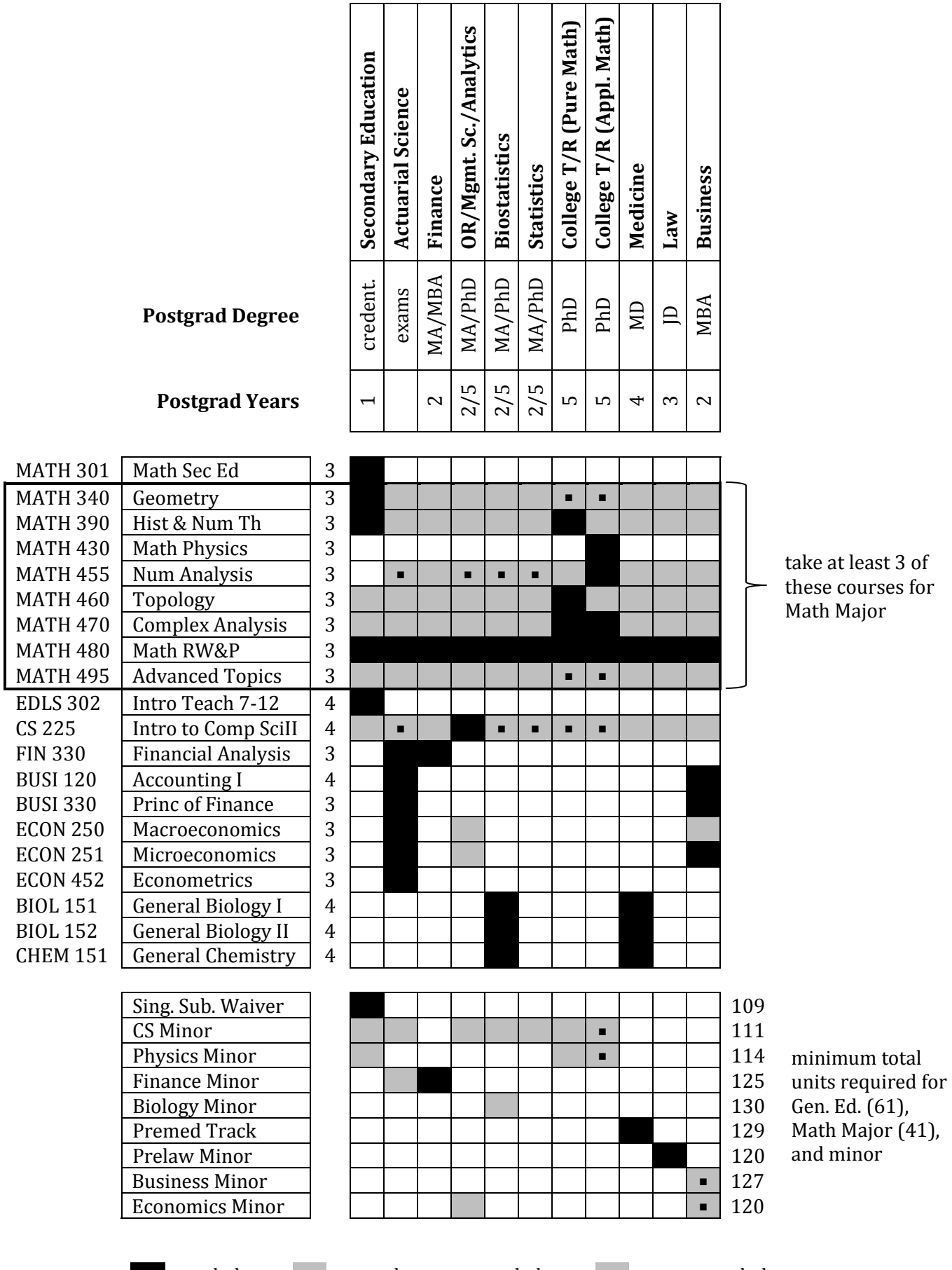
	Students beginning in MATH 150 Precalculus	Students beginning in MATH161 Calculus I	Students beginning in MATH 162 Calculus II	Students beginning in MATH 263 Multivariable Calculus
Fall '15	MATH150 Precalculus LDRS100 First-Year Seminar GE (recommended ENGL110) GE (recommended MIN108)	MATH161 Calculus I PHYC161 Phys. Sci. Eng. I LDRS100 First-Year Seminar GE (recommend ENGL110 or MIN108)	MATH162 Calculus II PHYC161 Phys. Sci. Eng. I LDRS100 First-Year Seminar GE (recommend ENGL110 or MIN108)	MATH263 Multivariable Calc. PHYC161 Phys. Sci. Eng. I LDRS100 First-Year Seminar GE (recommend ENGL110 or MIN108)
Spring '16	MATH161 Calculus I CS220 Intro. to Comp. Sci. I GE (recommended COMM111) GE (recommended UBBL100)	MATH162 Calculus II *PHYC162 Phys. Sci. Eng. II* GE (rec. ENGL110 or MIN108) GE (rec. COMM111 or UBBL100)	MATH280 Disc. Math & Proof *PHYC162 Phys. Sci Eng. II* GE (rec. ENGL110 or MIN108) GE (rec. COMM111 or UBBL100)	MATH280 Disc. Math & Proof *PHYC162 Phys. Sci Eng. II* GE (rec. ENGL110 or MIN108) GE (rec. COMM111 or UBBL100)
Fall '16	MATH162 Calculus II MATH280 Disc. Math & Proof	MATH263 Multivariable Calc. MATH280 Disc. Math & Proof	MATH263 Multivariable Calc. CS220 Intro. to Comp. Sci. I	MATH390 Hist & Number Th. CS220 Intro. to Comp. Sci. I
Spring '17	MATH290 Linear Algebra MATH360 Prob. & Stat.	MATH290 Linear Algebra CS220 Intro. to Comp. Sci. I	MATH270 Diff. Equations MATH290 Linear Algebra *CS225 Intro to Comp. Sci. II*	MATH270 Diff. Equations MATH290 Linear Algebra
Fall '17	MATH263 Multivariable Calc. **MATH301 Math Sec. Teach.** MATH390 Hist. & Number Th. PHYC161 Phys. Sci. Eng. I	**MATH301 Math Sec. Teach.** MATH390 Hist & Number Th. MATH450 Real Analysis *CS225 Intro to Comp. Sci. II*	**MATH301 Math Sec. Teach.** MATH390 Hist & Number Th. MATH450 Real Analysis	**MATH301 Math Sec. Teach.** MATH450 Real Analysis *CS225 Intro to Comp. Sci. II*
Spring '18	MATH270 Diff. Equations *PHYC162 Phys. Sci. Eng. II* EDLS300 Intro to Teach. Prof.	MATH270 Diff. Equations MATH360 Prob. & Stat. ***MATH460 Topology*** EDLS300 Intro to Teach. Prof.	MATH360 Prob. & Stat. MATH400 Abstract Algebra ***MATH460 Topology***	MATH360 Prob. & Stat. MATH400 Abstract Algebra ***MATH460 Topology***
Fall '18	MATH340 Geometry MATH450 Real Analysis MATH480 Math R. W. & P.	MATH340 Geometry MATH480 Math R. W. & P.	MATH340 Geometry MATH480 Math R. W. & P.	MATH340 Geometry MATH480 Math R. W. & P.
Spring '19	MATH400 Abstract Algebra ***MATH470 Complex Analysis*** MATH496 Senior Seminar	MATH400 Abstract Algebra ***MATH470 Complex Analysis*** MATH496 Senior Seminar	***MATH470 Complex Analysis*** MATH496 Senior Seminar EDLS300 Intro to Teach. Prof.	***MATH470 Complex Analysis*** MATH496 Senior Seminar EDLS300 Intro to Teach. Prof.

Electives: Choose at least 1 course **Bold: Offered every other year**

How to Prepare for Your Career While You're in College

As with any degree, translating a Mathematics B.A. into a successful and meaningful career requires careful planning, consultation, and prayer. While the journey looks a little different for each person, attendance at the following key events can help to make sure that your time with APU Mathematics prepares you well for wherever God leads you next!

EVERY SEMESTER	**Academic Advising (required)** Watch your email for date(s) and times. You are required to have an advising meeting with a math faculty member each semester prior to registering for the following semester. During your first advising meeting, we will help you to draw up a four-year plan. Starting with your second advising meeting, we ask you to bring with you a tentative course schedule for the following semester. We will look it over with you, answer any questions you have, and discuss careers, research and internship opportunities, etc.
FALL	**Career Night** Come hear from guest speakers working in a variety of mathematical fields and learn how you can best prepare for the career of your choice. **Research Night** Come listen to your fellow students present the research they have done with APU faculty as you consider whether you might like to apply to participate in an undergraduate research project. **Putnam Mathematical Competition** Join our team as we practice during Fall Semester and participate in this legendary national competition on the first Saturday of December. Take the exam all four years and watch your scores climb! This competition is the perfect way to develop your problem solving skills, and a good score looks impressive on a graduate school application.
SPRING	**Pacific Coast Undergraduate Math Conference** Sign up to attend this local conference featuring a career panel, presentations by undergraduates from around the area, and a keynote address on a compelling application of mathematics to society. **Statistics Career Day** This highly informative event is hosted just down the road at City of Hope each spring.
SUMMER	**Research and Internships** A research experience or internship is the best way to prepare for your future career. Discuss your interests with a faculty adviser early on. Applications for summer are often due in January and February.


Secondary Education
Actuarial Science
Finance
OR/Mgmt. Sc./Analytics
Biostatistics
Statistics
College T/R (Pure Math)
College T/R (Appl. Math)
Medicine
Law
Business
Postgrad Degree
credent.
exams
MA/MBA
MA/PhD
MA/PhD
MA/PhD
PhD
PhD
MD
JD
MBA
Postgrad Years
1
2
2/5
2/5
2/5
5
5
4
3
2
MATH 301 Math Sec Ed 3
MATH 340 Geometry 3
MATH 390 Hist & Num Th 3
MATH 430 Math Physics 3
MATH 455 Num Analysis 3
MATH 460 Topology 3
MATH 470 Complex Analysis 3
MATH 480 Math RW&P 3
MATH 495 Advanced Topics 3
take at least 3 of these courses for Math Major
EDLS 302 Intro Teach 7-12 4
CS 225 Intro to Comp SciII 4
FIN 330 Financial Analysis 3
BUSI 120 Accounting I 4
BUSI 330 Princ of Finance 3
ECON 250 Macroeconomics 3
ECON 251 Microeconomics 3
ECON 452 Econometrics 3
BIOL 151 General Biology I 4
BIOL 152 General Biology II 4
CHEM 151 General Chemistry 4
Sing. Sub. Waiver 109
CS Minor 111
Physics Minor 114
Finance Minor 125
Biology Minor 130
Premed Track 129
Prelaw Minor 120
Business Minor 127
Economics Minor 120
minimum total units required for Gen. Ed. (61), Math Major (41), and minor
needed
strongly recommended
recommended

Career Resources

GRADUATE PROGRAM SEARCH ENGINE

Most (but certainly not all) careers in mathematical fields require a graduate degree. The American Mathematical Society has an excellent search engine for finding graduate programs satisfying various criteria. www.ams.org/programs/students/findgradprograms/fgp-search You can visit the websites of individual graduate programs to find their admissions requirements.

GENERAL RESOURCES

WeUseMath.org weusemath.org
A colorful website with more than 40 profiles of careers that use math. Each profile lists salary range, education required, math required, when math is used, potential employers, and links.

Mathematical Association of American (MAA) www.maa.org/careers

American Mathematical Society (AMS) www.ams.org/careers

Society for Industrial and Applied Mathematics (SIAM) www.siam.org/careers

Association for Women in Mathematics (AWM) sites.google.com/site/awmmath/info/undergrads

SECONDARY EDUCATION

Secondary mathematics teachers are already in high demand and the need is expected to grow in the future. www.nctm.org Teachers complete a one-year credentialing program and possibly a masters degree.

Math majors aiming for a career in secondary education should follow the secondary education track, completion of which waives the CSET requirement for entrance into a credentialing program. They should also choose their general education courses to align with the prerequisites for whatever credentialing programs they are considering, whether at APU or elsewhere.

- **Math for America's** mission is "to improve mathematics education in U.S. public secondary schools by recruiting, training and retaining outstanding mathematics teachers and leaders." Fellows receive a full scholarship for their Master's degree/credentialing program and are paid up to $100,000 in stipends over five years, in addition to a full-time teacher's salary. www.mathforamerica.org

- **Teach for America** is a separate program with the mission of "growing the movement of leaders who work to ensure that kids growing up in poverty get an excellent education." www.teachforamerica.org

ACTUARIAL SCIENCE

Actuarial science applies statistics and probability to finance and insurance. Students pursuing actuarial science need to take some classes in economics and finance, in addition to their math classes. They may wish to minor in finance or computer science. In place of graduate school, actuaries pass a series of licensing examinations. Interested students should take the first one or two exams while they are an undergraduate. After being hired, actuaries are typically given time to study for the remaining exams as part of their work responsibilities.

- Be An Actuary www.beanactuary.org
- Society of Actuaries www.soa.org
- Casualty Actuarial Society www.casact.org

FINANCE

The field of finance addresses the ways in which individuals, businesses, and organizations raise, allocate, and use monetary resources over time, taking into account the risks entailed in their projects. Mathematicians can build models to help explain and predict the behavior of financial markets. Many schools offer master's degrees in Financial Mathematics. Students who pursue an M.A. or an M.B.A. in Finance can go on to work in investment banking, trading, financial advising, financial media, portfolio management, financial analysis, etc. Math majors interested in finance should complete a finance minor.

- Investopedia www.investopedia.com/university/financial-careers
- Careers in Finance www.careers-in-finance.com
- Finance Overview www.allbusinessschools.com/business-careers/finance

OPERATIONS RESEARCH/MANAGEMENT SCIENCE/ANALYTICS

Operations research uses mathematical methods to maximize the efficiency of organizations and their operations. Interested students should consider a minor in Computer Science or Economics. A mathematics major should be well prepared to pursue a master's degree in Operations Research. The Institute for Operations Research and the Management Sciences (INFORMS) website has a wealth of information regarding this career path.

- INFORMS www.informs.org/Build-Your-Career
- Learn About O.R. video www.learnaboutor.co.uk/flash/flash_video.htm

BIOSTATISTICS/STATISTICS

Statistics is the science of collection, analysis, and presentation of data. Data are not just numbers, but numbers that carry information about a specific setting and need to be interpreted in that setting. With the growth in the use of data comes a growing demand for the services of statisticians. Statisticians may apply their knowledge of statistical methods to a variety of subject areas, such as biology, economics, engineering, medicine, public health, psychology, marketing, education, journalism, and sports.

Statisticians typically have an M.A. or Ph.D. in Statistics or Biostatistics. Interested students should be sure to attend the Statistics Career Day at City of Hope in the spring of their freshman and/or sophomore years in order to gain familiarity with this career path. They should also consider completing a Computer Science Minor or (for students interested in biostatistics) a Biology Minor.

- American Statistical Association www.amstat.org/careers
- Biostatistics stattrak.amstat.org/2011/08/01/biostaticscareer/
- Summer Institute for Training in Biostatistics www.nhlbi.nih.gov/funding/training/redbook/sibsweb.htm

COLLEGE TEACHING AND RESEARCH (PURE OR APPLIED)

As your professors can attest, working as a faculty member at a college or university can be very fulfilling work. A Ph.D. is now usually required to get a full-time job teaching math at the college level. Professors (except at community colleges) do research in addition to teaching, and the Ph.D. provides training in research. The good news is that if you are accepted to a Ph.D. program in math or a related field, you can usually expect to have your tuition waived and to receive a stipend that will cover living expenses.

Those who plan to pursue a Ph.D. in Mathematics should have at least one research experience as an undergraduate (preferably an REU, see below) and should take as many challenging math courses as possible. Students interested an applied mathematics emphasis should strongly consider minoring in Physics or Computer Science.

- American Mathematical Society: What Do Mathematicians Do? www.ams.org/profession/career-info/math-work/math-work
- National Science Foundation (NSF) Overview of Mathematical Research www.nsf.gov/news/overviews/mathematics/overview.jsp
- NSF Research Experiences for Undergraduates (REUs) www.nsf.gov/crssprgm/reu

MEDICINE

While math is not the most common major for students preparing for medical school, it provides an excellent training in analytical thinking and quantitative analysis. For a student who plans to study

medicine but loves learning mathematics, a math major is a wonderful option (when taken alongside the courses in the Premed Track in the Department of Biology and Chemistry).

Math majors have the highest average MCAT score (30.5 in 2011) and are more likely to be accepted to medical school than applicants from most other majors. (American Association of Medical Colleges/AAMC) www.aamc.org/download/161692/data/table18.pdf

LAW

Math majors have the highest average LSAT score, 12.8% above the mean. (National Institute of Education). "The ABA does not recommend any undergraduate majors or group of courses to prepare for a legal education. Students are admitted to law school from almost every academic discipline. … Whatever major you select, you are encouraged to pursue an area of study that interests and challenges you …" (American Bar Association/ABA)
www.americanbar.org/groups/legal_education/resources/pre_law.html

Students planning to attend Law School are encouraged to consider APU's Prelaw Minor, housed in the Department of History and Political Science.

BUSINESS

Math majors have the highest average GMAT score, 13.3% above the mean. Of the students attending the top 20 business schools in the U.S., 33% majored in Math/Natural Science/Engineering/Technical Disciplines. (BeattheGMAT.com) www.beatthegmat.com/mba/2009/11/20/which-undergrad-major-is-most-preferred-by-the-top-mba-programs

Students planning to attend Business School are encouraged to minor in Business or Economics.

Summer Programs

Program	Dates	Eligibility	Description	Application Deadline
Research at APU	arranged with the professor	depends on the project	Faculty members in the APU Mathematics and Physics department often do research together with students during the summer. There is funding available to pay students for their work on a research project. Students are typically expected to present their work both on and off campus during the following school year.	Varies by professor, but may be as early as January. You should initiate a conversation with potential research mentors as soon as you know you might be interested.
Internship	varies	varies	Students are encouraged to arrange summer internships in areas which they are interested in exploring as career options. The Department of Mathematics and Physics maintains a binder of internship opportunities on the bookcase in the office. Please feel free to speak with individual professors regarding opportunities of which they may be aware.	varies
NSF Research Experience for Undergraduates (REU)	varies, usually 6-10 weeks	varies, but may involve prerequisites and/or class standing; must be citizens or permanent residents of the U.S.	The NSF funds a large number of research opportunities for undergraduate students through its REU Sites program. An REU Site consists of a group of ten or so undergraduates who work in the research programs of the host institution. Each student is associated with a specific research project, where he/she works closely with the faculty and other researchers. Students are granted stipends and, in many cases, assistance with housing and travel. www.nsf.gov/crssprgm/reu	January, February, or March

Budapest Summer Semester in Mathematics	Usually Mid-June to early August	successful completion of MATH 280	Spend part of your summer in Budapest learning mathematics from leading Hungarian professors. This new summer program is ideal for students seeking to take introductory or upper-division courses in a culture known for excellence in mathematics education and research. **Tuition:** $4195 www.budapestsemesters.com/summer-program/	Usually by March 1
Summer Mathematics Program for Women Undergraduates at Carleton College, Northfield, MN	Not offered in 2015	female students during summer after first or second year	An intensive four-week summer program offered by Carleton College to encourage talented undergraduate women to pursue advanced degrees in the mathematical sciences. www.math.carleton.edu/smp	Check Website
The EDGE Program Summer Session: Enhancing Diversity in Graduate Education	Usually in June	women who have applied to graduate programs in the mathematical sciences	The EDGE Program is sponsored by Morehouse and Pomona Colleges with the goal of strengthening the ability of women students to successfully complete PhD programs in the mathematical sciences and place more women in visible leadership roles in the mathematics community. Along with the summer session, EDGE supports an annual conference, travel for research collaborations, travel to present research and other open-ended mentoring activities. www.edgeforwomen.org	Usually by March 1

Semester Programs

Program	Dates	Eligibility	Description	Application Deadline
Budapest Semesters in Mathematics	Fall and/or Spring Semester each year	successful completion of MATH 280	Budapest Semesters in Mathematics (BSM) is an academic program held in Budapest, Hungary for American and Canadian undergraduates. All courses are taught in English. From modest beginnings in 1985, BSM has come to be viewed as one of the most prestigious study-abroad programs for undergraduate students of mathematics. Our own Dr. McCathern attended BSM as an undergraduate! **Tuition:** $10,695 per semester www.budapestsemesters.com	for Fall: April 1 for Spring: October 15
Budapest Semesters in Mathematics Education	Fall and/or Spring Semester each year	successful completion of MATH 280	Budapest Semesters in Mathematics Education (BSME) is a semester-long program in Budapest, Hungary, designed for American and Canadian undergraduates and recent graduates interested in teaching middle school or high school mathematics. BSME is specifically intended for students who are not only passionate about mathematics, but also the *teaching* of mathematics. **Tuition:** $10,595 per semester www.bmseducation.com	for Fall: March 15 for Spring: October 15

Mathematics Advanced Study Semesters (MASS) at Penn State University	Fall Semester	successful completion of MATH 280, MATH 290, and MATH 400	The program combines advanced learning with research initiation and provides a highly charged interactive environment among a critical mass of talented and motivated students and a committed group of strong research faculty and top graduate students. For most of its participants, the MASS program serves as a spring board to graduate schools in mathematics. The program consists of three courses chosen from major areas in Algebra, Analysis, and Geometry respectively, specially designed and offered exclusively to MASS participants, and a weekly working seminar. Additional features include colloquium-type lectures by visiting mathematicians and mathematical projects involving research and creative use of computers. www.math.psu.edu/mass	Usually by April 1
Math in Moscow, at the Independent University of Moscow	Fall and Spring Semesters	successful completion of MATH 290 and MATH 400	A semester program offering twenty one math courses and two theoretical computer science courses. A Russian language course, courses in Russian history, history of science, and Russian literature (in English) are also offered. The main feature of the Russian tradition of teaching mathematics has always been the development of a creative approach to studying mathematics from the very outset. Not memorizing theorems and proofs, but discovering mathematics yourself under the guidance of an experienced teacher—this is our principle! Even in our treatment of the most traditional subjects, you will find significant connections with contemporary research topics. Indeed, most of our teachers are internationally recognized research mathematicians; all of them have considerable teaching experience in English. **Tuition:** $8500 per semester www.mccme.ru/mathinmoscow	for Fall: March 30 for Spring: September 30

Center for Women in Mathematics at Smith College—The Junior Program	Fall and Spring Semesters	one or two semesters, usually during junior year	Students spend a semester or year at Smith, taking 3 math courses each term. Standards include courses in analysis, algebra, statistics, number theory, combinatorics, graph theory, differential equations, complex analysis, topology, and geometry. There are also topics courses reflecting the diverse interests of the faculty. In recent years, these have included relativity, analysis of algorithms, chaos and fractals, cryptography, mathematical sculpture, set theory, and phyllotaxis. Visiting students take a seminar together that includes a lecture series, undergraduate curriculum review, an introduction to mathematical research and writing, and discussions on career paths, applying to graduate school, and taking the GREs. Every student has the opportunity to join a research team, working on a project with a Smith faculty member. www.math.smith.edu/center/junior.php	for Fall: March 15 for Spring: October 15 late applications may be accepted on a rolling basis