WASHINGTON STATE UNIVERSITY
Department of Mathematics and Statistics

Department of Mathematics & Statistics Graduate Student Handbook

M.S. in Mathematics
M.S. in Statistics
PhD in Mathematics
PhD in Statistical Science

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1 TABLE OF CONTENTS

2 INTRODUCTION

This handbook offers guidance to students working toward advanced degrees in mathematics and statistics at Washington State University. In all of our degree programs we attempt to combine a sound general core of fundamental mathematics and statistics with electives that reflect individual interests, needs, and opportunities. Students can obtain an M.S. or Ph.D. in Mathematics, with optional areas of emphasis in applied mathematics, and teaching in mathematics. The department also offers an M.S. in Statistics and a Ph.D. in Statistical Science.

Graduate students should accept much of the responsibility for their own training. This includes planning a meaningful program of study, studying for courses and examinations, and writing a dissertation or completing a project.

It is important to note that some of the regulations and requirements mentioned are from the Graduate School and are university-wide in scope, while others originate in the Department of Mathematics and Statistics and pertain only to mathematics and statistics students. The Graduate School determines the procedures regarding the Master's and Doctoral Final Oral Examinations, the Doctoral Preliminary Examination, total hours required for each degree, and the format for a thesis or dissertation. Specific course requirements and rules governing the Graduate Qualifying Examination and the Doctoral Qualifying Examination originate with the Department.

There are many more resources and important information available at the Graduate School website (gradschool.wsu.edu). On that site, be sure that you consult the page about New and Current Students and the current version of the Graduate School Policies and Procedures Manual. That manual is the definitive source for information on Graduate School regulations and requirements, while this guide is the official source of information concerning departmental regulations and requirements valid on the date of issue. For an up-to-date list and description of Mathematics and Statistics courses offered, consult the University Catalog (catalog.wsu.edu).

Departmental policies pertaining to graduate programs are set by the graduate faculty of the Department of Mathematics and Statistics. The departmental Graduate Studies Committee serves as an intermediary between the graduate students and the graduate faculty. Questions concerning the content of this document and petitions requesting a possible waiver or modification of any rule of departmental origin should be directed to this committee. Students should feel free to seek advice or assistance from any member of the mathematics faculty, and especially from the Chair of the Department, the Associate Chair of the Department, and the members of the Graduate Studies Committee. In addition, students should not hesitate to seek assistance from the Graduate Program Coordinator on administrative matters pertinent to the graduate programs of the Department.

3 NOTICE OF NON-DISCRIMINATION

In matters of admission, employment, housing or services, or in the educational programs or activities it operates, WSU does not discriminate or permit discrimination by any member of its community against any individual on the basis of sex (including sex stereotypes, sex characteristics, pregnancy or related conditions, sexual orientation, and gender identity), race, color, national or ethnic origin, physical disability, mental disability, sensory disability, use of a trained service animal, age, religion, creed, genetic information, marital status, protected veteran status, honorably discharged veteran, member of the military, or immigration or citizenship status except as authorized by federal or state law, regulation, or government contract.

WSU policies comply with federal and state civil rights laws and regulations, including, but not limited to: Title IX of the Education Amendments of 1972 (20 USC § 1681), Title IX implementing regulations 34 CFR 106, Title VII of the Civil Rights Act of 1964 (42 U.S.C. 2000d et seq) and the Pregnancy Discrimination Act, Title I and II of the Americans with Disabilities Act (ADA) of 1990 as amended, the Rehabilitation Act of 1973 (P.L. 93-11) and 45 CFR Part 84, Title VI of the Civil Rights Act of 1964 (42 U.S.C. 2000d et seq), Title IV of the Civil Rights Act of 1964 (42 U.S.C. 2000d et seq), Chapter 49.60 RCW, and the Gender Equality in Higher Education (Chapter 28B.110 RCW).

Inquiries about the application of these laws and regulations (including inquiries regarding the application of Title IX and its implementing regulations), as well as reports and complaints of discrimination and harassment, can be made verbally or in writing to WSU's Compliance and Civil Rights, the Department of Education's Office of Civil Rights, or both:

Compliance and Civil Rights
Tel: 509-335-8288
Email: ccr@wsu.edu
Online: Online Reporting/Complaint Form
In-person: French Administration Building Room 220
Address: PO Box 641022
Pullman, WA 99164-1022
Title IX or Deputy Title IX Coordinator: TitleIX.Coordinator@wsu.edu
ADA Coordinator: ADA.Coordinator@wsu.edu

U.S. Department of Education Office of Civil Rights
Online: Online Complaint Form
Address: Lyndon Baines Johnson Department of Education Bldg
400 Maryland Avenue, SW
Washington, DC 20202-1100
Tel: 800-421-3481
FAX: 202-453-6012; TDD: 800-877-8339
Email: OCR@ed.gov
Local OCR office: https://ocrcas.ed.gov/contact-ocr

Reports and complaints about conduct that may constitute discrimination (including sex discrimination under Title IX) can be made verbally or in writing to Compliance and Civil Rights and the university's Title IX Coordinators at the contact information above. WSU's prohibition on and relevant procedural guidelines for discrimination, discriminatory harassment, sex discrimination, and sexual harassment, including sexual assault, dating violence, domestic violence, and stalking, are available here:

- WSU's Policy Prohibiting Discrimination and Harassment
- CCR's Procedural Guidelines
- WSU's Standards of Conduct for Students
- Employee manuals:
    - Faculty Manual
    - Administrative Professional Handbook
    - Civil Service code
    - Collective Bargaining Agreements

4 PREREQUISITES FOR ADMISSION

All graduate students are expected to have a background in mathematics or statistics equivalent to that provided by an undergraduate degree. Normally this means that a student has taken advanced, upper-division courses typical of a mathematics or statistics major course of study. Specific classes that are expected prerequisites for each degree are listed below. Students admitted with a deficient background are expected to make up these deficiencies at the earliest opportunity.

For applicants to the **MS and PhD Mathematics** program, a student's background in mathematics would ideally include familiarity with the material covered in Math 401 Introduction to Analysis, Math 402 Introduction to Analysis II, Math 420 Linear Algebra, Math 421 Algebraic Structures, and some experience with computer programming.

For applicants to the **PhD Statistical Science** program, a student's background in statistics would ideally include a course in probability theory, similar to Stat 443 Applied Probability, and a course in mathematical statistics or statistical theory, similar to Stat 456/556 Introduction to Statistical Theory.

Students considering the **M.S. in Statistics** should have a major in Mathematics, Statistics, or a field in which statistics is heavily used. Minimum admission requirements for the M.S. in Statistics include three semesters of calculus (including one semester of multivariate calculus), Linear Algebra (similar to Math 220), a course in computer programming, and at least one upper division course in probability and statistics (similar to Stat 360, Stat 370, Stat 412, Stat 423).

For students already registered to a doctoral program at Washington State University who are interested in completing an M.S. in Statistics concurrently, please see The MS in Statistics section for information on that process.

5 MASTER OF SCIENCE IN MATHEMATICS & STATISTICS: POLICIES AND PROCEDURES

The Department of Mathematics & Statistics offers an M.S. degree in Mathematics and an M.S. degree in Statistics, with possible Mathematics options including Applied, Computational Finance, and Teaching. A full-time graduate student typically takes two years to complete the program. Completing the M.S. degree requires four components, including:

Coursework – Each option has specific requirements, but at minimum, a student must complete a total of 30 credit hours, which includes at least 26 hours of graded coursework, 2-4 hours of Math/Stat 702 and 1 hour of Math 500 Proseminar, to be taken the week before the student's first fall semester. Additionally, teaching assistants are required to take three semesters of Math 533 Teaching College Mathematics.

Administrative paperwork – To assess progress and accomplishments, students must complete an annual review at the end of each spring semester. The semester before they graduate, all M.S. graduate students are required to submit a *Program of Study* and then an *Application for Degree* (online in the student's MyWSU portal by the deadlines listed by the Graduate School, normally the seventh week of final semester).

The *Program of Study* includes the signatures of all committee members and the department chair and indicates that the committee approves the student's coursework to fulfill the requirements for the degree. Adjustments to the program of study and changes to the student's committee can be submitted to the Graduate School when necessary.

Committee Composition:

- All members must hold a degree at a level comparable to the degree sought by the student (WAC 250-61-100).
- The committee must include at least three current WSU faculty members.
- At least two of these three members must be current members of the Faculty of the Graduate School.
- At least two members must be from the student's graduate program faculty.
- Out of these two, at least one must be a member of the Graduate Faculty.

The *Application for Degree* cannot be filed until an approved Program of Study is on file with the Graduate School. It is advised that students apply for their degree the semester before their intended graduation, so the student is notified of requirements to be completed their final semester. Candidates may not schedule a *final examination* until an Application for Degree has been filed.

Final Exam – All Master's degree students must complete a final examination that may cover all of the student's coursework including Math/Stat 702. The student's advisory committee may conduct the examination when all requirements of the Department and the Graduate School have been satisfied. Scheduling forms are available online at the Graduate School website and must be turned in at least four weeks before the end of the semester of graduation and at least two weeks (10 working days) before the exam date. The format for M.S. examinations varies by discipline and project; students should work with their committee chair to determine the expectations for the exam.

Extracurricular activities – Besides meeting the requirements needed to obtain a degree, students should voluntarily and energetically devote time to additional courses, outside reading of both books and journals, attend colloquia and special lectures by local and visiting speakers, work on assigned problems, and participate actively in seminars and professional meetings. Participating in these activities may be a crucial part of obtaining desirable employment after graduation.

5.1 Course Policies and Procedures

Prerequisites – Students pursuing an M.S. in Mathematics are expected to have a background equivalent to that provided by our undergraduate degree in mathematics. Ideally, this would include familiarity with the material covered in Math 401 and 402 (Introduction to Analysis), Math 420 and 421 (Linear Algebra and Algebraic Structures), and some experience with computer programming. Students with a deficient background are expected to make up these deficiencies at the earliest opportunity.

Students considering the M.S. in Statistics should have a major in Mathematics, Statistics, or a field in which statistics is heavily used. Minimum admission requirements for the M.S. in Statistics include three semesters of calculus, Math 220 (Linear Algebra), a course in computer programming, and at least one upper-division course in probability and statistics (e.g. Stat 360, Stat 412, Stat 423).

Transfer Credit – Up to eight hours of transfer credit may be given for suitable coursework done elsewhere in the pure and applied options. Up to six hours may be requested in the mathematics teaching option. Transfer credit is requested by listing the courses on the program of study and attaching the course syllabus; approval of the program of study implies approval of transfer credit. Courses taken toward a completed M.S. or B.S. degree may NOT be used toward another M.S. degree at WSU. All other graded graduate-level course work (with a grade of B or higher) taken as a graduate student, but not taken toward a completed graduate degree, may be used toward an

M.S. degree at WSU. Other general regulations regarding transfer credit can be found in Chapter 6 of the Graduate School Policies and Procedures Manual.

Note: The departmental graduate handbooks are in a transitional period while we continue to update the PhD programs. Please do not hesitate to ask if you have questions about any policies or procedures for your degree.

6 THE M.S. IN MATHEMATICS

Description and Learning Outcomes – This broadly defined program provides flexibility for students to design a course of study according to their interests, particularly in pure mathematics. It can also lay a solid foundation for further doctoral study in Mathematics, working in industry, or for teaching at the high school, community college, or university level as an instructor. This M.S. program is designed to lead the student to the following learning outcomes:

- Problem Solving: Students will be able to identify mathematical and computational methods in order to solve problems.
- Deductive Thinking: Students will be able to read and write logical arguments in order to prove advanced mathematical results.
- Effective Communication: Students will be able to effectively communicate mathematical concepts, problems and their solutions in written and oral form.

For admission to this program, please consult Section 4 for prerequisites.

Courses – The M.S. in Mathematics requires at least 32 semester hours of approved graduate work. Math 501, Math 500, and four hours of Math 702 are the only required courses for the degree; the remaining 24 hours must be graded coursework selected from the options listed below. At least 18 of these hours must be from the approved list of mathematics and statistics graduate electives below. The remaining 6 hours of graded credit are elective and may be taken in other departments with approval of the advisor through the submission of a program of study. These may include 500-level courses, a maximum of two 400-level courses, and up to one 300-level course (if in another department).

Required courses:

(5 credits)	Math 500	Proseminar (1 credit)
	Math 702	Directed Study (4+ credits)

Core Courses:

(3 credits)	Math 501	Real Analysis (3 credits)

Math/Stat Electives: 6 courses chosen from:

(18+ credits) Math 502-574, Math 586
Stat 508-577, including Stat 443 and excluding Stat 511.
A maximum of two Statistics courses can be counted.

Additional Electives:	two courses
(6 credits)	Any Department (including Mathematics and Statistics)

Math 702 and M.S. Examination – The four required hours of Math 702 involve independent study under the guidance of a faculty member, normally the chair of the student's advisory committee. The results of this study are often summarized in a paper, but this is not mandatory. In addition, students must complete a final oral examination, covering the content of the student's coursework including Math 702, 401, 402, 420, and 421 (Analysis, Linear Algebra, and Abstract Algebra). The format for the final examination is at the discretion of the student's committee, and it is the student's responsibility to be aware of their requirements. The student's committee will conduct this examination when all other requirements for graduation have been fulfilled.

7 THE M.S. IN MATHEMATICS – APPLIED MATHEMATICS OPTION

Description and Learning Outcomes – This is a two-year professional degree specifically designed to train mathematicians and scientists/engineers with strong mathematics backgrounds in up-to-date applied mathematical, computational and statistical skills. Such training is intended to produce individuals who can confidently undertake interdisciplinary research. The focus will be in preparing individuals to face the mathematical and other research challenges in business and/or industrial sectors. In order to achieve these goals the program requires:

- A broad background in the areas of Numerical Analysis/Optimization, Modeling/Simulation, and Statistical Analysis
- A concentration in one of the above areas or one that matches the student's interests
- Development of an individual project
- A strong computing component.

The M.S. in Mathematics (Applied Option) is designed to meet the following learning outcomes:

- Problem Solving: Students will be able to identify mathematical and computational methods in order to solve problems.
- Deductive Thinking: Students will be able to read and write logical arguments in order to prove advanced mathematical results.
- Effective Communication: Students will be able to effectively communicate mathematical concepts, problems and their solutions in written and oral form.

For admission to this program, please consult Section 4 for prerequisites.

Courses – The M.S. in Mathematics (Applied Option) requires at least 32 hours of approved graduate course work from the list below, 27 of which are graded credits. Twelve of these graded credits are requirements from four different areas: one course each from the a) Differential Equations, b) Computational, c) Statistics, and d) Optimization categories, and the remaining 15 credit hours are electives that:

- Must include at least three courses in an emphasis area of the student's choice, subject to the advisory committee's approval. This emphasis area should be included on the Research Topic/General Area section of the Program of Study.
- Include at most three 400-level courses on the program of study, as permitted by the Graduate School for an M.S. degree.

At least seven of the nine required graded courses for this degree must have the prefix MATH or STAT. At most one course involving mathematics education (e.g. Math 531, 532, 534, 535, or 590) may be counted.

Required courses:

(5 credits)	Math 500	Proseminar (1 credit)
	Math 702	Master's Directed Study (minimum 4 credits)

Differential Equations Requirement – Select one of the following courses:

(3 credits)	Math 415	Intermediate Differential Equations
	Math 512	Ordinary Differential Equations
	Math 540	Applied Mathematics I: PDEs

Computational Requirement:

(3 credits)	Math 548	Numerical Analysis
	or another computational course as approved by student's committee	

Statistics Requirement:

(3 credits) Select Stat 435, Stat 443, or any 500-level Statistics course

Optimization Requirement – Select one of the following courses:

(3 credits)	Math 464	Linear Optimization
	Math 564	Convex and Nonlinear Optimization
	Math 565	Nonsmooth Analysis and Optimization with Applications
	Math 566	Optimization in Networks
	Math 567	Integer and Combinatorial Optimization
	Math 574	Topics in Optimization

Graduate Electives:

(15 credits) Five additional graduate-level courses, including at least three from a chosen emphasis area (see below for examples). Courses from another department related to the student's research interests may be included, but note that students are responsible for the prerequisite material before taking a course. Topics courses may be included where appropriate and if approved by the student's committee.

Examples of emphasis areas include (but are not limited to) courses in the following, or any other focus approved by the student's committee or chair of the graduate studies committee:

Optimization*:
Math 464, 564, 565, 566, 567, 574

Mathematical Modeling:
Math 570, 571, 579, 586

Data Analytics:
Stat 435, 437, 536, 577, CptS 415, 570, 577

Computational Science:
Math 516, 544, 545, 546, 566, CptS 515, 570

Mathematical Finance:
Math 516, 545, 546, 564, 565, 566, Stat 516, 519, 544, EconS 510, 511, 512, Fin 429, 427, 481

Mathematical Biology:
Math 512, 516, 563, 579, 586, CptS 570, Stat 435, 544

Mathematical Engineering:
Math 512, 516, 544, 545, 546, 566, 570, Stat 523, 544, Engineering courses

*As one course is already taken for the Optimization elective, only two additional courses are needed to complete an Optimization emphasis

Math 702 and M.S. Examination – Students must take at least four hours of Math 702. Ordinarily, the student must complete a project in Applied Mathematics under the direction of their advisor and committee. The final M.S. exam may also cover all of the student's coursework and the content of Math 401 & 402 Analysis, Math 420 Linear Algebra, and Math 421 Abstract Algebra. The student's advisory committee will conduct this examination when all other requirements for graduation have been fulfilled. The format of the final examination and project is at the discretion of the advisory committee.

Electives and Internships – During a standard two-year program, a student taking 10 credit hours (most students take more) will have time to include several elective courses in addition to the course work required. Students are strongly encouraged to take additional courses in math or other departments, spend a summer on an internship, and to attend seminars in applied mathematics. These elective courses, internship, and the project completed in Math 702 should form an effective combination in a particular area of interest to each student.

8 THE M.S. IN MATHEMATICS – MATHEMATICS TEACHING OPTION

Description and Learning Outcomes – This is a two-year professional degree designed to prepare teachers of mathematics at the community college, four-year college, or secondary levels. The program combines advanced work in mathematics with coursework in education and practice teaching, providing a foundation in both mathematical content and teaching methodology.

This M.S. program is designed to meet the following learning outcomes:

- Critical Thinking: Students will have developed the skills necessary to critically read and evaluate both practitioner and research articles in mathematics education journals.
- Pedagogical Content Knowledge: Students will have the mathematical knowledge necessary to teach upper secondary and lower-level college mathematics.
- Effective Communication: Students will be able to speak effectively about mathematics and write scholarly contributions to practitioner journals.

For admission to this program, please consult Section 4 for prerequisites.

Courses – A candidate must complete 35 semester hours of approved graduate work, both in mathematical content and teaching methods. This must include 27 semester hours of graded course work and 8 semester hours of non-graded work.

Required courses:

(5 credits)	Math 500	Proseminar (1 credit)
	Math 702	Master's Directed Study (minimum 4 credits)

Core Courses:

(15 credits)	Math 501	Real Analysis (3 credits)
	Math 531	Intersections of Culture and Mathematics (3 credits)
	Math 532	Advanced Mathematical Thinking (3 credits)
	Math 533	Teaching College Mathematics (3 credits)
	Tch_Lrn 581	Learning and Development in Math and Science (3 credits)

Practical Training:

(3 credits, nongraded)	Math 597	Instruction Seminar (1 credit/semester, 3 semesters)
	One semester shadowing Math 251 or 252 Fundamentals of Mathematics for elementary teachers.	
	Two or more semesters teaching an undergraduate math course.	

Graduate Electives: (12 credits, graded) Four courses from the following list; at least one course must be included from each of the three groups:

Group 1: Algebra, Discrete Math, & Geometry

Math 505	Abstract Algebra
Math 507	Advanced Theory of Numbers
Math 553	Graph Theory
Math 555	Topics in Combinatorics

Group 2: Probability & Statistics

Stat 443	Applied Probability
Stat 510	Topics in Probability and Statistics
Stat 519	Applied Multivariate Analysis
Stat 544	Applied Stochastic Processes
Stat 548	Statistical Theory I
Stat 549	Statistical Theory II
Stat 575	The Theory of Multivariate Analysis

Group 3: Applied & Numerical

Math 464	Linear Optimization
Math 566	Optimization in Networks
Math 540	Applied Mathematics I
Math 541	Applied Mathematics II
Math 548	Numerical Analysis
Math 563	Mathematical Genetics
Math 564	Convex and Nonlinear Optimization
Math 565	Nonsmooth Analysis and Optimization with Applications
Math 567	Integer and Combinatorial Optimization
Math 570	Mathematical Foundations of Continuum Mechanics I
Math 574	Topics in Optimization
Math 579	Math Modeling in the Bio and Health Sciences
Math 586	Math Modeling in the Natural Sciences

Math 702 and M.S. Examination – The four required hours of Math 702 involve independent study under the guidance of a faculty member, normally the chair of the student's advisory committee. The topic of the study must pertain to curricular and pedagogical issues relevant to teaching mathematics. The results of this study are often summarized in a paper, but this is not mandatory. In addition, students must complete a final oral examination, covering the student's coursework and the content of Math 702, 401, 402, 420, and 421. This will include an oral presentation on the results of the student's Math 702 project. The student's advisory committee

will conduct this examination when all other requirements for graduation have been fulfilled. The format of the final examination, project, and/or paper is at the discretion of the advisory committee.

9 THE M.S. IN STATISTICS

Description and Learning Outcomes – This is a two-year degree designed to prepare students to work in industry or to apply to a PhD program by providing them with a broad statistical skill set. Students may enroll in the M.S. in Statistics program directly or while seeking a PhD in another field. Students can choose courses from five field areas: Statistical Theory, Applied Statistical Methods, Bioinformatics and Biostatistics, Econometrics and Time Series, and Data Analytics.

This M.S. program is designed to lead the student to the following learning outcomes:

- Problem solving skills: Students are expected to learn the fundamental tools of statistical modeling and implementation. Skills for identifying and solving statistical problems arising in various interdisciplinary areas are an important expected learning outcome associated with this degree.
- Ability to work individually or in groups: Statistical modeling can be pursued at an individual level or as part of a group effort with the group comprised of experts in various allied fields. Students are expected to develop such statistical skills so that modeling and analysis can be done in a timely and efficient manner.
- Communication skills: Students should develop effective communication skills so that the interpretation and implications of the results obtained from analysis of a statistical model can be presented in an effective manner.

For admission to this program (if you are not already a doctoral student at WSU), please consult Section 4 for prerequisites.

For PhD Students in Other Departments – There are many disciplines and sub disciplines that require extensive advanced training in statistics to perform graduate research work. One natural avenue for students at WSU to obtain this advanced training is to pursue an M.S. in Statistics. It provides the skillset they need to perform research in their primary field of study, and such a degree enhances their marketability. All students enrolled in a PhD program in Pullman are able to receive advanced statistical training at the Master of Science level. By pursuing this option, a student can simultaneously be enrolled in the M.S. in Statistics option and the program of their primary PhD degree-granting unit.

Normally, students will have taken several graduate-level Statistics courses before adding the M.S. program to their PhD program. Once they have found an advisor and formed a committee, students will fill out an Add an Academic Program Degree Level form, to be submitted by the graduate coordinator in the Department of Mathematics & Statistics. There is no additional

application fee. Students must obtain consent from their primary department and the Department of Mathematics & Statistics to submit this form. At the same time, the student should submit a completed Program of Study for the M.S. Statistics. Note that the Department of Mathematics & Statistics does not usually provide assistantships to students who are getting a PhD in another department. The degree must be added at least one semester before the semester the student intends to complete the degree.

Courses – The M.S. in Statistics requires a minimum of 31 credit hours, including 2-4 credits of Stat 702, passage of a comprehensive examination, and/or a written project. Any changes to the requirements for a particular student can be made only with prior approval of the student's committee and the chair of the Graduate Studies Committee. Special topics covered in Stat 510 may be used to satisfy an elective with approval of the student's committee. Students who do not have a background in a field outside of statistics, mathematics, or computer science are encouraged to take at least two upper division courses in another substantive area. Those students who complete an undergraduate degree at Washington State University and receive a B or better in Stat 443 and Stat 456/556 may substitute other electives in place of that core requirement.

Core requirements account for 24 of the required credit hours; the remaining 9 hours must include three or more courses representing at least two field areas chosen from the table below. At most, two courses may be outside of the "STAT" or "DATA" prefix.

Required Courses:

(2 – 5 credits) Stat 702 (2 – 4 credits)
Math 500 (1 credit, not required for the student getting a PhD in another department)

Core Courses:

(20 credits) Stat 443 AND Stat 556 Probability and Statistical Theory
OR Stat 548 AND Stat 549 Statistical Theory (6 credits)
Stat 512 Analysis of Variance of Designed Experiments (3 credits)
Stat 536 Statistical Computing (3 credits)
Stat 530 OR Stat 535 Regression (3 credits)
Stat 575 The Theory of Multivariate Analysis (3 credits)
Stat 590 Statistical Consulting Practicum (2 credits, non-graded)

Electives: Three courses from at least two field areas listed below.
(9 credits) Students may select three courses from the Data Analytics field.

Statistical Theory*:

Stat 544	Applied Stochastic Processes
Stat 548	Statistical Theory I
Stat 549	Statistical Theory II
Stat 577	Statistical Learning Theory

Applied Statistical Methods:

Stat 519	Applied Multivariate Analysis
Stat 574	Linear and Nonlinear Mixed Models
Stat 576	Bayesian Analysis

Bioinformatics and Biostatistics:

Stat 520	Statistical Analysis of Qualitative Data (infrequent)
Stat 522	Biostatistics and Statistical Epidemiology (infrequent)
Math 563	Mathematical Genetics
Crop_Sci 545	Statistical Genomics

Econometrics and Time Series:

Stat/MgtOp 516	Time Series
Econ 511	Econometrics I
Econ 512	Econometrics II
Econ 513	Econometrics III

Data Analytics:

Stat 435	Statistical Modeling for Data Analytics
Stat 437	High Dimensional Data Learning and Visualization
Math 566	Optimization in Networks
CptS 534	Neural Network Design Application
CptS 540	Artificial Intelligence
CptS 570	Machine Learning
CptS 575	Data Science
CptS 591	Elements of Network Science

*Stat 548 and 549 cannot be used in the field area if counted for the core requirements.

Stat 702 and M.S. Examination – There is no thesis requirement; however, an M.S. in Statistics student is required to either (i) take two written exams, offered at the beginning of each fall and spring semester (more information below), or (ii) do a Masters project equivalent to 2 – 4 hours of Stat 702.

i. The written exams are given twice per year, usually the week before classes start at the beginning of the Fall and Spring semester. The exams are the same exams as the GQE exams required by PhD students but have lower scores for passing. They consist of two 3-hour exams offered over two days. Most of the material over which the exams are based is covered in the following four courses: Stat 512 and 443 (offered every Fall), and Stat 530 and 556 (offered every Spring). A more detailed list of topics is provided in Appendix II. Students must pass each 3-hour exam to pass the M.S. written exams. A student has two attempts to pass the exams. During the first attempt, students must attempt both exams. Should a student not pass one of the two exams, they need only take the exam not passed when taking the exam for the second time. After passing the exams, students will receive 2 credits of Stat 702 during their final semester of their MS degree.

ii. For the Master's project, early in the student's graduate program (by the second semester as recommended by the Graduate School), the student should obtain a project supervisor and form an M.S. committee. The student project supervisor will normally serve as the chair of the M.S. committee, which will usually include two additional faculty with an interest in Statistics. It is the committee's responsibility to give final approval of the project. The student must select one of three M.S. project options to satisfy the project requirement. Selection of the project option must be made in consultation with the student's M.S. committee chair. The three project options are as follows:

1. The student can do an independent research project (advised by the supervisor). Acceptable topics for a project include original data analysis or original research on a statistical problem. The student is required to write the final draft of the project report.
2. The student can thoroughly study a statistical modeling and methodology paper (suggested by the supervisor). The student then reads the selected paper, together with at least three other relevant papers, and then prepares a comprehensive written report which includes, but is not limited to, the central objectives of the problem, modeling, methodology, implementation, results, and conclusions. The student is required to write a summary report on the topic and to include in the report the computer code for implementation of the methodology.
3. The student can complete an internship that is compatible with the student's chosen career specialization within statistics (approved by the supervisor). The internship should be a full-time affiliation for a period of not less than eight weeks duration and not less than 400 hours. A monthly report is required during the internship, and a written report is to be turned in at the end of the internship.

For all three options, the student is required to write a final summary report on the subject and make it available to the M.S. committee at least two weeks prior to the final Master's Examination. It is the committee's responsibility to give final approval. The final Master's

Examination is a one-hour oral exam conducted by the student's M.S. committee. The oral exam will consist of a 30-minute presentation of the student's project/paper/internship, followed by a 15-minute period for questions by the committee related to the results contained in the Masters project.

Suggested schedule for an MS Statistics student obtaining a PhD in another program:

Year 1		
Fall:	Stat 512	Analysis of Variance of Designed Experiments
	Stat 443	Applied Probability
Spring:	Stat 556	Intro to Statistical Theory (prereq Stat 443)
	Stat 530	Applied Linear Models (name may be changing)
Year 2		
Fall:	Stat 575	Theory of Multivariate Analysis (prereq Stat 556)
	Stat 536	Statistical Computing (prereq Stat 556)
Spring:	Stat 590	Statistical Consulting (at end of coursework)
	Stat Elective	
Year 3		
Fall:	Stat Elective	
	Stat Elective	
Spring:	Defense	

Note: It is strongly recommended that students who are interested in the MS statistics program complete Stat 443 and Stat 512 first in the fall, then Stat 556 and Stat 530 the following spring. These courses will prepare the student for future electives and core requirements. Stat 443 should be considered a prerequisite for all other classes and must be taken before Stat 556. Please contact the graduate coordinator with any questions at mathstat.gradinfo@lists.wsu.edu

10 THE PHD IN MATHEMATICS

Description and Learning Outcomes – The degree of Doctor of Philosophy in Mathematics is awarded in recognition of distinctive scholarship and original contributions to knowledge.

Students may want to take a broad range of courses beyond the courses required for their PhD. This may include taking additional courses offered by other departments or within the Department of Mathematics and Statistics such as statistics, math education, or additional math courses. The motivated student may consider getting a MS in Statistics, Computer Science, Math Education, or a M.S. in another graduate program.

Entering students are not required to have a Bachelor's degree in Mathematics. However, they will be required to demonstrate a grasp of the core areas of advanced calculus (also known as Introduction to Analysis) and linear algebra at the level of a Bachelor's degree in Mathematics. For more information on admission prerequisites to this program, please consult Section 4.

The PhD program is designed to lead the student to the following learning outcomes:

- Critical Thinking: Students will be able to think critically and creatively.
- Knowledge and Scholarship: Students will be able to identify and conduct original research and scholarship.
- Ethical and Responsible Research: Students will be able to conduct research in an ethical and responsible manner.
- Effective Communication: Students will be able to effectively communicate research work in written and oral form.

Departmental requirements and regulations for the PhD in Mathematics are specified below. The regulations of the Graduate School for doctoral programs are available in the Graduate School Policies and Procedures Manual.

Required Coursework:

The course work requirements for the Mathematics doctoral degree consist of core graded courses, elected graded courses, and non-graded courses. A candidate must complete 27 semester hours of graded course work. Twelve semester hours consist of the core courses.

Core courses – all students must take:

Math 501 Real Analysis

Math 511 Advanced Linear Algebra

All students must take **two** of the following four courses:

Math 502 Functional Analysis
Math 505 Abstract Algebra (offered every 4 years)
Math 506 Commutative Algebra (offered every 4 years)
Math 554 Advanced Graph Theory (offered every other year)

Elective courses:

The remaining graded courses (15 semester hours), termed elective courses, must be numbered 500 or above. Up to 9 hours of non-graduate level graded course work may be included. Conjoint courses, such as MATH 540, shall count as 400 level courses for these requirements.

No more than 6 credit hours of graded coursework from 400 or 500-level non-math courses may be applied to the 15 semester hours of graded elective courses. The external courses, as well as all math courses meeting this requirement, must be approved by the student's PhD committee.

Other required courses:

All doctoral students are also required to take one hour of Math 500 (to be taken before the student's first Fall semester), which will include short presentations by faculty on departmental research areas, and 20 total hours of Math 800. Teaching assistants are required to take three semesters of Math 533, Teaching College Mathematics. Students are strongly encouraged to participate in Departmental Seminars throughout their graduate studies.

Further course work may be required by the Program of Study, which will be assembled in consultation with the student's Doctoral Committee.

Exception to these requirements may be recommended by the student's Doctoral Committee and must be approved by the Graduate Studies Committee.

11 THE PHD IN MATHEMATICS – APPLIED MATHEMATICS OPTION

The Applied Mathematics Option allows students to combine mathematics with computational science, data analytics, statistics, and machine learning to tackle some of today's most challenging problems.

Students are encouraged to take a broad range of courses beyond the courses required for their PhD. This may include taking additional courses offered by other departments or within the Department of Mathematics and Statistics such as statistics, math education, or additional math courses. The motivated student may consider getting a MS in Statistics, Computer Science, Math Education, or a M.S. in another graduate program.

Entering students are not required to have a Bachelor's degree in Mathematics. However, they will be required to demonstrate a grasp of the core areas of advanced calculus (also known as Introduction to Analysis) and linear algebra at the level of a Bachelor's degree in Mathematics. For more information on admission prerequisites to this program, please consult Section 4.

The degree of Doctor of Philosophy in Mathematics – Applied Math Option is awarded in recognition of distinctive scholarship and original contributions to knowledge. This PhD program is designed to lead the student to the following learning outcomes:

- Critical Thinking: Students will be able to think critically and creatively.
- Knowledge and Scholarship: Students will be able to identify and conduct original research and scholarship.
- Ethical and Responsible Research: Students will be able to conduct research in an ethical and responsible manner.
- Effective Communication: Students will be able to effectively communicate research work in written and oral form.
- Computational competency: Students will be able to effectively problem solve by logically applying appropriate algorithms within computational technology.

Departmental requirements and regulations for the Applied Mathematics Option are specified below. The regulations of the Graduate School for doctoral programs are available in the Graduate School Policies and Procedures Manual.

Required Coursework:

The course work requirements for the Applied Mathematics Option consist of core graded courses, elected graded courses, and non-graded courses. A candidate must complete 27 semester hours of graded course work. Twelve credit hours consist of the core courses.

Core courses – all students must take:

Math 501	Real Analysis
Math 511	Advanced Linear Algebra

All students must take **two** of the following four courses:

Math 548	Numerical Analysis (conjoint with MATH 448, offered every year)
Math 512	Dynamical Systems (previously known as Intermediate Differential Equations, offered every other year)
Stat 544	Applied Stochastic Processes (offered every other year)
Math 554	Advanced Graph Theory (offered every other year)

Elective courses:

The remaining graded courses (15 semester hours), termed elective courses, must be numbered 500 or above. Up to 9 hours of non-graduate level graded course work may be included. Conjoint courses, such as MATH 548, shall count as 400 level courses for these requirements.

Although students are encouraged to take non-math courses, no more than 6 credit hours of graded coursework from 400 or 500-level non-math courses may be applied to the 15 semester hours of graded elective courses. The external courses, as well as all math courses meeting this requirement, must be approved by the student's PhD committee.

Other required courses:

All doctoral students are also required to take one hour of Math 500 (to be taken before the student's first Fall semester), which will include short presentations by faculty on departmental research areas, and 20 total hours of Math 800. Teaching assistants are required to take three semesters of Math 533, Teaching College Mathematics. Students are strongly encouraged to participate in Departmental Seminars throughout their graduate studies.

Further course work may be required by the Program of Study, which will be assembled in consultation with the student's Doctoral Committee.

Exception to these requirements may be recommended by the student's Doctoral Committee and must be approved by the Graduate Studies Committee.

12 THE PHD IN MATHEMATICS WITH EDUCATION EMPHASIS

Description and Learning Outcomes – the degree of PhD in Mathematics with Education Emphasis is awarded in recognition of scholarship and original contributions to the teaching and learning of mathematics. The main difference from other PhD choices is in the research focus. The requirements for this PhD include competence in core mathematics as well as study in the research methodologies applicable to research in mathematics education.

This PhD program is designed to lead the student to the following learning outcomes:

- Critical Thinking: Students will have a working knowledge of the literature in mathematics education research. They will understand different theories of learning mathematics and styles of research.
- Knowledge and Scholarship: Students will have mastered the tools and knowledge (both mathematical and educational) necessary to conduct original research in mathematics education that will lead to a publishable quality dissertation.
- Ethical and Responsible Research: Students will have completed the necessary training in ethical research and will fully understand and have experience with the issues involved in conducting educational research.
- Effective Communication: Students will be experienced in writing research-based journal articles, making research presentations at conferences and speaking frequently in front of their peers.

Departmental requirements and regulation for the PhD in Mathematics are specified below. The regulations of the Graduate School for doctoral programs are available in the Graduate School Policies and Procedures Manual. Appeals requesting waiver or modification of any rule of departmental origin may be submitted to the Graduate Studies Committee.

For admission to this program, please consult Section 4 for prerequisites.

Courses and Hours – The course work for the PhD in Mathematics with Education Emphasis shall be as follows. A candidate must successfully complete 72 hours of approved coursework. At least 34 semester hours must be graded coursework and numbered 500 or above (except for up to 9 hours of 400-level graded course work). All doctoral students are required to take one hour of Math 500 (to be taken before the student's first Fall semester) and 20 total hours of Math 800. Teaching assistants are required to take three semesters of Math 533 Teaching College Mathematics.

The rest of the coursework must include the following courses:

Core:

Math 501, 511, 531, 532

Foundation in Mathematics (5 courses from the following):

Math 502, 503, 504, 505, 507, 512, 525, 543, 544, 553, 555, and 564. Alternative courses may be selected in consultation with your advisor. The intent here is to provide breadth of background in mathematics.

Educational Foundations, Research Methodologies, and Statistical Analysis:

Tch_Lrn 581, Tch_Lrn 584, Ed Psych 507, and Stat 520 OR Stat 530

It is also recommended that the student participate in the joint WSU/UI Mathematics Education Seminar each semester and take two or more additional graded math courses numbered 500 or above to strengthen the mathematical foundations.

Teaching Experience – There are two additional requirements to those described in the section regarding Teaching Experience under PhD Policies and Procedures. First, most students graduating with this degree will be expected to teach the equivalent of Math 251 and 252 when they are hired as faculty members. Thus, students earning this degree are required to do an internship with a Math 251 or 252 instructor during which they will become familiar with the manipulatives used to teach these courses and gain experience teaching and assessing pre-service elementary teachers in an activity-based environment.

Second, they will teach a 200-300 level mathematics course with serious mentoring by their advisor or another faculty member approved by the advisor. The intent here is to help candidates develop all aspects of their teaching skills in a more autonomous environment than calculus.

13 THE PHD IN STATISTICAL SCIENCE

Description and Learning Outcomes – Students pursuing a PhD in Statistical Science will gain core knowledge in statistics and working knowledge in an allied interdisciplinary domain. Students will take core and elective statistics courses offered through the Department of Mathematics & Statistics, statistics courses offered through allied departments that have in-depth application of statistical methods, and at least two courses from one of the partnering allied departments. Students are also encouraged to have a faculty from an external department to serve on their PhD committee, and strongly encouraged to have that individual serve as co-chair of the student's PhD committee. The PhD dissertation will be focused on developing new statistical methods and solving problems for data challenges in a chosen field of interest.

This PhD program is designed to lead the student to the following learning objectives:

- Have knowledge of advanced statistical theory and statistical methodology
- Have a working knowledge of a domain that generates their problem
- Have knowledge in statistical computing and be familiar with commonly used statistical software such as R, S-PLUS, SAS, and data management programs
- Apply statistical knowledge to real life problems effectively and ethically, understanding the theoretical assumptions and practical limitations of the methodologies applied
- Communicate effectively the principles and methods of statistical science in both written and oral forms
- Conduct independent research in statistical sciences with focus on interdisciplinary research

Courses – Students pursuing a PhD in Statistical Science must complete a total of 72 credit hours. The curriculum is comprised of seven core statistics courses (21 credit hours), two fundamental applied statistics courses (6 credit hours), two general statistics electives (6 credit hours), and two elective courses in an external subject (6 credit hours), for a total of 39 graded credit hours. Examples of interdisciplinary, external subjects include Veterinary Medicine, Electrical Engineering, Computer Science, Economics, and Biological Sciences, but courses can be taken from any department as agreed upon by the student's PhD committee. Students must also take seven non-graded credit hours: Stat 590 (2 credit hours), Stat 591 Seminar (4 credit hours), and Math 500 (1 credit hour, taken their first fall semester). Additional credits can be obtained through Stat 800 (minimum of 20 credits of Stat 800 required). Teaching assistants are required to take three semesters of Math 533 (Teaching College Mathematics). The degree requirements are listed below:

Core Statistics:

(21 credits)	Stat 536	Statistical Computing
	Stat 548	Statistical Theory I
	Stat 549	Statistical Theory II
	Stat 556	Introduction to Statistical Theory
	Stat 574	Linear and Nonlinear Mixed Models
	Stat 575	The Theory of Multivariate Analysis
	Stat 577	Statistical Learning Theory

Core Applied Statistics:

(6 credits)	Stat 512	Analysis of Variance of Designed Experiments
	Stat 530	Applied Linear Models

General Statistics Electives: two courses

(6 credits)	Stat 516	Time Series
	Stat 519	Applied Multivariate Analysis
	Stat 520	Statistical Analysis of Qualitative Data
	Stat 522	Biostatistics and Statistical Epidemiology
	Stat 544	Applied Stochastic Processes
	Stat 576	Bayesian Analysis

Interdisciplinary Electives: **two courses**, in consultation with PhD committee, at the 400-level or higher.
(6 credits)

Practicum: (2 credits)	Stat 590	Statistical Consulting Practicum
Seminar: (4 credits – 4 semesters)	Stat 591	Seminar in Statistics
Proseminar: (1 credit)	Math 500	Proseminar

14 PHD POLICIES AND PROCEDURES

The proceeding parts of this guide outline the substance of the PhD graduate programs in mathematics and statistical science at WSU. Certain mechanisms and procedural rules are required, however, to implement individual programs. The present section summarizes the most important of these. These rules reflect both Graduate School and departmental policies. Refer to the Graduate School Policies and Procedures manual for a specification of the rules originating from the Graduate School.

The Department of Mathematics & Statistics offers a PhD degree in Mathematics and a PhD degree in Statistical Science, with possible Mathematics options including Applied and Education Emphasis. A full-time graduate student typically takes five years to complete the program. Completing the PhD degree requires four components, including:

Coursework – Each option has specific requirements, but at minimum, a student must complete 72 total credit hours, comprised of at least 34 hours of graded coursework, 20 hours of Math or Stat 800 Directed Study to pursue a dissertation topic, and 1 hour of Math 500 Proseminar, to be taken the week before the student's first fall semester. Additionally, teaching assistants are required to take three semesters of Math 533 Teaching College Mathematics.

Administrative paperwork –

Annual Review – completed each spring to assess progress and accomplishments, as well as set goals for the upcoming year.

Program of Study – includes the signatures of all committee members and the department chair, and indicates that the committee approves the student's coursework to fulfill the requirements for the degree. Adjustments to the program of study and changes to the student's committee can be submitted to the Graduate School when necessary. See PhD Policies and Procedures for information on doctoral advisory committee composition.

Application for Degree – Filed online through my.wsu.edu and cannot be filed until the preliminary exam has been completed. It is advised that students apply for their degree the semester before intended graduation, so the student is notified of requirements to be completed their final semester. Candidates may not schedule a *final examination* until an application for degree has been filed.

Exam Scheduling Forms – Submission of scheduling forms is required for both the preliminary exam and the final exam. These are due to the graduate coordinator no less than ten business days from the date of the exam.

Research, Dissertation and Final Defense – see FDE for more information.

Extracurricular Activities – besides meeting the requirements needed to obtain a degree, students should voluntarily and energetically devote time to additional courses, outside reading of both books and journals, attend colloquia and special lectures by local and visiting speakers, work on assigned problems, and participate actively in seminars and professional meetings. Participating in these activities may be a crucial part of obtaining desirable employment after graduation.

Summary of Doctoral Procedures:

Procedure	Under Direction Of	Date
Obtain Advisor	Chair of Grad Studies Committee	As soon as possible
Online Training	Graduate School	As soon as possible after admission
GQE	Chair of Grad Studies Committee	See Doctoral Examination Str.
Submit Program of Study	Advisor and Doctoral Committee	During 2nd year
DQE	Doctoral Committee	During 3rd year
Preliminary Examination	Doctoral Committee; Scheduled through Graduate School[a]	Ideally end of 4th year; at least four months prior to the Final Oral Examination[e]
Application for Degree[b]	Graduate School	At least four months before graduation
Final Examination[c]	Graduate School	See Doctoral Examination Str.
Dissertation Submission[d]	Graduate School	10 days after defense

Notes:

[a] Submit completed scheduling form with approved examination date, time, and place to the Graduate School at least 10 business days prior to examination date.

[b] It is strongly advised that the application for degree be submitted one semester before the final oral examination is scheduled so that students can be notified of graduation requirements (to-do lists) before enrolling for their last semester.

[c] Submit completed scheduling form with approved examination date, hour, and place and a copy of the dissertation to the Graduate School at least 10 working days prior to the examination date. It is required that a copy of the dissertation be cleared by the Graduate School for compliance of format at the time of scheduling the final examination. A copy of the dissertation must be available for public inspection at least 5 working days prior to the final examination in the department office location designated by the department. The student must provide a copy of the dissertation to each member of the doctoral committee and to the Representative of the Graduate Studies Committee at least 5 working days before the date of the final examination.

[d] Doctoral students wishing to participate in Commencement must satisfy all requirements for the degree by the Wednesday preceding the Commencement.

All forms may be picked up in the Graduate School Office or downloaded at gradschool.wsu.edu.

[e] Salary will be increased after passing the Preliminary Exam.

14.1 Switching Between Statistical Science and Mathematics Doctoral Programs

In rare circumstances, the department may approve a student to switch between the Mathematics and Statistical Science doctoral programs. To apply, a student must first have a faculty member (typically a faculty member who is willing to be the student's PhD supervisor) indicate support for a change of program in a memo. The student should also work with this faculty member to propose a timeline to prepare and take the required GQE of their discipline, i.e., (1) when the student will take courses needed for the GQE and (2) when the student will attempt the GQE. Students who are approved to switch doctoral programs will normally have no more than a total of three attempts at the two forms of the GQE (not including the free try their first semester) and must pass the GQE by the end of their 5th academic semester (typically the Fall of the third year).

The above support memo, a personal statement by the student explaining the reason for the request, timeline, and a change of program form should be submitted to the Graduate Studies

Committee for consideration. It should be noted that the student's PhD work should meet the learning objectives of the new PhD program.

The number of semesters a student is supported from departmental funding (e.g., Teaching Assistantship) is not extended due to switching programs.

14.2 Course Policies and Procedures

Prerequisites – (also in Section 3, above) All graduate students are expected to have a background in mathematics or statistics equivalent to that provided by an undergraduate degree. Students admitted with a deficient background are expected to make up these deficiencies at the earliest opportunity. For applicants to the **MS and PhD Mathematics** program, this would ideally include familiarity with the material covered in Math 401 Introduction to Analysis, Math 402 Introduction to Analysis II, Math 420 Linear Algebra, and Math 421 Algebraic Structures, and some experience with computer programming. For applicants to the **PhD Statistical Science** program, this includes a course in probability theory, similar to Stat 443 Applied Probability, and a course in mathematical statistics or statistical theory, similar to Stat 456/556 Introduction to Statistical Theory.

Transfer Credit – Graduate credit earned elsewhere (excluding extension work, special problems, workshops, etc.) may be applied as part of the program if the work is of "A" or "B" quality. Up to 15 credits of graded courses may be transferred. Courses substitution may be approved by a faculty member who has taught the WSU course within the last three years. Courses substitution may or may not count toward the PhD graded course requirements. The graded courses that count toward a PhD degree are determined by the student's thesis committee at the time of submitting a Program of Study (typically done during the second year). Transfer credit is requested by listing the courses on the Program of Study; approval of the Program of Study implies approval of transfer of credit. Other general regulations regarding Transfer Credit can be found in the Graduate School Policies and Procedures Manual.

14.3 Residence

On-campus Residence: One of the greatest assets of our graduate program is the community of graduate students and faculty – developing a support group, getting involved with student organizations, working together on course and program requirements, and engaging in informal conversation and collaboration. To encourage part-time doctoral students to engage in this community and to make timely progress, doctoral students must spend at least one academic year (two consecutive semesters) in person at their home campus, i.e., enrolled full-time and present on campus. Exceptions may be requested, see Section 16

Residence for tuition purposes: Domestic students who are non-residents of the State of Washington will be expected to become residents as soon as they are eligible (after one year). For more information regarding establishing residency in the state of Washington, see the Graduate School's Information about residency requirements.

International students who are not permanent residents nor citizens of the United States are not qualified to become residents of the state of Washington for tuition purposes.

14.4 Responsible Conduct of Research Education

All graduate students are required to complete web-based training Responsible Conduct of Research as soon as possible and inform the Graduate Program Coordinator of the department that training has been completed. This training is mandatory and must be repeated after a four-year period.

14.5 Graduate Student Code of Rights and Responsibilities

The University seeks fair and expeditious action on academic and conduct issues. Refer to WSU Graduate School Policies and Procedures – Graduate Student Rights and Responsibilities.

14.6 Policy on Consensual Relationships

According to WSU Business Policies and Procedures Manual Chapter 60, faculty and ASEs are prohibited from engaging in romantic and sexual relationships with students they currently or in the foreseeable future will teach, advise, supervise, evaluate or have some other form of influence or control over. For more information contact Human Resource Services, 509-335-4521/hrs@wsu.edu or Compliance and Civil Rights (CCR), 509-335-8288, ccr@wsu.edu.

14.7 Enrollment

Students who are employed as an ASE must be enrolled in a minimum number of credit hours – see the next section.

Students may request a leave of absence (LOA) for up to two consecutive semesters (not including summer semester). Contact the Program Coordinator for more information.

For PhD students, after finishing coursework and passing the Preliminary Exam, students may elect to not enroll in any courses (Continuous Doctoral Status). International students must consult with the Office of International Programs before entering Continuous Doctoral Status. However, the semester a student graduates, the student must enroll in a minimum of two research credit hours (i.e. MATH 800 or STAT 800).

14.8 Course Load and Regulations

The following table indicates minimum and maximum numbers of credit hours for a full-time graduate student at WSU stipulated by the Graduate School. Anything below the minimum is less than a full load and must be approved by the advisor; anything above the maximum is an overload and must be approved not only by the advisor but also by the Dean of the Graduate School.

Semester	Minimum – on assistantship (first year)	Minimum – on assistantship	Minimum – without WSU assistantship (international)	Minimum – without assistantship (domestic)	Maximum (with/without assistantship)
Fall, Spring	10	12	10	6	18
Summer*	0	0	0	0	9

* Rarely, for some employment statuses, a few students may need to enroll for 3 credit hours in the summer.

The normal course load for a graduate student in the Department of Mathematics and Statistics must be consistent with the requirements in the table above, and in addition must satisfy the guidelines described in the next two paragraphs.

Students holding departmental assistantships during the academic year are expected to carry at least ten (10) for the first year, or twelve (12) credit hours during the Fall and Spring semesters. For students holding an assistantship requiring enrollment in 3 credit hours, the 3 credit hours may be taken during any one of the three summer sessions. Any credits in excess of three credits taken during the summer are the financial responsibility of the student. Students with no assistantships may carry a course load that satisfies the requirements in the table above.

In addition, the courses that a graduate student takes during any semester must satisfy the set of regulations below, where the phrase "graduate-level course means":

- Any course with the prefix Math and a number from 501-590 (inclusive) or
- Any course with the prefix Stat and a number from 507-590 (inclusive) or
- Courses taught outside the Department specifically mentioned in the graduate program descriptions in this handbook, or
- Any course taught outside the Department (irrespective of number) vital to the student's program, if approved by the student's advisor.

Additional course regulations:

1. All full-time graduate students should register for 702 (MS) or 800 (doctoral) research credits each semester as follows:
    a) If a student has a thesis advisor already and is working on a research project, they should enroll for one credit in the respective course under the advisor's supervision.
    b) If a student does not have a thesis advisor yet and is not doing research, they should enroll for one credit in the respective course under the supervision of the Graduate Director.
    c) If students are taking preliminary or final exams, they must enroll in two research credits for that semester.
    d) Until a doctoral student has passed the Graduate Qualifying Examination, full-time graduate students must enroll in 1 credit hour of MATH/STAT 800. Part-time students may enroll 0 or 1 credit hour of MATH/STAT 800 before passing the Graduate Qualifying Examination.

2. Each graduate student with an assistantship from the Department of Mathematics and Statistics must enroll in at least nine (9) hours of graduate level course work per semester (Fall and Spring), with the following exceptions:
    a) A first-year student who finds it necessary to take an undergraduate course preparatory to taking a graduate level course, may substitute for a graduate-level course this undergraduate course (this may be done for more than one course)
    b) A doctoral student, having passed the Graduate Qualifying Examination may substitute up to three (3) hours of MATH/STAT 800 for graduate-level course credit
    c) A candidate for a doctoral degree who has passed the Doctoral Qualifying Examination is required to enroll in at least one graded graduate-level course
    d) A master's student who is enrolled in at least three hours of Math/Stat 702 in the final semester of the master's program is not required to enroll in any graduate-level course

14.9 Switching to or Adding a Graduate Program

Master's students who wish to change to a doctoral program must formally apply by the posted deadlines. If such a change of program is approved, it is subject to the following rules:

a) The outcome of any attempt to pass the GQE during the Master's course of studies is valid for the doctoral program and counts toward the maximum number of two attempts allowed to pass this exam.

b) If applicable, the student must use their remaining attempts to pass the GQE on the next two available opportunities following the semester in which the switch to the doctoral program is approved.
c) All other regulations and timing rules regarding the exams past the GQE (i.e., DQE, PDE, and FDE) apply as described in the doctoral program.
d) The total maximum period of financial support is as described in §4.5.

Doctoral students who want to obtain a master's degree in the course of their studies must file a Plan and Degree Level Change Form to add the Master's program. Subsequently, a Program of Study must also be submitted (four months before the final Master's examination).

14.10 GRADES

In the grading system used at WSU, numerical equivalents of letter grades are:

A = 4.0 A- = 3.7 B+ = 3.3 B = 3.0 B- = 2.7 C+ = 2.3 C = 2.0
C- = 1.7 D+ = 1.3 D = 1.0 D- = 1.0 F = 0.0

To be in good standing with a graduate program, graduate students must maintain a 3.0 cumulative grade point average and 3.0 program grade point average. If a student drops below the 3.0 requirement, the student is put on a probationary status. Please refer to the Graduate School Policies and Procedures.

Courses outside the department and not in the student's minor department may be taken on a Pass/Fail basis; this should be arranged at the time of registration by submitting the appropriate forms; the grade in any such course will be "Pass" or "Fail."

14.11 ADVISOR AND ADVISORY/DOCTORAL COMMITTEE

The Chair of the Graduate Studies Committee assigns new graduate students an advisor, who, in consultation with appropriate people, helps the student prepare his/her program and recommend the composition of his/her doctoral committee. The composition of the Doctoral committee is governed by:

1. The Graduate School Policies and Procedures Manual
2. The Graduate Program in Mathematics and Statistics Bylaws, as to who is a member of the Graduate Faculty and who can serve on student committees.

The Graduate School has issued the following general guidelines for the formation of committees:

- The committee must have at least three current members of the Faculty of the Graduate School.

- All committee members must hold a doctoral degree.
- At minimum, the committee must have two tenured/tenure-track faculty who are members of the graduate faculty in the student's graduate program. The third member must be graduate faculty in a WSU graduate program but is not required to be permanent tenure track faculty.
- 4th Committee Member:
    - Experts outside of WSU and faculty from other institutions may serve on committees as a fourth member.
    - If the statistics minor is chosen, a statistics faculty member must be represented as the fourth committee member.
- In all of the above cases, for any non-WSU member, or for any non-tenured/non-tenure track faculty outside of the student's graduate program, please attach a vitae and include a rationale to be reviewed for approval by the Dean of the Graduate School.
- Any exception to the composition noted above, or to program bylaws, requires a memo requesting an exception to policy (e.g. co-chair from another department, adjoint as co-chair, half or more of the committee composed of members outside Math/Stat).

The student usually has a definite voice in the formation of these committees and in exercising this privilege should consider the appropriateness of prospective members. An ideal committee should be made up of people all of whom have special reasons to be interested in the student's program, but represent varying viewpoints.

Committees are responsible for directing the student's program and conducting preliminary and final examinations of the student. Furthermore, the doctoral committee has the particularly important responsibility of guiding the student's thesis work and deciding on the acceptability of the finished thesis. Most of this responsibility usually falls on one member (normally the chair) of the doctoral committee, who, in this role, is called the student's thesis advisor or major professor.

Note: The departmental graduate handbooks are in a transitional period while we continue to update the PhD programs. Please do not hesitate to ask if you have questions about any policies or procedures for your degree.

15 DOCTORAL EXAMINATION STRUCTURE

The doctoral examination structure consists of four examinations: Graduate Qualifying Examination (GQE), Doctoral Qualifying Examination (DQE), Preliminary Doctoral Examination (PDE), and Final Doctoral Examination (FDE). The Graduate School Policy requires that all students can have two attempts to pass each examination. Note that if a student fails to pass an exam after the allowed number of attempts, the program will notify the Graduate School to recommend dismissal from the program. These examinations are described below.

15.1 GRADUATE QUALIFYING EXAMINATION (GQE)

Mathematics: The GQE is a two-part written exam. Problems written for the GQE are designed to assess the test-taker's knowledge of mathematical ideas spanning two areas: (1) advanced calculus (upper level calculus and introductory real analysis) and (2) linear algebra at the advanced undergraduate level. Each area is described in greater detail in Appendix I, including topics covered, courses offered in each area, and suggested study resources.

The GQE will be prepared and graded by a committee of up to four faculty members chosen by the Chair of the Department. Rules concerning the GQE are:

- The GQE is typically given twice a year – the week before classes start fall and spring semester.
- The GQE is given over a two-day period where students complete one part of the exam per day (linear algebra the first day and analysis the second). Each part of the exam is allotted a three-hour time block. The results of both parts of the GQE submitted by the student are considered in determining whether they pass.
- The GQE will consist of 10 problems, five from each area.
- Students can take the GQE in the first semester of enrollment (penalty-free attempt) and have at most two subsequent attempts to pass the GQE.
- Full-time students with a previous mathematics degree must pass the GQE by the end of their third semester in the program (not counting summer semesters). Students without a previous mathematics degree must pass the GQE by the end of their fourth semester in the program (not counting summer semesters) but still have at most two attempts after their first semester.
- Part-time students with a previous math degree must pass the GQE before completing 21 credit hours, and part-time students without a previous math degree must pass the GQE before completing 30 credit hours.
- Students who have not passed within the expected timeline can appeal for an additional attempt, but such appeals will rarely be granted. See below for information on the appeals process.

Statistical Science: The GQE consists of two written exams. Problems written for the GQE are designed to assess the test-taker's knowledge of statistical ideas spanning two areas of statistics: (1) Statistical Theory (Probability and Mathematical Statistics) and (2) Statistical Methods and Applications (Design of Experiments and Regression Analysis). The GQE will be set at the level of difficulty of senior undergraduate/first-year graduate level WSU statistics courses. Each area is described in greater detail in Appendix II, including topics covered, courses offered in each area, and suggested study resources.

The GQE will be prepared and graded by a committee of up to four faculty members chosen by the Chair of the Department. Rules concerning the GQE are:

- The GQE is typically given twice a year – the week before Fall semester commences (regularly) and the week before Spring semester commences (as needed).
- The GQE is given over a two-day period where students complete one part of the exam per day, theoretical statistics the first day and applied statistics the second. Each exam is allotted a three-hour time block. The GQE will consist of four problems from Statistical Theory and four from Statistical Methods and Applications.
- A standardized formula sheet, prepared by the GQE Committee, is provided to students to support exam preparation. The sheet will also be provided during the GQE. **Disclaimer:** The formula sheet is intended as a reference tool only. Exam questions may go beyond the material included on the sheet. Students are expected to demonstrate a thorough and comprehensive understanding of the subject matter beyond the formulas provided.
- Students must achieve a passing score in both exams independently. If a student fails one exam, they will only need to retake that specific exam, rather than both exams.
    - Students can take the GQE in the first semester of enrollment (penalty-free attempt) and have at most two subsequent attempts to pass the GQE.
- Both exams must be passed by the beginning of the fourth semester for full-time students. Part-time students must pass the GQE before completing 30 credit hours. Exceptions may be granted by formally appealing to the Graduate Studies Committee.
- A typical student will take the four courses (Stat 512 and 443 in Fall, Stat 530 and 556 in the Spring) to prepare themselves for the exam. However, there may be topics in the exams not covered in the above-mentioned four courses. Students should refer to the Appendix II for the detailed list of topics.
    - Students who have not passed within the expected timeline can appeal for an additional attempt, but such appeals will rarely be granted. See below for information on the appeals process.

GQE Appeals

- Appealing the grading of the GQE – Requests by students to view the graded exams, inquiries, or any objections regarding the grading must be addressed to the Chair of the Graduate Studies Committee, who will act as a liaison between students and the GQE Committee.
- Appealing for an additional attempt at the GQE –In exceptional cases, a student may appeal for an additional attempt at the GQE. When considering an appeal, it is recommended the student talk to the Chair of the Graduate Studies Committee and/or their faculty advisor before submitting an appeal. The written appeal should be submitted to the Chair of the Graduate Studies Committee. A letter of support from a member of the Graduate Faculty, usually the faculty advisor, addressed to the Graduate Studies Committee often strengthens a student's request. Appeals are granted on a case-by-case basis by the Graduate Studies Committee. The Chair can solicit feedback from other relevant members of the department.

15.2 Doctoral Qualifying Examination (DQE)

The Doctoral Qualifying Examination (DQE) is a written and/or oral examination that demonstrates that a student has the ability to learn and apply advanced knowledge. The student's Doctoral Committee will define the material to be covered on the DQE and the format of the DQE, and they will compose and grade this examination. Rules concerning the DQE are:

- The format of the exam and scope of material covered in the exam must be communicated in writing to the student and all members of the DQE committee before the exam is given.
- An exam cannot be given over more than a 4-month time period.
- Students will have at most two attempts to pass the DQE.
- Students are expected to pass the DQE after passing the GQE and by the end of their third year.
- Part-time students are expected to pass the DQE before completing 42 credit hours.
- The DQE will be given at a time suitable for the student and the committee.
- The possible results for the DQE are (1) pass, (2) fail, (3) conditional pass. In the case of a conditional pass, the student's doctoral committee will provide a written plan and timeline that must be satisfied for a student to formally pass. All decisions will be communicated in writing to the student, committee members, and graduate coordinator.
- An approved Program of Study must be filed with the Graduate School before the DQE can be scheduled.

15.3 Preliminary Doctoral Examination (PDE)

The Preliminary Doctoral Examination (PDE) is an oral examination that follows the Graduate School rules for Preliminary Doctoral Examinations. The PDE will begin with a presentation by the student to his/her doctoral committee on a dissertation research problem and a plan of research to be followed toward its solution. The examination will include questions and feedback from members of the doctoral committee on the student's presentation. Rules concerning the PDE are:

- The PDE will be given at a time suitable for the student and the committee, within the Graduate School regulations.
- Students will have at most two attempts to pass the PDE.
- Students should be aware that the PDE must be passed 4.5 months before the Final Doctoral Exam can be attempted. Therefore, students planning to complete their degree in five years need to complete the PDE by the end of their fourth year or early in their fifth year.

Once the Preliminary Examination has been passed, the student technically becomes a candidate for the PhD. This means that the student's primary focus should be on preparing and writing a dissertation, and they are considered All But Dissertation (ABD). ABD status is required to be eligible for many WSU scholarships and allows for flexibility to pursue employment opportunities outside WSU.

Should there be any changes to the scope or topic of the dissertation work between the prelim and the defense, it is the responsibility of the graduate student to inform all committee members and to get their approval. It is also good practice for the student to arrange a meeting with all committee members once a semester between the prelim and the defense.

15.4 Final Doctoral Examination (FDE, Defense)

Dissertation – The dissertation is a scholarly, original study that represents a significant contribution to the knowledge of the chosen discipline. The originality, importance and correctness of the dissertation should be comparable to what would appear in a peer-reviewed research journal. It is expected that a paper based on the student's work has been or will be submitted for publication.

Students must be aware of the dissertation format requirements as published by the Graduate School and be enrolled in research credits (800-level) while preparing and defending the dissertation. The committee should be kept informed of the student's research progress throughout the dissertation-writing process, and should discuss any potential problems with a student's research as soon as the problem is noticed. A draft of the dissertation containing all of

the major results and implications should be provided to the committee members no later than four weeks before the exam so that committee members can provide feedback before officially scheduling the exam with the Graduate School. Submission of the scheduling exam form (two weeks before exam) with all committee signatures indicates that only minor revisions will be required for publication in the WSU dissertation database following the defense. This written, approved dissertation draft must be submitted to the Graduate School when the defense is scheduled two weeks before the exam date. The student must pay any costs associated with graduation or preparation and duplication of the manuscript.

The Final Doctoral Examination – The FDE is an exam that is scheduled after the student has completed their dissertation and it has been approved by the student's Doctoral Committee. It will be an oral examination following the rules of the Graduate School and requires the submission of the Final Exam Scheduling Form and draft of the dissertation ten or more business days before the exam. The FDE is devoted mainly to a presentation of the content of the dissertation by the student and includes questions from members of the doctoral committee.

Rules concerning the FDE are:

- The FDE will be given at a time suitable for the student and the committee, within the Graduate School regulations.
- Students will have at most two attempts to pass the FDE.
- For students on assistantship, please consult the Assistantship Section about timelines for departmental financial support.

Note that students who have not completed their doctoral degree (i.e., have not passed the FDE) within 3 years of the semester they passed their preliminary exam, or within 10 years from the beginning date of the earliest course applied toward the degree, must request from the Graduate School an Extension of their degree program.

16 ASSISTANTSHIPS AND OTHER AWARDS

Academic Student Employee (ASE) Research and Teaching Assistantships serve three primary purposes:

1. To provide the assistant with financial aid while pursuing graduate studies
2. To give the assistant an opportunity for apprenticeship in research and teaching
3. To augment the research and teaching programs of the Department.

16.1 TERMS FOR ASE RESEARCH AND TEACHING ASSISTANTSHIP

The normal appointment of an ASE as a research or teaching assistantship is considered a half-time appointment, meaning 20 hours/week on average. Assistantship appointments are made on a semester-by-semester basis. Fall semester appointments begin on August 16th and end December 31, while spring semester appointments begin on January 1st and end May 15th. Summer appointments are sometimes available. If a doctoral student takes and passes the Preliminary Exam, the salary will increase starting from the semester following the one in which the Preliminary Exam took place.

The Graduate Studies Committee reviews current academic standing and the level of performance in assistantship duties of each graduate student at the end of each semester. Continued financial support in the form of a teaching or research assistantship is available to students who remain in good academic standing in the Department and perform their assistantship duties in a satisfactory manner.

16.2 MAXIMUM PERIODS OF SUPPORT

The usual maximum periods of support (from the time of first enrollment in graduate studies in the Department) are as follows.

- Students entering a doctoral program with a previous degree in mathematics or statistics typically have up to five years of financial support in pursuit of their degree.
- Students entering a doctoral program without a previous degree in mathematics or statistics typically have up to six years of financial support in pursuit of their degree.
- Students entering a Master's program are generally not fully funded; if they are, the maximum period of support for Master's students is two years (four semesters). For Master's candidates who decide to change to a doctoral program, the maximum period of support will be as if the student enrolled in the doctoral program on the date of first enrollment in the master's program.
- These maximums do not include summer semesters.

16.3 Request for an Extension of Financial Support

A student may submit a request for an extra semester or year of financial support, but it is rare that such a request will be granted. All requests must be sponsored by the student's doctoral advisor. The advisor and the student should each email a written request to the Chair of the Graduate Studies Committee. The student should include the reasons for the request and their academic goals and timeline, and the advisor's letter typically supports the student's extension request and provides context to the Committee regarding the student's progress. Extensions are granted on a case-by-case basis by the Graduate Studies Committee. The Chair can solicit feedback from other relevant members of the department as well. Requests are subject to available funds and current departmental need. Note that this extension request is for departmental funding only; a request to extend a student's program beyond the Graduate School regulations (six years for MS, ten years for PhD, four years from date of preliminary exam) must be submitted according to the Graduate School Policies and Procedures Manual.

16.4 Duties for ASEs Research and Teaching Assistants

Research Assistants – A research assistant is usually assigned to a particular member of the faculty, who then directs his/her work as assistant. In some departments, research assistants often literally assist the professor in research, but in mathematics this is seldom feasible and the research assistant is often engaged, in effect, on a separate project which may be more closely related to his/her thesis plans than anything else. As of Fall 2024 all research assistants are part of the WSU/UAW Contract, and so must comply with WSU/UAW Contract. ASEs weekly workload on average is twenty (20) hours per week.

Teaching Assistants – Teaching assistants may perform a wide variety of tasks, ranging from relatively routine paper grading to having complete charge of an individual class. In general, an effort is made to provide teaching assistants with assignments that will be of greatest benefit to them without neglecting the needs of the undergraduate students with whom they deal.

It is not always easy for a teaching assistant to arrive at a balance between activities as a student and activities as a teacher. Undergraduate teaching is an important function of the Department, and teaching assistants have a large share in it; they should accordingly avoid slighting it, and bring to it as much conscientiousness and imagination as they can.

Anything worth reading about college teaching in general, and about the teaching of college mathematics or statistics in particular, should be of potential interest to the teaching assistant. There exist some useful documents addressed directly to teaching assistants in mathematics, statistics, and kindred disciplines. A good place to start is the web site of the Mathematical Association of America. Information useful to the teaching assistants is provided in Math 500

Proseminar, a course offered to teaching assistants in the week before Fall semester begins and in Math 533, a one-credit hour course on teaching college mathematics. All new graduate teaching assistants are required to attend this seminar before they begin their assistantship duties. Math 597 Mathematics Instruction Seminar provides additional information useful for teaching assistants for their assigned courses.

Teaching assistant appointments officially start on August 16th for fall semesters and January 2nd for spring semesters. Teaching assistants are expected to be on campus on August 16th for fall semesters and January 2nd for spring semesters. Because of scheduling uncertainties, assignments for teaching assistants are subject to modifications. As of Fall 2024 all teaching assistants are part of the WSU/UAW Contract, and so must comply with WSU/UAW Contract. ASEs weekly workload on average is twenty (20) hours per week.

Once teaching positions for each semester have started, all teaching assistants must be available for contact via email and/or by phone.

Once the position has begun, the teaching assistant must maintain regular contact with his/her supervisor via email, phone, and/or office visits. If the position is primarily a grading position, the supervisor is the instructor for the associated course. If the position is a teaching or tutorial position, the supervisor is the course coordinator for the associated course. All teaching assistants are assigned a mailbox in Neill Hall outside the main office of the department. Teaching assistants must check their email frequently and respond in a timely manner (usually within two working days or less). Emails about their teaching assignments may come from students, course coordinator, staff, or other faculty. Graded material must be promptly returned to the students by the agreed deadline. All grading must be completed following procedures and standards set by the supervisor. In case of an emergency that might prevent meeting a deadline, the supervisor must be notified as soon as possible.

All teaching assistants are expected to hold student hours. All teaching and tutorial teaching assistants must add one credit of Math 597 (Math Instruction Seminar). There are separate Math 597 sections (led by course coordinators) for each of the primary teaching assistant assignment courses: Math 100, 103, 106, 108, 171, 172 and Stat 212.

Teaching assistants are expected to be on-campus until their teaching assistantship duties (including grading final examinations and submitting final course grades) for the semester are complete. Teaching assistants should not make travel plans at the end of the semester that result in departures prior to the completion of their teaching duties.

All teaching assistants are required to take three semesters of the one credit course Math 533 Teaching College Mathematics.

16.5 Departmental Policies Regarding Teaching Assistants

Teaching assistantships are critical to the existence of our graduate program. In many cases, the financial support they provide makes it possible for students to continue their education at the graduate level. With the assistantship comes the responsibility of conscientiously carrying out the TA duties. A major challenge for graduate students is to balance their own graduate studies with their TA duties.

The following guidelines have been developed to assist graduate students in achieving this balance:

- Whenever possible, first year graduate students will be assigned to either lead calculus tutorials or grade for a lower division class. These positions will give the first-year students slightly less responsibility and more time to adjust to graduate classes and to prepare for the GQE.
- In the final semester of their doctoral work, students may be given more flexible TA duties to allow for completion of their dissertations, job interviews, and presentations at professional meetings.
- Students in the middle of their doctoral program or the second year of their masters program may be assigned to teach courses in which they have more autonomy such as Math 105, 106, 107, 108, 201 or 202. Occasionally, more advanced courses such as 220, 273, and 315 will be available. This arrangement gives graduate students valuable teaching experience after they have acclimated to the graduate program and at a time when they have completed most of their course work.
- TA teaching requests will be honored whenever possible within the constraints above. This will include the opportunity to teach a variety of courses if the graduate student desires it.
- TAs will receive support from their Course Coordinators in the form of sample course materials, course administration, test scheduling and planning, teaching observations and feedback, resolution of student problems, final grade approval, and so forth. For multiple section courses, regular meetings may be required, but normally should not exceed once a week.

16.6 Other Awards

There exist fellowships, traineeships, and other kinds of support for graduate students; these are provided by state, federal and private agencies. Graduate students at WSU are automatically considered for those administered at WSU, as these become available. Applications for awards not administered through WSU are left to the individual student, who may, however, count on the cooperation of the Department in these matters.

The variety of these awards, and the rapidity with which their terms change, make it impractical to list them here. Detailed information about departmental and university awards and scholarships can be found on the departmental website under Scholarships and Fellowships.

17 OTHER USEFUL INFORMATION

Annual Graduate Student Review – An annual progress review of each graduate student is performed at the end of the spring semester. The review takes place on a form with two parts provided by the department. Students complete part I of the form and his/her advisor completes part II. It is recommended that prior to completing this form, students meet with their advisors to discuss their progress.

Exceptions to Departmental Requirements and Regulations – Both the student and the student's committee have considerable latitude in meeting departmental and Graduate School requirements. When a waiver of a departmental requirement or suspension of a departmental regulation is desired, however, the student should transmit the request with a recommendation for action to the Graduate Studies Committee. A written statement of the decision of the Graduate Studies Committee will be sent to the Department Chair, members of the Advisory Committee, and the student. Once per semester the Chair of the Graduate Studies Committee will inform the Graduate Faculty of the exceptions the Graduate Studies Committee has made, in an anonymous way, if any exceptions have been made.

Decisions of the Graduate Studies Committee in such matters can be overruled only through action of the departmental graduate faculty. A meeting of the departmental graduate faculty will be called by the Chair of the Graduate Studies Committee to act on an appeal of such a decision when requested in writing by five members of the graduate faculty. The student must make appeals within 10 business days of the decision by the Graduate Studies Committee.

Attendance at Departmental Colloquia – The Department organizes a colloquium series during the academic year. The colloquium presentations are usually made by leading scholars. The Department considers attending and participating in departmental colloquia as a vital part of the education of graduate students. Therefore, all graduate students are expected to attend the departmental colloquia.

Library Privileges – Mathematics and Statistics books and journals are housed in the Owen Science and Engineering Library. Other materials may be obtained by special order or by interlibrary loan or photocopy; the science librarians can supply information about these services. The library of the University of Idaho, which has a generous policy toward off-campus borrowers, contains some items not available at WSU, such as runs of certain journals. Every graduate student should become familiar with the arrangement and facilities of the science library. In particular, they should become familiar with accessing library resources electronically. Advanced graduate students should form the habit of scanning the latest issues of journals for items relevant to their research projects.

Summer Program – The Department of Mathematics and Statistics at WSU has a limited summer program. Or formal offerings for graduate students usually consist of a reading course and one or

two regularly scheduled graduate courses. There are sometimes also informal seminars, which are open to anyone who is willing to participate. We are, however, attempting to increase our summer offerings for the benefit of all concerned.

Professional Societies and Placement – One way a graduate student may express commitment to the profession and maintain contact with the rest of the mathematical world, is to join one or more professional societies. Most of these allow graduate students to enjoy all the privileges of memberships reduced rates. The organizations most likely to be of interest are probably:

- American Mathematical Society (research emphasis)
- Society for Industrial and Applied Mathematics (emphasis on applied math)
- American Statistical Association
- Mathematical Association of America (emphasis on understanding mathematics)
- National Council of Teachers of Mathematics
- Association for Women in Mathematics

Job opportunities for mathematicians are undergoing considerable evolution. General as well as specific information about employment opportunities for mathematicians is available from all of the above professional societies.

Most students expect to move into a suitable position immediately after the last academic degree is obtained, if not before. This sometimes calls for early and aggressive effort. Members of the faculty are glad to provide their help and advice.

Electronic announcements of job openings for mathematicians or statisticians received by the department are forwarded to all graduate students as soon as they are received.

In general, finding the first employer in one's mathematical career is a challenging and momentous matter. A great deal of help is available from institutions and individuals and through a one-credit-hour professional development class (MATH 599), but ultimately the initiative and the crucial decisions must come from the individual student. Following is suggested timeline to be well prepared to get a position after graduation.

Year Three: You are encouraged to apply for internships or summer schools in your research area. Most applications are due in the late fall for the following summer. One-credit hour course titled Professional Development is offered each fall to help students develop application materials.

Year Four: You are encouraged to apply for internships or summer schools in your research area. Most applications are due in the late fall for the following summer. One-credit hour course titled Professional Development is offered each fall to help students develop application materials. Start writing papers for publication if you have not already begun.

Year Five: You are encouraged to apply for positions in your research area. This may be in academia, private industry, or federal position such as at a national lab. Applications for academic positions are typically due in late fall for the following academic year. One-credit hour course titled Professional Development is offered each fall to help students develop application materials.

18 APPENDIX I: THE GRADUATE QUALIFYING EXAMINATION IN MATHEMATICS (GQE)

General Comments – The GQE is set by an examining committee appointed by the Department Chair. The Chair of the Graduate Studies Committee, or his/her representative, administers the examination. A unique ID number is assigned to each examinee and only these ID numbers identify the examination papers. The names of the students will be correlated with the examination papers only after the final outcome of the examination has been determined.

Graded copies of the examination papers will be made available in the department office for inspection by the graduate faculty. Each paper will be marked with a consensus score for each problem, a consensus total score, appropriate comments, and the recommended outcome of the examination. After the graduate faculty has had at least a day to weigh the recommendations of the examining committee, the Graduate Faculty will convene to decide the final outcome of the examination for all participating students. It is inappropriate for members of the examining committee or other faculty members to discuss the performance of an examinee with any student, including the examinee, prior to the final announcement of the examination results.

Topics for the Graduate Qualifying Examination – Here are listed topics that a student should know for passing the GQE. Courses at WSU cover most, if not all, of these topics, but this list is not intended as a syllabus for any course. It is the student's responsibility to prepare adequately.

> **Topics in Advanced Calculus:** Metric spaces, Cauchy sequences and completeness, limits, continuity, Intermediate Value Theorem, differentiation, Mean Value Theorem, Taylor's Theorem, L'Hôpital's Rule, monotone functions, convexity and curvature, infinite series, sequences and series of functions, Fundamental Theorem of Calculus, Mean Value Theorem for integrals, improper integrals, partial and directional derivatives, Jacobian matrix, gradient vector, chain rule, Divergence Theorem, Stokes' Theorem, Inverse Function Theorem, Implicit Function Theorem, change of variables in multiple integrals, Lagrange multipliers.
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> > **References:** This material is covered at the appropriate level, for example, in the following texts: T. Kaplan, Advanced Calculus, Addison-Wesley, 2002; A. Taylor and W. R. Mann, Advanced Calculus, Wiley, 1983; W. A. J. Kosmala, A Friendly Introduction to Analysis—Single and Multivariable, Pearson Prentice Hall, 2004.
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> **Topics in Linear Algebra:** Vector spaces, subspaces, linear independence, bases and dimension, inner product spaces, norms, triangle inequality, Cauchy-Schwarz inequality, orthogonality, orthonormal bases, orthogonal projections, basic matrix operations, matrix transpose, trace of a matrix, determinants and their properties, invertibility, eigenvalues and

eigenvectors, characteristic polynomials, matrix equivalence, matrix similarity, diagonalizability, linear transformations, matrix representations of linear transformations, range and null space (kernel) of a linear transformation, symmetric and hermitian matrices or operators, unitary matrices, normal matrices.

References: This material is covered at the appropriate level, for example, in S. H. Friedberg, A. J. Insel, and L. E. Spence, Linear Algebra, Pearson Prentice Hall, 2003; P. J. Oliver and C. Shakiban, Applied Linear Algebra, Pearson Prentice Hall, 2006.

19 APPENDIX II: THE GRADUATE QUALIFYING EXAMINATION IN STATISTICAL SCIENCE (GQE)

General Comments – The GQE is set by an examining committee appointed by the Department Chair. The Chair of the Graduate Studies Committee, or his/her representative, administers the examination. A unique ID number is assigned to each examinee and only these ID numbers identify the examination papers. The names of the students will be correlated with the examination papers only after the final outcome of the examination has been determined.

Graded copies of the examination papers will be made available in the department office for inspection by the graduate faculty. Each paper will be marked with a consensus score for each problem, a consensus total score, appropriate comments, and the recommended outcome of the examination. After the graduate faculty has had at least a day to weigh the recommendations of the examining committee, the Graduate Faculty will convene to decide the final outcome of the examination for all participating students. It is inappropriate for members of the examining committee or other faculty members to discuss the performance of an examinee with any student, including the examinee, prior to the final announcement of the examination results.

Topics for the Graduate Qualifying Examination – Here are listed topics that a student should know for passing the GQE. Courses at WSU cover most, if not all, of these topics, but this list is not intended as a syllabus for any course. It is the student's responsibility to prepare adequately.

Topics in Statistical Theory:

Probability*:* Discrete random variables, continuous random variables, expectation and moments, moment generating functions, bivariate and multivariate distributions, marginal and conditional distributions, independence, covariance and correlation, multivariate normal distributions (marginal and conditional distributions, bivariate normal), distributions of functions of random variables, order statistics, large sample theory, convergence in probability and distribution, central limit theorem.

Mathematical Statistics: Finite and large sample sampling distributions, method of moments estimation, maximum likelihood (ML) estimation, ML estimation for the multivariate normal distribution, properties of estimators, unbiased estimation, Bayes and minimax estimators, Cramér-Rao lower bound, best linear unbiased estimation, uniformly minimum variance unbiased estimator, sufficiency and completeness, Neyman factorization, Lehmann-Scheffé completeness theorem, regular exponential class, confidence intervals, tests of hypothesis, uniformly most powerful tests, generalized likelihood ratio tests, contingency tables and goodness of fit.

Reference: L.J. Bain and M. Engelhardt, Introduction to Probability and Mathematical Statistics, 2nd Edition, Duxbury Thomson Learning, 1992.
WSU Courses: Stat 443 Applied Probability & Stat 556 Introduction to Statistical Theory

Topics in Statistical Methods and Applications:

Design of Experiments: Concepts and techniques in design of experiments for the completely randomized design, randomized complete block designs, split-plot designs, designs with repeated measures and the analysis of covariance. Development of statistical models for the experimental designs covered, including fixed and random effects (mixed models), inference and multiple comparison techniques.

Regression Analysis: Linear models, simple linear regression, multiple linear regression, weighted least squares, multicollinearity, robust regression, bootstrapping with linear models, qualitative predictors, nonlinear regression, logistic and Poisson regression.

References: R. Ott and M. Longnecker, An Introduction to Statistical Methods and Data Analysis (Chapter 2.4-2.5, 8, 9, 14-17, and 18.1-18.4), Seventh Edition, Cengage Learning, 2015.
R. O. Kuehl, Design of Experiments: Statistical Principles of Research Design and Analysis, Second Edition, Brooks/Cole, Cengage Learning, 2000.
M. Kutner, C. Nachtscheim, J. Neter, and W. Li, Applied Linear Statistical Models, Fifth Edition, McGraw-Hill/Irwin, 2004.
WSU Courses: Stat 512 Analysis of Variance of Designed Experiments & Stat 530 Predictive Models: Foundations in Data Science