



Department of Mathematics
Guide for the Undergraduate

Fall 2009

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1 Why Study Mathematics?

You may be considering a major in mathematics. Maybe you've already made the plunge. In either case, you must have enjoyed mathematics and now probably would like to learn more. These could be reasons enough. But there are other reasons -- good reasons -- for choosing mathematics as your undergraduate major.

Mathematics is the oldest and most fundamental of the sciences, with a history that goes back at least four thousand years. Many of the oldest mathematical ideas are still being studied and are in constant use.

Mathematics is also a dynamic, rapidly growing subject that sprouts new ideas, new methods, and new applications every day. Major long-standing problems are being solved one after another, and new ones are being identified all the time. Many of the most exciting developments in the "high tech" revolution depend on mathematical discoveries made since you were born - maybe since you entered high school!

And, in recent years, the use of mathematics has been expanding not only in its traditional territory - the physical sciences and technology - but also into the biological and health sciences, the social and management sciences, and even the humanities.

Of course, the computer has been a close partner of mathematics in many recent developments, but mathematics continues to have its own flavor and insights, and goes right on making its own distinctive contributions.

There are many ways of becoming a part of all this - opportunities that can lead to enjoyable, productive, and satisfying careers. Declaring a major in mathematics is a good first step.

It should also be said that a major in mathematics can be part of a liberal education **par excellence**, and in particular can provide a solid base for further study in many other fields.

2 Mathematics at WSU

For most of a century there has been a Department of Mathematics at WSU, where a bachelor's degree with a major in mathematics, a master's degree in mathematics, and (since 1959) a doctorate in mathematics have been offered.

The faculty of the department consists of about 30 people, all of whom have PhD's and are active scholars as well as committed teachers. Most of them are known nationally for their contributions to the mathematical world - for their research, for example, or for their involvement in various projects in support of mathematics and mathematics education. Some members of the mathematics faculty have held high offices in national professional organizations. At any one time some members of the faculty may be away conducting collaborative research at other institutions; but at the same time WSU regularly has visiting mathematicians from other parts of the world, and one of the special opportunities that goes with being associated with the department is that of learning from these informative visitors. In addition, the teaching and administrative duties of the department are supported by several instructors, each with excellent teaching credentials and at least an MS in Mathematics.

There are usually between thirty and thirty-five graduate students in the department. Each of them is studying for a MS or PhD degree or both. (For details about the graduate degree programs in mathematics at WSU, see the Graduate Study Bulletin and the Graduate Student Handbook, available at www.math.wsu.edu.) With a few exceptions, graduate students hold either graduate teaching assistantships or graduate research assistantships, which provide financial support for their study along with chances to acquire or improve skills for teaching undergraduate mathematics or doing research, respectively.

The number of undergraduate students majoring in mathematics varies from year to year. Recently the total number has been close to one hundred fifty, with approximately forty percent in the secondary mathematics education program, which is designed to prepare future high school mathematics teachers. A considerable number also have second majors; recent examples of majors that have been paired with mathematics include physics, computer science, biotechnology, civil engineering, electrical engineering, biological sciences, and human development. Our undergraduate students come from all parts of Washington State, many other states, and some foreign countries, and study mathematics for many reasons. Many of our students are excellent scholars with outstanding records, and have been amply represented in the Honors Program, the McNair Achievements Program and have participated in several undergraduate research programs.

The office and facilities of the Department of Mathematics are located in Neill Hall. There is a directory of personal offices on the wall in the foyer, and there is a directory with office hours located outside the main office. This will include the faculty and teaching assistant offices, the departmental administrative office (Neill 103), and the three computer laboratories (Neill 3, Neill 101W, Neill 120). The departmental website at www.math.wsu.edu contains further information about the department and its educational and research programs.

3 What Do Mathematics Graduates Do?

You may be asked by your friends, "What can a person do with a mathematics degree?" The possibilities are limitless for those with a creative, imaginative mind and the ability to think critically and solve real and theoretical problems. New opportunities are emerging currently due to the nature of the technology and data driven society we live in. The computer chip industry as well as Wall Street has been taking advantage of mathematicians' expertise for decades. Now other businesses are also finding mathematicians essential for their success. Finding these opportunities can be a challenge, but the flexibility in the types of work you can do is also an asset.

Below and in Section 5 you will find descriptions and job titles for different types of mathematicians.

A *theoretical mathematician* tries to further the world's understanding of mathematics. Job titles include: Accounting Analyst, Marketing Associate, Operations Research Analyst, Product Quality Engineer, Research Associate, or System Level Designer.

An applied mathematician attempts to use mathematical models or methods for solving real world problems. Job titles include: Contracts Specialist, Director of Information Technology, Quality Engineer, Program Manager, Project Analyst, Relations Manager, and Software Engineer or Programmer.

A *research statistician* may be hired by a particular company or industry, or work for an independent research center to do contract work for a variety of companies. For example, a research statistician may collect and analyze data for a medical study, employment patterns for a particular industry or the government, research population trends, or educational improvements.

Statisticians may also work as analysts. Some of this work might overlap areas that a research statistician would work on. A statistical analyst could also be a financial analyst, program analyst, or a risk management analyst.

Actuaries help businesses assess the risk of certain events and study ways to minimize the impact of such a risk. Thus, actuaries play a significant role in the insurance industry. Actuaries analyze data to estimate the chance and the resulting cost of events such a death, disability, or loss of property. They also address financial questions regarding, for example, the determination of pension contributions in order to produce a certain income upon retirement or business investments to maximize returns in light of potential risks. With their training in statistics, business and finance, actuaries help shape financial strategies and insurance policies. The professional designations of actuaries depend on the organization to which they belong, and their progress in the actuarial exam system. After passing a series of exams, an actuary receives the designation of Associate. For example, actuaries who specialize in property and casualty receive the Associate of the Casualty Actuarial Society (ACAS) designation. Actuaries who analyze pensions or investments receive the Associate of the Society of Actuaries (ASA) designation. After receiving the Associate designation, the actuary may elect to continue to take the actuary exams in order to achieve the highest designation of Fellow.

An *operations researcher* applies mathematical concepts to help a business generate a number of ways to solve a problem and then analyze the most efficient approach. A classic example is scheduling for an airport. The landing and take-off of all planes must be scheduled precisely to avoid collisions. The handling of baggage, food and beverages must all be coordinated with flight schedules. Then it is also necessary to route passengers in a way to avoid bottlenecks in the terminal concourses, food vendors, etc. Job titles might include: Business Analyst, Director of Management Science, Economics Analyst, Quality and Customer Satisfaction Consultant, Manager in Risk Management, System Analyst, or Senior Financial Analyst.

Mathematics teachers may teach at any level. For K-5 teaching, a BA in elementary education is the norm. Some states now require middle school mathematics teachers to have a much more extensive background in mathematics. Currently in Washington State there are two ways to certify: K-8 or 5-12. An endorsement in middle school mathematics is recommended for those interested in teaching grades 6-9. If you want to teach at a community college, you will need an MS in mathematics with some math education background. For teaching at a four year institution, instructors need a minimum of an MS, and regular faculty need a PhD.

There are a number of mathematics professional organizations where you can find information about mathematics career opportunities.

Some Professional Organizations for Actuaries:

<http://www.actuary.org>

<http://www.aspa.org>

<http://www.casact.org>

<http://www.ccaacturries.com>

<http://www.iasa.org>

<http://www.soa.org>

Some Professional Organizations for Mathematicians:

<http://www.ams.org>

<http://www.maa.org>

<http://www.imstat.org>

<http://www.iamg.org>

<http://www.siam.org>

<http://www.cms.math.ca>

<http://www.awm-math.org/>

Some Professional Organizations for Statisticians:

<http://www.amstat.org>

<http://www.casact.org>

<http://www.mfmag.com>

<http://www.imstat.org>

<http://www.iasa.org>

A Professional Organization for Research Analysts:

<http://www.informs.org>

Some Professional Organizations for Mathematics Teachers:

<http://www.nctm.org>

<http://www.rethinkingschools.org>

<http://www.amatyc.org>

<http://www.whatkidscando.org>

<http://annenbergfoundation.org>

<http://mathcentral.uregina.ca>

4 Getting Started

In the following pages you will find the information you need to start and work through your program as a mathematics major. If you designate mathematics as your intended major when you start your coursework at WSU, you will be given a pre-major advisor in the Mathematics Department. Once you begin taking classes at WSU, you should complete Math 171, 172 (or 182) and 220 (or 230) as soon as you can. Note that Math 182 and 230 are the honors versions of Math 172 and 220, respectively. The honors classes give students enrichment opportunities and smaller class sizes. Your advisor or the course instructor can give you permission to enter these classes. After completing Math 171, 172 (or 182) and 220 (or 230), you can apply to certify as a math major. The instructions for doing this follow in this section. After certification, you will be assigned to a mathematics major advisor within the department. Your advisor will help you plan your program so that you complete both your general requirements and the specific requirements for one of the several mathematics major options.

As a mathematics major, you will be required to select and follow one of the options listed in the next section. Modern mathematics is a huge field. It will help your possibilities for getting a job, or getting into graduate school, if you do some specializing during your undergraduate career. The types of things you can do with each option are described in the pages that follow. Notice especially that some faculty members who can give you more information are listed. Your advisor can also be very helpful to you as you consider which option to follow. Information on the “core” courses common to all math majors and all of the options is given in Section 5 of this guide.

Criteria for Certification

The following list provides the criteria for certification in Mathematics or General Studies – Mathematics Education.

1. Applications for certification are accepted at any time during fall and spring semesters. Decisions are made within ten working days of receipt of application. Application forms are available in the Mathematics Department office (Neill 103). Applications are evaluated and certification decided by a faculty member.
2. Applicants must have an overall grade point average of at least 2.00. The mathematics core consists of Math 171, Math 172 (or 182), and Math 220 (or 230). This core (or its equivalent for transfer students) must be completed **before** applying for certification. Students with at least a 2.50 grade point average in the mathematics core will be certified automatically. Those with less than a 2.00 GPA in the mathematics core will normally not be certified. Others will be considered on a case-by-case basis.
3. The department chairperson considers appeals on certification decisions. Students who are denied certification may reapply after completing at least twelve more semester hours, whereupon decisions are based on grades in mathematics, science, and computer science courses; cumulative grade point average and grade patterns; and a personal interview.

4. Certified students whose cumulative grade point average or grade point average in mathematics courses numbered 171 and above, falls below 2.00 for two consecutive semesters, or who are academically deficient, are subject to de-certification. Applications for re-certification are handled in the same manner as certification applications for those previously denied

The application for certification is provided as the last page of this document.

5 The Bachelor of Science Mathematics Degree

5.1 List of Options

The Mathematics Bachelor of Science (BS) degree program at WSU has the following options:

- Actuarial Sciences
- Computational Mathematics
- Mathematical Modeling
- Operations Research
- Theoretical Mathematics
- Secondary Mathematics Teaching

Students interested in the General Education Program should consult an advisor at the Student Advising and Learning Center (SALC, Lighty 260).

You are required to declare one of these options, and to follow the curricular provisions of the chosen option, as approved by your advisor. You should choose an option area as quickly as it is reasonable to do so. Normally, this will occur by the end of the first semester of the junior year. Students for whom special circumstances apply may take a coherent list of courses, recommended and approved by the advisor, that may not be specifically within one of the stated optional areas.

5.2 Mathematics Major Core Requirements

In addition to the General Education requirements and the College of Sciences requirements, as a major in mathematics you are required to take 171, 172 (or 182), 220 (or 230), 273 (or 283), 300, 301, 315, 360 (or 443), 398, 401, 402, 420, 421; four additional 3-credit 300-400 level math courses specified by your chosen option; Phys 201, Cpt S 121 or 251, and Engl 402 (or 403 for non-native English speakers).

If you are following the Secondary Mathematics Teaching program, you must take Math 303, Math 325, and Math 330, but are not required to take Math 402 and Math 420. Math 320 may be substituted for Math 421. Cpt S 121 or 251 is not required. Engl 201 (or 301) should be taken instead of Engl 402.

There are Checklists and Schedule Worksheets in Section 9 where all requirements are listed.

5.3 Mathematics Degree Options

5.3.1 Actuarial Science Option

Description: Actuaries are professionals with a specialized education in mathematics and business who are employed in connection with insurance and other financial security programs. Actuarial responsibilities involve research, planning, forecasting, and decision-making as regards risk and

contingency in insurance programs. Actuaries use applied mathematics to define, analyze and solve complex business and social problems. They apply their knowledge to all aspects of insurance and pension operations and are found wherever insurance-related problems arise. The actuary's primary work is to design insurance programs that will meet specific social needs and operate on a sound financial basis. The programs may involve life insurance, health insurance, pensions and other employee benefit plans, property and liability insurance, or social insurance (such as social security).

To become a Fellow in the Society of Actuaries, it is necessary to pass a series of actuarial exams. The entire process of becoming an actuarial Fellow can take 3 to 7 years of study and work experience beyond the bachelor's degree. For the first actuarial exam, a student needs a substantial background in calculus, probability, and statistics. Additional courses in economics, business, insurance, and finance provide further preparation and background for subsequent exams. However, even though their training is basically in mathematics, business, and economics, practicing actuaries must deal with people with greatly varying educational backgrounds and so must be able to explain and communicate complicated concepts effectively. Communication skills, both written and oral, are essential for success as an actuary.

Job Market and Salary Information: Employment of actuaries is expected to grow at a stable pace through 2012. Recently, new employment opportunities arose from the need to analyze annuities, risks related to property casualties and medical issues, and health-care costs. Annual salaries for actuaries compare favorably with those of other professionals with comparable education and experience. According to recent salary surveys, in 2005 new actuarial fellows earned between \$87,000 and \$120,000, whereas actuarial fellows with five years of experience averaged \$86,000 and \$131,000. The average annual starting salary for graduates with a bachelor's degree in actuarial science was approximately \$40,000 in 2003. For those who successfully pass subsequent exams, salary increases come rapidly. Along with salaries, most actuaries receive excellent fringe benefits from their employers.

Suggestions: A broad range of training is needed to become a skilled actuary. Students need broad training in mathematics, business and economics as well as development of their communication skills. Additional experience (e.g. summer internships) or skills (e.g. computer programming) will be attractive to employers. Job prospects for entry-level positions are tremendously improved for those who have passed at least one or two of the initial actuarial exams.

Resource People: Professors Jacorux, Jandhyala, Li, and Pascual.

Required Courses: Math 360, 416, 423, 443, and 456 (background material for actuarial exams).

Suggested Courses: Acctg 230 and 231, BLaw 210, EconS 101, 102, 301, 302, 311, Fin 325 and 350, and Math 448 provide additional background for actuarial exams.

Note: You may need certification in the College of Business in order to register for Business courses. A minor in Accounting or Finance, for example, is recommended.

Information about the actuarial exams and review materials can be downloaded from the Society of Actuaries web site at <http://www.soa.org>.

5.3.2 Computational Mathematics Option

Description: Computational Mathematics provides the interface between models of physical, biological, economic, or engineering systems and the mathematical and statistical methods appropriate for their analysis. A practitioner in this area of mathematics, therefore, needs to be able to communicate effectively, sometimes across several disciplines, and also should have broad computational experience as well as a good grounding in mathematics, numerical analysis, statistics, and computer programming.

Job Market Information: Computer use is widespread in industry, government and private laboratories, and business. Larger organizations have recognized the need for persons with computational mathematics backgrounds to make effective use of computers. Common entry job titles are research analyst, systems analyst, and mathematical analyst or operations analyst. After acquiring on-the-job experience, many of these people move into engineering or project management positions.

Salary Information: Starting salaries are usually in the range of \$35,000 - \$45,000.

Suggestions: A minor or a double major in computer science is recommended. Participation in the Work-Study Internship program (Cpt S 498) or summer employment involving computer experience is strongly recommended.

Resource People: Mathematics professors Ariyawansa, Asaki, K. Cooper, Dillon, Genz, Johnston, Krishnamoorthy, Lapin, Manoranjan, Mifflin, Schwartz, Tsatsomeros, Vixie, Watkins, and Yin.

Required Courses: Cpt S 122, Math 364, 448, and two of Math 416, 440, 464, or 466.

Suggested Courses: It is strongly recommended that some electives be used for a Computer Science minor with Cpt S 223 and three 300-400 level Cpt S courses excluding computer skills and literacy course (e.g. Cpt S 317, 322 and 445 or 450). The minor in computer science must be approved by the computer science undergraduate coordinator.

5.3.3 Mathematical Modeling Option

Description: Many areas of mathematics have recently begun to emphasize applications to real-world problems. There is a growing realization among non-mathematicians that analytical mathematical models are valuable tools to improve our understanding of diverse phenomena. The use of mathematical models cuts across the spectrum of engineering and the physical, biological and social sciences. In consequence, there are many career opportunities for mathematical modelers at all levels of training, from BS to PhD. These opportunities are to be found in academic institutions; in business and industry, such as manufacturing, marketing, aerospace, agriculture, and communications; in government and private laboratories, agencies and research centers, such as the Argonne, Brookhaven and Los Alamos National Laboratories, the National Institute of Standards & Technology, the Naval Research Labs, and the Bell Laboratories.

Job Market Information: Many of the job opportunities at the BS level require training in computer applications of mathematics. Others require background in specialized subjects such as optimization or applied statistics. Most employers are searching for employees who have broad training in applied and applicable mathematics with exposure to natural sciences or engineering. The program of study for the Modeling Option includes these various elements.

Salary Information: Salaries of professionals trained in Mathematical Modeling are variable and commensurate with experience, training, and demand. Many companies pay higher salaries to employees with special skills or expertise. An entry-level salary of \$30,000 at the BS level would be typical.

Science and technology will play an ever-increasing role in our society. As this state of affairs evolves, applied mathematicians willing to pursue careers with industries and businesses in the technological forefront will be in demand and will be compensated accordingly.

Suggestions: Students pursuing the Mathematical Modeling option should expect a broad training in applied mathematics. This training should include exposure to practical computer programming and familiarity with a variety of mathematical computer software packages. Modeling students at WSU have access to a variety of computer systems. The Department supports many mathematical programming packages, including Maple and MATLAB.

Graduation and degree requirements are described in the current college catalog. It is also strongly recommended that students in the Modeling option complete a minor in an applied area outside of mathematics. Suitable minors include business administration, finance, biology, chemistry, engineering, economics, forestry, geology or physics. You should discuss possible minors with your advisor.

Resource People: Mathematics professors Asaki, K. Cooper, Dillon, Genz, Gomulkiewicz, Khapalov, Krishnamoorthy, Lapin, Manoranjan, Mifflin, Panchenko, Pate, Schumaker, Schwartz, Vixie, Watkins, Wollkind, and Yin.

Required Courses: Four of Math 340, 415, 440, 448, and 486.

Suggested Courses: Strongly recommended electives are two of Math 364, 416, 423, 441, or 464. A minor in an applied subject area, chosen in consultation with the adviser, is also strongly recommended.

5.3.4 Operations Research Option

Description: Operations Research (OR) is the discipline of applying advanced analytical methods to help make better decisions. OR analysts typically develop or use a variety of mathematical methods to model a particular system. Specialists in this area are employed in industry, government, private consulting, and universities. Some analysts may be in staff organizations supporting top management, while others may be in line organizations directly involved with the management decisions.

The classical military and industrial applications of OR include inventory control, maintenance, and scheduling. More recent areas of use in the private sector are to be found in marketing, financial planning and exploration; and in the public sector in public health, regional planning and educational systems. The most recent advances have been in such diverse fields as criminal justice, banking operations, population control, meteorology, energy development, ecological systems, medical decision-making, and bioinformatics.

Job Market Information: According to the U.S. Bureau of Labor Standards (BLS, www.bls.gov), the demand for operations researchers is expected to increase dramatically. Opportunities for OR analysts exist in almost every industry because of the diversity of applications for their work. In today's global marketplace, businesses must compete more effectively for their share of profits than ever before. Public as well as non-profit agencies must compete for ever-scarcer funding dollars. New technologies developed over the past several years have given operations researchers sophisticated tools to cope with

these challenges. The BLS also predicts that in the near future, opportunities for OR analysts will be best in management, scientific and technical consulting firms. Opportunities in traditional fields like the military will exist as well. It is important to note that many jobs in OR have other titles, such as operations analyst, management analyst, systems analyst, and computer scientist.

Professional Information: According to the BLS, OR analysts held about 58,000 jobs in 2004. Major employers include computer system design firms; insurance carriers and other financial institutions; telecommunications companies; management, scientific, and technical consulting service firms; and federal, state and local governments. According to recent surveys by the Institute for Operations Research and Management Science (INFORMS, www.informs.org), OR professionals have an average salary of \$65,000 to \$85,000 per year in business and industry; \$57,500 in federal government for those with at least a master's degree, and associate professors (doctorate level) earn about \$60,000.

For more information from the Institute for Operations Research and Management Science see the website – <http://www.informs.org>. This site includes an online version of the *Career Booklet* that is also available in the Mathematics Department office.

Suggestions: Supporting courses and part-time or summer jobs involving Computer Science, Statistics, Economics, Business Administration, and/or Engineering are strongly encouraged.

Resource People: Mathematics professors Asaki, Ariyawansa, Johnston, Krishnamoorthy, and Mifflin. Elsewhere on campus: M.C. Wang.

Required Courses: Math 364, 464, and two of Math 325, 416, 448, 453, 456, and 466.

5.3.5 Theoretical Mathematics Option

Description: If you are interested in pursuing a graduate degree in mathematics or enjoy mathematics and would like a solid general undergraduate degree in mathematics, you should consider the Theoretical Mathematics Option. Because of its sound mathematical content and the fact that modern applications use mathematics from many areas of mathematics that are theoretically based, it leaves the graduate with many career opportunities. The numerous electives also allow greater flexibility in planning an unusually broad undergraduate experience. This option prepares the student for graduate study in one of the mathematical sciences or even in other fields, such as economics, law, and business, where a strong mathematical background is a great asset.

Job Market and Salary Information: Because of the great variety of possibilities, it is difficult to be precise about opportunities or beginning salaries. Nevertheless, a person with a new BS in core mathematics who is employed in industry is likely to start at \$35,000 - \$45,000. Beginning salaries for those with a graduate degree naturally depend on the kind of graduate study done and which graduate degrees are earned. Specifically, those who continue studying core mathematics, earn a PhD, and go into college teaching or university teaching and research, now begin at an average of about \$50,000 for nine months. Someone with the same background who goes into a twelve-month non-academic position may start at about \$60,000.

Suggestions: This option is not so much a single program as a framework of mainstream mathematics with many electives. The individual student is thus free to select electives to form a personal program

especially suited to his or her interests and plans. For formal graduation and degree requirements, see the current college catalog.

Resource People: Mathematics professors S. Cooper, Hudelson, Johnston, Kallaher, Khapalov, Lapin, McDonald, Panchenko, Tsatsomeris, Vixie, and Webb.

Required Courses: Four of Math 302, 303, 325, 415, 441, or 453.

5.3.6 Secondary Mathematics Teaching Option

Description: Since many of you are recent high school graduates, you generally understand the primary duties of a high school mathematics teacher. However, there are many opportunities related to educating high school students besides tasks associated with classroom teaching. With a BS degree in mathematics with the secondary teaching option, it is possible to: run a "math lab" designed to provide tutorial help for high school or even college students; chair a middle or high school mathematics department; write mathematics curriculum; develop educational technology; assume active leadership roles in professional state or national organizations; teach extension or night classes; or work with the superintendent's office on various projects including setting/revising state standards. Also, there are many new opportunities for specialists or math coaches as the shortage of qualified mathematics teachers continues to drain the limited pool of teachers, especially in the middle schools. A math specialist or mathematics coach works with district mathematics teachers to aid in various areas: adoption of new curriculum; development of supplemental material for existing curricula; writing grants to obtain materials or pay for professional development or travel.

Job Market and Salary Information: Currently, the demand for qualified mathematics teachers is very high in secondary and middle schools. Salaries in public schools in the State of Washington for 2006-2007 start at approximately \$31,000 (for a BS) and may be as high as \$42,000 for someone with a master's degree. Experienced teachers with the highest qualifications are earning salaries of \$58,000. Teachers who are Nationally Board Certified earn an additional yearly bonus of \$3,500. You can search the website for the Office of the Superintendent for the state you plan to teach in for more information on these issues. In Washington, this information can be found at the Office of the Superintendent of Public Instruction (OSPI) <http://www.k12.wa.us>.

Suggestions: If you are interested in teaching secondary mathematics, then you must have a sophisticated understanding of the mathematics that provides the foundation for the curriculum you will teach. Current national standards push for a more conceptual understanding of mathematics involving critical thinking rather than relying solely on memorization, and this requires that teachers have a greater depth of mathematical understanding than they might have had in the past.

There are two ways you can complete the mathematics requirements that meet state certification to teach secondary mathematics. One is to complete the requirements for a mathematics BS with Secondary Teaching Option as described in the current catalog. The other method is through the General Studies program. The requirements for the mathematics major in the General Studies program are given under the Department of Education in the current college catalog to ensure requirements meet the minimum state requirements. The General Studies program requires less mathematics coursework than a Mathematics BS, and is for those students who prefer broader teaching goals, such as teaching two subjects or receiving extensive coaching training. However, if you decide not to continue with a teaching

career, the General Studies degree is not sufficient for many of the career paths that one can follow with a BS in mathematics.

Resource People: Mathematics professors S. Cooper, Kallaher, Knott, and Vincent. The coordinator for field placement in Teaching and Learning is Christine Sodorff.

Required Courses: Math 303, 325, 330, 431, and 432, and two additional 3-credit 300-400 level math courses.

Substitutions: Math 402, 420 and Cpt S 121 or 251 are not required; Engl 201 (or 301) should be taken instead of Engl 402. Math 320 may be substituted for Math 421.

T&L Requirements: Secondary education teacher certification also currently requires Psych 105, EdPsy 468, T&L 300, 301, 317, 464, 465, 466, 467, 469, and 470; a T&L advisor should be consulted for proper sequencing and approval. Enrollment in Teaching and Learning (T&L) courses after T&L 301 requires admittance to the teacher preparation program. (Contact the T&L Department in the College of Education for information and an advisor). T&L 415 (student teaching) completes the program of study.

Note on Certification: Certification into the Secondary Mathematics Education option is a two step process. First you are certified by the Mathematics Department in a manner consistent with the other options. The second step is to be admitted into the secondary program by T&L. The Mathematics Department is involved in that process, but T&L has the final say. If you have completed the first step, but not the second, your DARS report will show you as having a Teach option. After you have been admitted by T&L it will show as Teacher Prep in Secondary.

6 Special Opportunities

A university education entails many things beyond courses, degrees, sports, and social amusements. It is a cultural center. To obtain the most from your experience at WSU, you should take advantage of some of these additional opportunities.

For example, WSU offers such extracurricular opportunities as: clubs and other organizations catering to many interests; lectures, stage shows, film series, concerts, and other such events; an excellent intramural program, and athletic facilities for leisure time use; and, in the libraries, a fantastic collection of books, periodicals, records, tapes, etc. to which you have virtually unlimited access. In particular, you should take a look in the Owen Science and Engineering Library. While the books and periodicals that are kept there are primarily for advanced study and research, some of them are written for - or even by - undergraduates. Among the periodicals, take a look (for example) at *The College Mathematics Teacher*, *The Mathematics Intelligencer*, *The Mathematics Teacher*, or *The Mathematical Gazette*.

The Department of Mathematics offers some special opportunities that might be described better as "co-curricular" rather than "extracurricular." What follows is a list of some of these special opportunities.

Mathematics 499, Special Problems: This carries variable credit (1-4) and may be repeated. It provides an opportunity to pursue many kinds of special projects on your own, with faculty guidance. In spite of the course number, this possibility is not limited to seniors. If you are interested, see a suitable faculty member, preferably at or before registration.

Undergraduate Research: Among the faculty research projects there are almost always some in which an undergraduate can take a meaningful role. (At times, occasionally with financial support from the National Science Foundation, research projects have been set up specifically for the benefit of undergraduate participants.) Such activities can yield credit, publications, stipends, a running start on graduate study or a career, and a great deal of personal satisfaction. Every semester the department also has one or two undergraduate research scholarships available (see <http://sciences.wsu.edu/academics/scholarships.html>). If you are interested, ask a member of the mathematics faculty about possibilities. The Mathematics Department also offers cross-disciplinary undergraduate research opportunities such as the Undergraduate Program in Biology and Mathematics (<http://www.ubm.wsu.edu/about.html>).

Scholarships and Awards: The department has a number of scholarships and awards available to students at all levels. For more information, inquire in the Mathematics main office (Neill 103). Juniors must have a 3.25 overall GPA and seniors a 3.00 GPA to be eligible for these awards. Applications are reviewed every semester. If you are interested, check the departmental website at <http://www.math.wsu.edu/scholarships/scholarships.php> for more information. You might also check some of the websites listed in Section 3 to see if any of these societies offer funding opportunities.

Undergraduate Bulletin Board: A special bulletin board for undergraduates is located between Neill 103 and Neill 107. This board has announcements of special events, scholarships, employment opportunities and other matters of interest to math majors.

Undergraduate Teaching Assistantships: The Mathematics Department is sometimes able to employ qualified undergraduates to assist in teaching elementary courses. Students who have done this have often reported that they have found it satisfying and even exciting, and there is money attached. Juniors

must have a 3.25 overall GPA and seniors a 3.00 GPA to be eligible for these positions. Applications are reviewed every semester. If you are interested and would like more information see the Chair's secretary in Neill 107 or check the Mathematics departmental website at: <http://www.math.wsu.edu/positions> for more information.

Tutoring: Students in introductory level classes are sometimes interested in hiring more advanced students to help them learn mathematics. The Department cannot be formally involved in these arrangements, but does maintain a list of students who are willing to tutor. If you would like to be on the list, complete a form in the mathematics main office (Neill 103).

College Modeling Contest: In February of each year there is a national competition in applied mathematics called the College Modeling Contest. Teams of three students spend a weekend attempting to solve a "real world" applied problem. The group's solution is submitted to a national panel of judges. The best solutions get publicized. If you are interested, inquire in the Mathematics main office (Neill 103).

Putnam Competition: Each year in December the Mathematical Association of America sponsors a mathematical problem-solving competition called the William Lowell Putnam Competition. High scores carry considerable prestige and sometimes cash prizes. For a number of years WSU has groomed students for this competition and they have done well. If you are interested, inquire in the Mathematics main office (Neill 103).

Hacker Reading Room: Mathematics majors are invited to use the Hacker Reading Room (Neill 216) for studying and socializing from 8:00 a.m. to 4:30 PM Monday through Friday.

Math Club: The Math Club is open to all students interested in mathematics. They need not be math majors. The club offers events for socialization, networking, and learning about the opportunities available in the field of mathematics at WSU and the world. Interested students can find information about upcoming meetings at the Math Club link on the WSU Mathematics Department website <http://www.math.wsu.edu>.

7 Other Information

Answers to many questions about courses, academic regulations, university policies and procedures, etc., will be found in the current WSU Catalog and Time , and at the departmental website (www.math.wsu.edu), the WSU registrar (www.ronet.wsu.edu) and other WSU web sites (www.wsu.edu).

If you have a question about a specific course, whether or not you are currently enrolled in it, ask the instructor. If you have questions about schedules, office hours, drops/adds/withdrawals and the like, ask in the Mathematics main office (Neill 103). And by all means, whenever you have questions or problems that require the personal touch, ask your adviser. If all else fails, see the Mathematics Department Chair by making an appointment with his secretary.

As graduation approaches, you will be thinking more and more seriously about the future. Specifically, you will probably be thinking about employment and/or graduate schools. In connection with employment, you will find much interesting information in the booklet *Professional Opportunities in the Mathematical Sciences* that is published by the Mathematical Association of America and revised frequently. You can usually get a copy in the departmental office. On campus, the people in the Career Services Office are eager to help at all stages, from preliminary identification of your own special aptitudes and goals to scheduling interviews with recruiters from possible employers. There are many places where you can look for short-term or part-time jobs on and off campus. Good places to begin are the Temporary Employment Office and the office of the Professional Experience Program.

The most useful compilation of information on US and Canadian graduate programs in the mathematical sciences is the annual "*Special Issue: Assistantships and Fellowships in the Mathematics Sciences*" of *Notices of the American Mathematical Society*, which appears in December. The Owen Science Library usually has several copies and often you can borrow one from a faculty member who regularly receives the *Notices*. Members of the mathematics faculty can often give you first-hand information about graduate programs you may be considering. If you are interested in teaching, the Brain Library in Cleveland Hall has additional resources about the teaching job market. In any case, you should get together with your advisor to talk about your professional plans after graduation no later than in the fall of your senior year.

You should not wait until your senior year to get acquainted with these valuable resources.

8 Course Offering Time Table

Legend: F=Fall, S=Spring, s=summer, O=Odd numbered years only, E=Even numbered years only, c// = concurrent

Course #	Course Title	Prerequisites and Co-requisites	Offered
171	Calculus I	Math 107 or 108 with a grade of C or better	F, S, s
172	Calculus II	Math 171 with a grade of C or better	F, S, s
182	Honors Calculus II	Math 171 with a grade of C or better & Instructor permission	F
220	Linear Algebra Intro	Math 171 or c//	F, S, s
230	Honors Linear Algebra Intro	Math 171 or c// & Instructor permission	S
273	Calculus III	Math 172 with a grade of C or better	F, S, s
283	Honors Calculus III	Math 182 or Instructor permission	S
300	Mathematical computing	Math 220	F,s
301	Mathematical Reasoning	Math 220 or 230 with a grade of C or better	F,S,s
302	Theory of Numbers	Math 172, 220, and 301 with a grade of C or better	SO
303	Higher Geometry	Math 220 with a grade of C or better	F
315	Differential Equations	Math 273 with a grade of C or better; Math 220 with a grade of C or better or c//	F, S, s
320	Modern Algebra	Math 220 with a grade of C or better	S
325	Combinatorics	Math 220 with a grade of C or better	S
330	Secondary Teaching Models	Math 220	F
340	Introduction to Mathematical Biology	Math 140 or 172 with a grade of C or better and 3 credits of biology	F
351	Elem. School Teacher Math	Math 252 with a grade of C or better	SO
360	Probability and Statistics	Math 172	F, S, s
364	Optimization	Math 202 or 220	F, S
375	Vector Analysis	Math 315	FE
398	Math Snapshots	Math 172	S
401	Intro to Math Analysis I	Math 301 with a grade of C or better	F
402	Intro to Math Analysis II	Math 401	S
415	Intermediate Differential Equations	Math 315	SE
416	Simulation	Math 360 and a computer programming course	FO
420	Linear Algebra	Math 220 (or 230) and 301 with grades of C or better	F
421	Abstract Algebra	Math 301 with a grade of C or better	S
423	Statistical Methods	Math 360 or one 3 hour statistics course	S
431	Culture and Math	Math 301	F
432	College & Secondary Math Teaching	Math 301	S
440	Applied Math I	Math 315	F, S, s
441	Applied Math II (Complex Analysis)	Math 315	S
443	Applied Probability	Math 172, 220	F, S, s
448	Numerical Analysis	Programming Language & Math 315	F, S
453	Graph Theory	Math 220	F

Course #	Course Title	Prerequisites and Co-requisites	Offered
456	Statistics Theory Intro	Math 443 or Stat 430	S
464	Operations Research	Math 273	S
466	Network Optimization	Math 325 or 364 or knowledge of linear programming	FE
486	Math Modeling	Math 315	FE

9 Program Checklists and Schedule Worksheets

9.1 Secondary Teaching Option Checklist and Schedule Worksheet

9.1.1 Secondary Teaching Option Checklist

Credits			Completed	Credits			Completed
Core Math			✓	Arts, Humanities, Soc Sci			✓
4	Math	171	_____	3	Psych 105	_____	_____
4	Math	172/182	_____	3	[H,G]	_____	_____
2/3	Math	220/230	_____	3	[I,G,K]	_____	_____
2	Math	273/283	_____	3	[H,G,S,K]	_____	_____
3	Math	300	_____	3	[H,G,I, S,K]	_____	_____
3	Math	301	_____	3	[H,G,I, S,K]	_____	_____
3	Math	315	_____	0	[D]: one above	_____	_____
3	Math	325	_____	Sciences			
3	Math	360/443	_____	4	Phys 201	_____	_____
1	Math	398	_____	4	[B, P, Q]	_____	_____
3	Math	303	_____	3	[B, P, Q]	_____	_____
3	Math	330	_____	1	Lab [B, P, Q]	_____	_____
3	Math	401	_____	Electives			
3	Math	320/421	_____	3	Tier III	_____	_____
3	Math	431	_____	T&L Courses			
3	Math	432	_____	1	T&L 300	_____	_____
Math Option				2	T&L 301	_____	_____
3	Math	_____	_____	2	T&L 317	_____	_____
Communications				3	T&L 464	_____	_____
3	Engl	101	_____	3	T&L 465	_____	_____
3	Engl	201/301	_____	2	T&L 466	_____	_____
World Civilizations				3	T&L 467	_____	_____
3	Gen Ed	110	_____	3	EdPsy 468	_____	_____
3	Gen Ed	111	_____	2	T&L 469	_____	_____
Foreign Language			_____	3	T&L 470	_____	_____
Writing Portfolio			_____	16	T&L 415	_____	_____

Note: At least 15 credits must be Tier I courses, 22 credits must be Tier II courses, and 3 credits must be a Tier III course. Arts, Social Sciences, Humanities, Diversity and Intercultural Studies courses must be chosen to satisfy the criteria set out in the Checklist under Arts, Hum, and Soc Sci (see WSU Catalog for which courses satisfy which designations.) Science courses must include Phys 201, one biological Science [B], one lab in addition to Phys 201 (students often take this with their biology class), for 12 credits total. One additional courses listed under MATH OPTION must be a 3-credit Math course numbered above 300.

In addition to the requirements listed above, you must satisfy the requirements specified by the Teaching & Learning Department in the College of Education and you should have a T&L advisor as well as a mathematics advisor.

9.1.2 Secondary Mathematics Teaching Option Schedule Worksheet

Freshman Year

<u>Fall Semester</u>	<u>Credits</u>	<u>Spring Semester</u>	<u>Credits</u>
Gen Ed 110 [A]	3	GenEd 111 [A] (GER)	3
Biological Science [B] (GER)	4	Psych 105 [S] (GER)	3
Engl 101 [W] (GER)	3	Arts & Humanities [H,G,D] (GER)	3
Math 171 [N] (GER)	4	Math 172	4
		Math 220/230	2/3

Sophomore Year

<u>Fall Semester</u>	<u>Credits</u>	<u>Spring Semester</u>	<u>Credits</u>
Arts, Humanities, or Social Sciences [H,G,S,K] (GER)	3	Intercultural [I,G,K] (GER)	3
Phys 201 [P] (GER)	4	Science [B,P,Q] (GER)	4
Math 300 [M]	3	Math 301	3
Math 273	2	Math 315	3
Engl 201 [W] (GER)	3	T&L 300	1
		Complete Writing Portfolio	

Junior Year

<u>Fall Semester</u>	<u>Credits</u>	<u>Spring Semester</u>	<u>Credits</u>
Arts & Humanities, Intercultural, or Social Sciences [H,G,I,S,K] (GER)	3	Arts & Humanities, Intercultural, or Social Sciences [H,G,I,S,K] (GER)	3
Math 303	3	Math 320 or 421 [M]	3
Math 330 [M]	3	Math 325	3
Math 401 [M] or 431	3	Math Option ¹ or 432	3
Math 360	3	T&L 317	2
T&L 301	2	Math 398	1

Senior Year

<u>Fall Semester</u>	<u>Credits</u>	<u>Spring Semester</u>	<u>Credits</u>
Math 401 [M] or 431	3	Math Option ¹ or 432	3
Tier III [T] (GER)	3	T&L 467	3
T&L 464	3	EdPsy 468	3
T&L 465	3	T&L 469	2
T&L 466	2	T&L 470	3

Fifth Year

<u>Fall Semester</u>	<u>Credits</u>	<u>Spring Semester</u>	<u>Credits</u>
T&L 415 (Student Teaching)	16		

Math Option courses must be Math courses numbered between 300 and 490.

9.2 Other Options Checklist and Schedule Worksheet

9.2.1 Other Options Mathematics BS Checklist

Credits			Completed	Credits			Completed
Core Math			✓	Arts, Humanities, Soc Sci			✓
4	Math	171	_____	3	[H,G]	_____	_____
4	Math	172/182	_____	3	[S,K]	_____	_____
2/3	Math	220/230	_____	3	[I, K,G]	_____	_____
2	Math	273/283	_____	3	[H,G,S,K]	_____	_____
3	Math	300	_____	3	[H,G,I, S,K]	_____	_____
3	Math	301	_____	3	[H,G,I, S,K]	_____	_____
3	Math	315	_____	0	[D]: one above	_____	_____
3	Math	360/443	_____	Sciences			
1	Math	398	_____	4	Phys 201	_____	_____
3	Math	401	_____	4	[B, P, Q]	_____	_____
3	Math	402	_____	3	[B, P, Q]	_____	_____
3	Math	420	_____	1	Lab [B, P, Q]	_____	_____
3	Math	421	_____	Electives			
Math Options				3	Tier III	_____	_____
3	Math	_____	_____	—	_____	_____	_____
3	Math	_____	_____	—	_____	_____	_____
3	Math	_____	_____	—	_____	_____	_____
3	Math	_____	_____	—	_____	_____	_____
Communication				—	_____	_____	_____
3	Engl	101	_____	—	_____	_____	_____
3	Engl	402	_____	—	_____	_____	_____
	Writing Portfolio		_____	—	_____	_____	_____
World Civilizations				—	_____	_____	_____
3	Gen Ed	110	_____	—	_____	_____	_____
3	Gen Ed	111	_____	—	_____	_____	_____
	Foreign Language		_____	—	_____	_____	_____
Other				—	_____	_____	_____
4	Cpt S	121/251	_____	—	_____	_____	_____

Note: At least 120 credits are required with 40 of these credits in courses numbered 300 or above. At least 15 credits must be Tier I courses, 22 credits must be Tier II courses, and 3 credits must be a Tier III course. Arts, Social Sciences, Humanities, Diversity and Intercultural Studies courses must be chosen to satisfy the criteria set out in the Checklist under Arts, Hum, and Soc Sci (see WSU Catalog for which courses satisfy which designations). Science courses must include Phys 201, one biological Science [B], one lab in addition to Phys 201 (students often take this with their biology class), for 12 credits total. All Mathematics Options, except the Secondary Teaching Option, require Cpt S 121 or 251. The four courses listed under Math Option must be chosen from one of the lists on the following page. For non-native English speakers, Engl 403 may be substituted for Engl 402. Additional courses may also be required or recommended for each option, and these are also listed on the following page.

9.2.2 Other Mathematics Options Required and Suggested Courses

Actuarial Science Option

Required: Math 360, 416, 423, 443, and 456 (background material for actuarial exams).

Suggested: Acctg 230 and 231, BLaw 210, EconS 101, 102, 301, 302, 311, Fin 325 and 350, and Math 448 provide additional background for actuarial exams.

Computational Mathematics Option

Required: Cpt S 122; Math 364, 448 and two of Math 416, 440, 464, or 466.

Suggested: It is strongly recommended that some electives be used for a Computer Science minor with Cpt S 223 and three 300-400 level Cpt S courses (e.g. 317, 322 and 445 or 450) excluding computer skills and literacy courses. A minor in computer science must be approved by the computer science undergraduate coordinator.

Mathematical Modeling Option

Required: Four of Math 340, 415, 440, 448, and 486.

Suggested: Two of Math 364, 416, 423, 441, or 464 and a minor in an area that uses mathematical modeling.

Operations Research Option

Required: Math 364, 464 and two of Math 325, 416, 448, 453, 456, or 466.

Theoretical Mathematics Option

Required: Four of Math 302, 303, 325, 415, 441, or 453.

Other Options Course Schedule

Note: The table below shows the schedule for the courses in each option. Courses in *italics* are only offered once every two years, so careful planning is required to schedule these courses in the correct semester. Courses from the “choose x of” lists are in parentheses.

<u>Option</u>	<u>Fall</u> <u>Odd Years</u>	<u>Spring</u> <u>Even years</u>	<u>Fall</u> <u>Even Years</u>	<u>Spring</u> <u>Odd Years</u>
Actuarial Sciences	360, <i>416</i> , 443	360, 423, 443, 456	360, 443	360, 423, 443, 456
Computational Math	364, 448, (<i>416</i> , 440)	364, 448, (440, 464)	364, 448, (440, <i>466</i>)	364, 448, (440, 464)
Math Modeling	(340, 440, 448)	(<i>415</i> , 440, 448)	(340, 440, 448, <i>486</i>)	(440, 448)
Operations Research	364, (<i>416</i> , 448, 453)	364, 464, (325, 448, 456)	364, (448, 453, <i>466</i>)	364, 464, (325, 448, 456)
Theoretical Math	(303, 453)	(325, 441, <i>415</i>)	(303, 453)	(<i>302</i> , 325, 441)

9.2.3 Other Options Schedule Worksheet

Freshman Year

<i><u>Fall Semester</u></i>	<i><u>Credits</u></i>	<i><u>Spring Semester</u></i>	<i><u>Credits</u></i>
Gen Ed 110 [A] (GER)	3	GenEd 111 [A] (GER)	3
Biological Science [B] (GER)	4	Social Science [S,K,D] ² (GER)	3
Engl 101 [W] (GER)	3	Cpt S 121 or 251	4
Math 171 [N] (GER)	4	Math 172	4
		Math 220 or 230	2/3

Sophomore Year

<i><u>Fall Semester</u></i>	<i><u>Credits</u></i>	<i><u>Spring Semester</u></i>	<i><u>Credits</u></i>
Arts & Humanities, or Social Sciences [H,G,S,K] ² (GER)	3	Intercultural [I,G,K] (GER)	3
Phys 201 [P] (GER)	4	Science [B,P,Q] (GER)	4
Math 300 [M]	3	Math 301	3
Math 273	2	Math 315	3
Elective ^{3,4}	3	Math 360	3
		Complete Writing Portfolio	

Junior Year

<i><u>Fall Semester</u></i>	<i><u>Credits</u></i>	<i><u>Spring Semester</u></i>	<i><u>Credits</u></i>
Arts & Humanities, Intercultural, or Social Sciences [H,G,I,S,K] (GER)	3	Arts & Humanities [H,G,I,S,K] (GER)	3
Math 420	3	Math 421 [M]	3
Engl 402	3	Math 398	1
Math Option Course ¹	3	Math Option Course ¹	3
Elective ⁴	3	Elective ⁴	3
		Elective ⁴	3

Senior Year

<i><u>Fall Semester</u></i>	<i><u>Credits</u></i>	<i><u>Spring Semester</u></i>	<i><u>Credits</u></i>
Math 401 [M]	3	Math 402	3
Math Option Course ¹	3	Math Option Course ¹	3
Arts & Humanities or Social Sciences [H,G,I,S,K] (GER)	3	Elective ⁴	3
Tier III [T] (GER)	3	Elective ⁴	3
Elective ⁴	3	Elective ⁴	3

Note: Some math courses are offered every other year. Some of you will take these courses in your junior year, while others will take them as seniors. The Mathematics Options Course Schedule should be used to plan your last two years of study so that you do not miss any of the courses you need in your program.

¹ See Mathematics Options list for required option courses.

² Actuarial Science Option students should take Econ 101, 102.

³ Computational Mathematics Option students must take Cpt S 122.

⁴ See Mathematics Options list for suggested electives.

10 Application for Certification in Mathematics

Date: _____

Name: _____ Student ID _____

Mailing Address: _____

Permanent Address: _____

Email: _____

Local Phone: _____ Permanent Phone _____

Application for certification in Mathematics with the option (circle one): Actuarial Science,
Computational Math, Modeling, Operations Research, Theoretical Math, Secondary Math Teaching.

Have you ever been denied certification or been de-certified in one of these areas at WSU? _____

If Yes, Explain:

Will this be a second major? _____ If yes, what is your other major? _____

Will this be a second degree? _____ If yes, what is your other degree? _____

Other Colleges Attended

<u>College or University</u>	<u>Year Last Attended</u>	<u>Credits (Sem. Hours)</u>	<u>GPA</u>
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Mathematics Core Course Grades

<u>WSU Course</u>	<u>Course Designation If not taken at WSU</u>	<u>College Where Course Completed</u>	<u>Credits (Sem. Hrs.)</u>	<u>Grade</u>
Math 171-Calculus I	_____	_____	_____	_____
Math 172-Calculus II (or 182)	_____	_____	_____	_____
Math 220-Linear Algebra (or 230)	_____	_____	_____	_____

Return completed the form, your academic file/transcripts and a certification card [pick up card from the Mathematics main office (Neill 103) or from SALC (Lighty 260)] to the Mathematics Main Office

The section below this line is for Mathematics Department use only.

Certification approved by: _____ Date: _____

Major Advisor Assigned: _____

Certification denied by: _____ Date: _____

Comments: