



Department of Mathematics  
Colorado State University  
Graduate Program Handbook

## Policies and Procedures of the Mathematics Graduate Program

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Department of Mathematics  
Colorado State University  
Louis R. Weber Building  
841 Oval Drive  
Fort Collins, CO 80523-1874

Welcome to the Mathematics Graduate Program at Colorado State University!

The Department of Mathematics is part of the College of Natural Sciences along with seven other departments, including Biochemistry and Molecular Biology, Biology, Chemistry, Computer Science, Psychology, Physics, and Statistics.

The Mathematics Graduate Program has approximately 70 graduate students, many of whom are supported by graduate teaching assistantships. Greater detail regarding the department, our programs, and the research interests of our faculty can be found on our web site:

<https://mathematics.colostate.edu/>

### **Disclaimer:**

Every effort is made for this document to be clear and concise, and as policies and procedures change this document will be updated in a timely manner. However, please keep in mind that updates cannot be made immediately. Please inform us if you should discover that something is not clear or has been omitted.

The Table of Contents is provided to assist you in navigating this document.

Updated March 1, 2020

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# Part I: General Information

## 1. Application Information:

We are happy to learn of your interest in our graduate program. We encourage applications from mathematically talented students from all fields who seek to prepare themselves for diverse careers that require strong analytical thinking skills.

If you have a GPA averaged over all your post high-school studies of 3.0 (A = 4.0) or higher, you are eligible to apply. While a bachelor's degree in mathematics is not required a significant background in mathematics is expected.

To start a new application you will first need to [create an account](#). The following information is required:

- Valid email address
- First and last name
- Birthdate

The account creation process confirms the email address and will send you a temporary PIN. Once an account record has been created and confirmed an application can be initiated.

After submitting your online application and paying your application fee, begin submitting the required supporting materials to complete your application.

You may check the [status of your application](#) at any time to ensure your application checklist is complete, or check on updates

## Requirements for U.S. Citizen or Permanent Resident Applicants:

- \$60 non-refundable application fee. The fee cannot be waived and must be paid before your application will be processed.
- Statement of Purpose.
- The GRE General test or the GRE Mathematics Subject test. Scores must be reported directly from [ETS](#) to Colorado State University using the institution code of **4075**. GRE scores generally take 3 - 4 weeks to be reported by ETS; therefore, please order your scores as early as possible.
- One **Official** transcript - Contact all previous institutions you have attended (undergraduate and graduate) to request official transcripts be sent directly to Colorado State University using the institution code of **4075**. Hard copy official transcripts should be sent to the Office of Admissions at:

Graduate Admissions  
Colorado State University  
Office of Admissions  
1062 Campus Delivery  
Fort Collins, CO 80523-1062

Transcripts are required for any college coursework taken during high school if college credit was earned. Colorado State University transcripts are not required.

- 3 Letters of Recommendation – Provide the name and email addresses for your three recommenders. They will receive an email from CSU that contains instructions on how to upload a letter of recommendation for you. There is no standard form or format for recommendation letters, so they should provide a letter with the format of their choosing.

### **Requirements for International Applicants:**

- \$70 non-refundable application fee. The fee cannot be waived and must be paid before your application will be processed.
- Statement of Purpose.
- The GRE General test or the GRE Mathematics Subject test. Scores must be reported directly from [ETS](#) to Colorado State University using the institution code of **4075**. GRE scores generally take 3 - 4 weeks to be reported by ETS; therefore, please order your scores as early as possible.
- One **official** transcripts or mark sheets and any certificates, diplomas, or degrees from each college or university attended are required regardless of the length of attendance, including courses in progress. Final records will be required upon completion of the course or degree. ALL records submitted must be in the native language; any credentials written in languages other than English **MUST** be accompanied by a certified English translation.
- Contact all previous institutions you have attended (undergraduate and graduate) to request official transcripts be sent directly to Colorado State University using the institution code of **4075**. Hard copy official transcripts should be sent to the Office of Admissions at:

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- 3 Letters of Recommendation – Provide the name and email addresses for your three recommenders. They will receive an email from CSU that contains instructions on how to upload a letter of recommendation for you.

There is no standard form or format for recommendation letters, so they should provide a letter with the format of their choosing.

- English Proficiency - TOEFL or IELTS. Request that [ETS](#) and/or [IELTS](#) report your scores directly to Colorado State University using the institution code of **4075**. Photocopies will not be accepted. TOEFL scores generally take 3 - 4 weeks to be reported by ETS. Therefore, please order your scores as early as possible.

Applicants are exempted from the TOEFL or IELTS requirement if the official language of their country is English, or they have recently earned a degree at an American

University. The Mathematics Department does not award conditional admissions for a low English proficiency score. Minimum scores are as follows:

TOEFL - Computer Based – 213, Paper Based – 550, Internet Based – 80

IELTS - 6.5

### **Application Deadlines:**

A complete application includes all supporting documents described above. All components of the application are considered by the Graduate Committee in order to competitively award Graduate Teaching Assistantships. If any supporting document arrives late, this may reduce an applicant's chances for receiving such an award.

General deadlines for the receipt of a complete application (including all supporting documents) are listed below.

<b>Term</b>	<b>Admission and Financial Support</b>	<b>Admission Only</b>
Fall	February 1	April 1
Spring	Funding not offered for spring	September 1

### **Once Your Application is Complete:**

Your application will be reviewed by the Graduate Committee once all the required documents are received. You will receive notification if required documents have not arrived, and also when your application file is complete.

The Graduate Committee will recommend admission or denial of admission to the Graduate School. The Graduate School will notify you of the final admission decision.

**Please note:** Meeting the minimum CSU or department standards does not entitle an applicant to admission. Meeting such standards only insures consideration of the application. Since CSU cannot accommodate all who meet the minimum standards, it reserves the right to select individuals for admission on the basis of merit in such a way as to promote the best interests of CSU and the society as a whole and to maximize the potential for individual accomplishment.

If you have any questions about your application status please send an email to [gradprogram@math.colostate.edu](mailto:gradprogram@math.colostate.edu)

## 2. Registration Requirements

All students admitted to a graduate program at CSU are required to be continuously registered in the fall and spring semester throughout their degree programs. This policy applies from the time of first enrollment through the graduation term. Students may fulfill this requirement by registering for any graduate credit-bearing course (regular or non-regular).

In order to register for classes, you will need to obtain an eID (electronic identity). If you are new to the university we recommend that you do this before arriving on campus. This can be accomplished by visiting:

<http://eid.colostate.edu/>.

Registering for your classes will be done via RAMweb at:

<https://ramweb.colostate.edu/registrar/Public/Login.aspx>

### Continuous Registration (CR) Status

As an alternative, students may opt for a Continuous Registration (CR) status. Registration for CR status is accomplished in the same way as registration for courses. Section ID numbers appear in the class schedule under the CR prefix. Students registering for CR will be assessed a fee for each semester of CR registration. Students who register for CR on or after the first day of the term will be charged a Late Registration Fee. Students must be either enrolled for at least one credit or must register for CR during the term (fall, spring, summer) they complete their degree requirements.

Students enrolled in CR have access to library services and campus computing services; they pay a mandatory University Technology Fee. CR students may also choose to purchase CSU student health insurance and/or access the CSU Health Network for a fee.

The maximum number of CR semesters a student may enroll in during his/her degree program is ten (10). When a student is in her/his first (1st), fourth (4th) and eighth (8th) semesters of CR, the student's advisory committee is required to review the student's progress and intentions related to degree completion, with input from the student. Upon completion of the review, a report that provides a student plan which includes academic expectations and an accompanying timeline for satisfactory progress for the degree will be forwarded to the department head/chair and student. A registration hold will be placed on a student with more than 10 semesters of CR unless the student's department head has submitted the student's progression plan and a petition to extend the number of CR semesters to a specific number beyond 10.

Students may register for CR for the following reasons:

- 1) They do not require the use of University resources (other than those listed above), but are actively working on their degree requirements. Students who are utilizing CSU facilities to conduct their research must not enroll in CR; instead, they must enroll in the appropriate number of research, thesis or dissertation credits. See Curricular Policies and Procedures Handbook, Appendix D, for information regarding faculty contact time needed to generate credit hours:

<http://curriculum.colostate.edu>

- 2) They will not be working on their degree requirements, but will be leaving the University for professional or personal reasons (e.g., mission service, medical or parental leave, work) or an official assignment for CSU.

Subject to the established time limits for the earning of graduate degrees and the various academic requirements, CR registrants need not apply for readmission should they wish to take additional graduate courses. Such students are ensured a place in their graduate programs as long as they remain in good academic standing. However, students who do not register will need to apply for readmission for their next semester of enrollment.

The availability of the CR option shall not supersede any other registration requirements to which students may be subject at the University, Department, or Program level. For example, the credit bearing registration requirement for graduate assistantships applies to all students appointed to these positions. Similarly, some departments may adopt more stringent CR policies than that expressed here.

### **Mathematics Seminar Requirement**

All graduate students are required to register for 1 credit of Seminar - MATH 592 every semester until they have a permanent advisor. Once a permanent advisor is chosen, the advisor will determine the nature of the seminar requirement, if any. During the course of each semester a minimum of 10 one-hour seminar meetings selected from the Green slopes, the Mathematics Colloquium, or research seminars organized by the mathematics faculty must be attended to satisfy the seminar requirement. Students will maintain an attendance sheet that will be signed by the seminar organizer and submitted to the Graduate Coordinator at the end of the semester.

### **3. Scholastic Standards**

To remain in good academic standing a student must demonstrate acceptable performance in course work after being admitted to the graduate program. This requires a cumulative 3.00 grade point average in all regular and non-regular coursework. For Mathematics, non-regular coursework consists of:

- Independent Study - MATH 695
- Research - MATH 798
- Seminar - MATH 592
- Thesis – MATH 699
- Dissertation - MATH 799
- Supervised College Teaching - MATH 584.

Overall, a 3.00 grade point average must be maintained in regular and non-regular courses graded traditionally (A through F).

In addition, good academic standing requires satisfactory progress toward degree milestones. A student's advisor and committee, as well as the Mathematics Graduate Committee, may render judgments as to whether satisfactory progress is being made toward the degree.

## Academic Probation

Failure to maintain a 3.00 grade point average will result in being placed on academic probation by the Graduate School as well as the loss of the Graduate Teaching Assistantship. The probationary period lasts for one semester allowing the student time to raise their GPA. Students on academic probation who do not regain good academic standing will be dismissed by the Graduate School.

However, new regularly admitted students will not be placed on academic probation or lose their Graduate Teaching Assistantship until they have completed 12 credits, or two semesters of graduate work, whichever comes first.

A student whose progress toward degree milestones is determined to be unsatisfactory may be placed on academic probation. The deficiency will be clearly documented in writing, stating the timeline for adequate improvement. Failure to meet this improvement plan will result in dismissal from the program. For more information on the department's dismissal policy, see section 8 below.

**Appeals Procedure:** Graduate students may appeal decisions concerning unsatisfactory performance. Informal resolution of appeals concerning unsatisfactory performance is encouraged whenever possible before initiating a formal appeal. The student should discuss the problem with the person or persons whose actions are challenged within 10 days following the adverse recommendation or decision. Typically, this is the student's advisor or the Graduate Director. If the matter is not resolved to the student's satisfaction within 20 days following the informal discussion, the student may initiate a formal appeal by submitting the matter in writing to the Vice Provost for Graduate Studies. Please see section 8 below, and the Graduate School Appeals Procedure contained in the Graduate Bulletin for more information.

## 4. Graduate Teaching & Graduate Research Assistantships

Graduate Teaching Assistants are a very important and integral part of the mathematics department teaching mission. The majority of our 70 graduate students are supported either as a teaching assistant or research assistant. Students work directly with faculty, developing solutions that span the boundaries between mathematics and other fields of scientific endeavor. They also gain invaluable experience teaching and learning through teaching assistantships.

GTAs are typically assigned to the Calculus Center, PACe Center or to teach a section of one of our beginning calculus courses.

### GTA & GRA Pay

**GTA & GRA Pay:** We offer three stipend levels based on progress in the degree program:

1. \$18,340.50 - All entering students
2. \$18,907.00 - Passed PhD qualifiers part (I)
3. \$19,432.50 - Passed PhD preliminary examination



**PayDay:** GTA & GRA contracts are for 9 months (4.5 months for fall and spring semesters). The 9-month contract begins August 16<sup>th</sup> and ends May 15<sup>th</sup>. You will receive a half-month of pay for August and May, so it is important to plan ahead. Payday for all monthly employees, which graduate assistants are, is the last working day of each month.

Returning GTAs and GRAs will be entered into the payroll system by the accounting office. If you are a new GTA beginning fall semester, you must complete payroll paperwork and be entered into the payroll system by August 10th to receive your first paycheck the last working day in August. If your paperwork is completed after this date your first paycheck will be delayed. You must be entered into the payroll system no later than August 16<sup>th</sup> or your start date will be delayed, which will result in your pay for August being reduced!

**GTA / GRA Contracts:** A GTA/GRA contract will be created once you are entered into the payroll system each semester. The contract will stipulate your base salary rate, FTE (Full Time Equivalency - which for GTAs and GRAs is 50%) and the dates of the assignment. You are required to sign a contract each semester, and if your work assignment or rate of pay is changed in some manner.

International students must obtain a social security number. Check with the office of International Programs regarding this process.

**Tuition:** As a GTA, or GRA you will receive a full tuition waiver. Although your full tuition bill will appear on your student account each fall and spring semester, you should not pay this bill. Your full tuition will be paid by the graduate school after census each semester.

**Fees:** There are miscellaneous fees of approximately \$1,200 per semester for the student to pay. These fees cover use of the student health center, athletic admissions, city bus pass, the university recreation center, and several other items.

The Graduate School, in partnership with Business and Financial Services has implemented a permanent program of waiving graduate assistant's late fees for the first billing cycle of each fall and spring semester.

This program was implemented because graduate assistants will not receive their first paycheck before the first billing cycle. Therefore, you can disregard the first eBilling notification each semester indicating that you will receive a late charge if your balance is not paid by the first billing date of the semester. You are exempt from this charge.

## **Taxes and deductions that will be withheld from your paycheck**

**Payroll taxes:** Your GTA/GRA stipend is considered taxable income. Taxes will be withheld based on the information you provided on your W4.

**Student Health Insurance Plan (SHIP) contribution taxes:** The contribution is considered "supplemental wages" and supplemental wages are taxed at a higher tax rate than regular/stipend earnings. Therefore, it is very important that GTAs and GRAs plan ahead! ALL the taxes for the entire contribution will be withheld from your September paycheck for fall semester and February paycheck for spring semester. These taxes can

be significant and you should plan for around \$300 each September and February to be withheld from your check for the SHIP contribution taxes.

Additional information about the Student Health Insurance Plan (SHIP) and the insurance contribution available to GTAs can be found in Section 5 of this document.

**Student Employee retirement Plan (SERP):** Graduate students being paid as a GTA/GRA who are enrolled in less than 5 credits each semester for the academic year and 3 credits for summer will automatically be enrolled in SERP and will have a total of 8.95 % (7.5 % SERP and 1.45 % Medicare) withheld from gross earnings for each pay period worked. A retirement savings account will be established in the student's name at TIAA/CREF.

Students must be registered by the census date each fall and spring term in order to be exempt. Adding credits after census date will not exempt an employee from the mandatory SERP assessment.

GTAs who teach for us over the summer will have their normal taxes + SERP deducted from their summer stipend each month since the required 3 credits for exemption will not be met.

## **Assistantship Requirements**

**Minimum Course Load for GTAs:** Unless otherwise approved, all GTAs must be enrolled in a minimum of 9 credit hours per semester in years 1 & 2. Subsequently, students will generally take 9 credits until they have fulfilled the credit requirements.

This requirement is part of the GTA contract and students that do not abide by it risk losing their assistantships. If you plan to take fewer than 9 credit hours for any reason, please seek formal approval in writing from either your academic advisor or the Graduate Director.

Exceptions to the 9 credit hour requirement may be made for students who have completed their regular course credit requirements for the degree program in which they are enrolled. Students who believe they have completed their credit requirements for their degree should have this confirmed with their advisor and the Graduate Coordinator, before seeking formal approval from the Graduate Director for a reduction in the 9 credit hour requirement.

**Physical Presence:** GTA contracts are from **August 16 – May 15** and physical presence outside of University Holidays may be required. Attendance at pre-semester meetings is required of all GTAs. Please check with your course coordinator (once he/she is assigned) to determine the time of your meeting. In addition, certain departmental meetings as well as graduate student workshops are mandatory. Inform your course coordinator of any anticipated absences well in advance.

**Establishing Residency:** If you are a GTA and a US citizen, you will need to establish Colorado residency as part of the GTA contract. The department of mathematics covers your full non-resident tuition your first year and resident tuition in the out-years. It takes one full year to establish residency, so you must begin the process immediately upon arriving in Fort Collins!

For detailed information about the process for establishing Colorado residency see the Office of Financial Aid's webpage on Residency Classification in Colorado:

<https://financialaid.colostate.edu/residency/>

For additional information about meeting the residency requirements for in-state tuition go to:

<https://financialaid.colostate.edu/in-state-tuition-requirements/>

## **GTA Training**

All incoming GTAs will complete GTA training and will be assigned a GTA mentor.

The two half-day training sessions will cover topics including:

- Policies of the department
- The teaching environment
- Preparing for teaching
- Technology workshop
- Teaching workshop-discussion
- Teaching workshop-practice

**GTA Mentors:** Each new GTA will be assigned a GTA mentor who will observe them two times in the classroom the first semester and give constructive feedback.

**Sexual Harassment Training Policy:** Colorado State University is committed to providing a safe environment for all members of our community, including faculty, staff, students, volunteers and visitors. This is not only the responsibility of our leadership through example, development of policy, and administrative actions, it is a responsibility that we all share, must be willing to understand and to which we must all contribute. Sexual harassment is an issue to which we must pay special attention, due to its particularly corrosive effects on our community, the legal ramifications of particular cases, policy implementation and the perception of our campus.

**All university employees** are required to take the Workplace Answers sexual harassment awareness online module.

Shortly after their official start date, every new employee will receive an email from **Workplace Answers** with a unique link, associated only with them, allowing the employee to access the training module.

Additional information can be found here <http://www.oeo.colostate.edu/sexual-harassment-awareness-training>

**Ethics training requirement:** Students expecting to receive GRA funding from any source will need to complete ethics training. The standard method of fulfilling this requirement is to take the one-credit course GRAD 544, however an alternative is

typically available for a one-day training course taught during the summer. Information can be found at <http://rcr.colostate.edu/>

## **GTA Teaching Assignments**

GTAs are typically assigned to the Calculus Center or to teach a section of one of our beginning calculus courses.

Calculus Center duties include holding office hours, running help and review sessions, facilitating groups working in large sections, grading and proctoring, staffing the help desk, and some professional development activities.

GTAs who teach a section of calculus will be giving 50 minute lectures to a class of about 30 – 35 students four days per week, holding office hours, grading, and proctoring evening exams. New GTA's are typically assigned to either calculus for the life sciences, or calculus I or II for mathematics majors, physical science majors and engineers. More senior GTAs can be assigned to calculus III or differential equations.

GTA teaching assignments are made by the Undergraduate Facilitator and department Chair in the weeks preceding the beginning of each semester. All graduate students are required to complete the Graduate Course and Work Preferences form each semester by the deadline posted so that we can take into account your class schedule and teaching/work preferences.

**Course Coordinator Meetings:** Most of the courses to which GTAs are typically assigned have course coordinators. The course coordinator maintains consistency across sections and will provide a class syllabus as well as examinations.

Your coordinator will meet with you in the week before classes as well as one hour per week during the semester. Your attendance at these meetings is mandatory.

**Duties:** GTA duties may take up to 20 hours per week, although ideally we would like to see students not average more than 18 hours per week. If you feel your work load is excessive, please discuss the situation with the course coordinator. If this does not resolve the situation please see any of the following: Undergraduate Director, Graduate Director, Graduate Coordinator, or Department Head.

You are responsible for your class. In the event of illness or other emergency, the front office staff can arrange for a sub (Phone: 491-7925). DO NOT recruit subs without getting front office approval. Missed classes must be made up - No exceptions.

## **Policy on GTA standards for teaching and the Calculus Center (CC)**

GTAs are expected to maintain a high quality of teaching as well as meet certain basic expectations. These include, but are not limited to

- Being on time to class and the CC and holding class/CC hours the entire time allotted, all of the time
- Holding regularly scheduled office hours and being there the full time
- Returning homework, quizzes, and exams to students in a timely manner
- Being well-prepared for lecture and help/CC sessions

- Adhering to the general guidelines provided by your course coordinator/CC director

#### Expectations for coordinated courses

- Following syllabus and course outline provided by the course coordinator
- Teaching the class using methods and material as outlined by the course coordinator.
- Attending instructor meetings, and proctoring and grading exams as scheduled by the department or the course coordinator

#### Expectations for the Calculus Center:

- Participating in exam grading and proctoring
- Staffing the Help Desk (TILT great hall)
- Performing the additional duties assigned to you by your course coordinator for the calculus class to which you are assigned
- Participating in professional development activities including leading CC workshops

#### Other expectations

- Instructors should dress in a professional manner, particularly avoiding dress that may be offensive, discriminatory, vulgar, or otherwise inappropriate. Student complaints will be handled by the graduate committee and undergraduate co-directors.
- No eating is allowed while holding office hours or working in the Calculus Center.
- Office hours must be held **on campus** between the hours of 7:00 a.m. and 8:00 p.m.

When a serious teaching concern arises, reported by either the course coordinator or another faculty member, the matter will go to the Graduate Committee where a course of action will be proposed, possibly including additional classroom observations. The case and proposed action will go in the GTA's file, and the matter will be revisited by the Graduate Committee after a period of time determined in the course of action. In the case of a second report of a serious teaching concern, the matter will again go to the Graduate Committee, where a course of action will be proposed with the possibility that the GTA may be placed on GTA Probation. GTA Probation requires that the matter be resolved, and failure to do so in a satisfactory manner, may result in a termination of GTA support.

### **Policy Regarding Length of GTA Support**

When a GTA is awarded, it is implicit that the assistantship will continue to be available, given satisfactory academic progress towards the degree as well as satisfactory performance of assistantship duties. Signs of unsatisfactory academic progress for GTAs might include failure to maintain a 3.0 GPA, dropping below the 9 credit hour minimum or lack of progress towards examination milestones. Signs of unsatisfactory performance of duties include, for example, not showing up for teaching your class, being chronically late, or inappropriate behavior. Student performance is reviewed at the end of each semester. We would like to emphasize that only rarely has it been necessary to discontinue a GTA prematurely.

For students entering the MS program, the normal period of GTA or GRA support is two years measured from the date the program is begun. Support will not be continued beyond two years for an MS student except in special circumstances. These cases must involve some exceptional situation.

GTA/GRA support for students in the Ph.D. program will continue, up to a maximum five years, provided the student makes satisfactory progress towards successful completion of the Ph.D. degree milestones: the Ph.D. qualifying examinations, Parts I and II, the preliminary examination and the Final Dissertation Defense.

A sixth year of support is possible and must be approved by the Graduate Committee. The [Request for Sixth Year of GTA Support](#) form must be submitted to the Graduate Committee by February 1st before fall semester of the sixth year begins. Late requests cannot be considered due to the timeline for the admission decisions for the fall incoming class, which is in February.

Note, however, that termination of GTA support does not necessarily constitute dismissal from the program. Students who are in good standing with the Graduate School of the University (which implies certain rules) are entitled to continue in the graduate program of the Department of Mathematics at their own expense.

The above rules outline the general intentions of the Department of Mathematics. However, in exceptional circumstances the Department may deviate from this policy.

## **5. Accessing Healthcare at CSU:**

[CSU Health Network](#) is every student's home for health and well-being at Colorado State University. All CSU students have full access to a wide range of medical, counseling and health education and prevention services, regardless of their insurance.

CSU Health Network is a fee-funded service on campus. The CSU health network fee and the counseling fee are both portions of the general fees that all students pay. The fees allow access to all services and provide reduced rates in comparison to community providers.

For information on accessing CSU Health Network services click [here](#).

For information on Eligibility, Fees and Service Charges click [here](#).

For information about Using Health Insurance at the CSU Health Network click [here](#).

For any additional questions or to make an appointment call (970) 491-7121

## **Health Insurance**

Good health care is essential to your academic success! The [Student Health Insurance Plan](#) (SHIP) is designed specifically for CSU students. It is a comprehensive PPO plan designed to comply with state and federal laws, save students time and money, and provide convenient access to quality medical care on and off campus.

The system is designed to work in conjunction with the Student Fee funded services provided at the [CSU Health Network](#) to ensure students have access to comprehensive high quality care. This program provides benefits both within the CSU Health Network and when services are provided outside of the CSU Health network.

Colorado State University requires all domestic students taking six (6) or more resident instruction credits to carry health insurance as a way of protecting your education investment. You must meet the health insurance requirement your first semester at CSU and every fall semester thereafter.

All enrolled students have **full access** to the services at CSU Health Network, **regardless of their insurance plan.**

## **How to Fulfill the Health Insurance Requirement**

### **For Domestic Students:**

**All domestic graduate students enrolled in six (6) or more resident instruction credits must take action in the CSU Student Health Insurance Waiver/Enrollment Portal by the deadline:**

1. If you are considering an individual/family/employer/government plan to meet the health insurance requirement, we encourage you do to the following:
  - Ensure your plan meets CSU, state, and federal guidelines for health insurance coverage. More information [here](#).
  - Contact your insurance carrier in advance to see how your plan will cover visits to CSU Health Network. Use the following information:
    - CSU Health Network Tax ID#: 846000545
    - CSU Health Network NPI#: 1528156437
2. Go to the [CSU Student Health Insurance Waiver/Election Portal](#) to access the secure online health insurance waiver/election portal.
3. Login with your CSU student ID number, last name and date of birth.
4. Choose one of the following two options to meet the requirement:
  - **WAIVE** the CSU Student Health Insurance Plan (SHIP) by providing proof of a comparable health insurance plan. Enter the requested information from your health insurance card (you will also need the plan subscriber's date of birth) in the [secure online form](#). This process should take less than 5 minutes to complete. Your waiver application will be audited with your insurance carrier to ensure the coverage is active and meets CSU, state, and federal requirements. Your waiver application is not complete until you receive an approval notification via email

**OR**

- **ENROLL** in the [CSU Student Health Insurance Plan \(SHIP\)](#) by indicating your interest in the [secure online form](#). **Do not wait**. To ensure you have access to your insurance benefits when plan coverage begins, you **MUST** enroll at least three weeks prior to the start of classes. [Click here to learn more about SHIP](#).
- 5. **IMPORTANT**: If you do not take action to WAIVE or ENROLL by the deadline, your student account will be charged for the cost of enrollment in the CSU Student Health Insurance Plan (SHIP). There will be no refunds or reversals after the deadline (see “Deadline” section above).
- 6. Students must meet the health insurance requirement their first semester on campus and every fall semester thereafter.

**For Domestic Students Enrolled in LESS than 6 resident instruction credits:**

Domestic graduate students enrolled in less than six resident instruction credits (including CR) may voluntarily enroll in the CSU-sponsored [Student Health Insurance Plan \(SHIP\)](#) by completing an [online enrollment form](#) or a paper enrollment form at the CSU Student Insurance Office by the University Add/Drop date (approximately two weeks after classes begin). Students taking less than 6 credits are not charged the University General Fees, therefore, the health access and counseling fees are added to the student’s account approximately 4-6 weeks after the beginning of the semester.

**For International Students:**

Colorado State University requires all international students enrolled at any level to carry health insurance as a way of protecting your educational investment.

International students are automatically enrolled in the [CSU Student Health Insurance Plan \(SHIP\)](#). If you have other health insurance coverage, including an US-based employer plan or individual health insurance plan, visit the [International/INTO Student Waiver](#) page for more information on how to submit a waiver request.

**Coverage to spouses, domestic partners and dependents of graduate students:** CSU does not provide insurance coverage to spouses, domestic partners and dependents of graduate students. This policy does not impact the current policy of the University that requires all international students, regardless of enrollment status, to demonstrate comprehensive health insurance coverage through either the University health insurance plan or a comparable plan.

If you have questions about the CSU health insurance or insurance options for dependents, please visit the [CSU Health Network](#) website or call the CSU Health Network at 970-491-7121.

**Health Insurance Contribution**

A health insurance contribution is available to those graduate assistants (GTA, GRA, GSA) who meet **ALL** of the eligibility criteria described below. Each semester, a health insurance contribution will automatically be applied to the student account and taxed through payroll around mid-September and mid-February for the fall and spring semesters respectively.



Therefore, students who are expecting the health insurance contribution may leave the balance due for the insurance unpaid on their student account since the full cost of the insurance will be covered by the contribution. The health insurance contribution will appear on the student's CSU account as a credit, approximately one week after the end of the regular add/drop date. The student does not need to apply for the health insurance contribution, they will automatically be identified. Depending on the number of semesters appointed, the health insurance contribution varies. See below for details.

**Important Tax Information about the health insurance contribution:** The contribution is considered "supplemental wages" and supplemental wages are taxed at a higher tax rate than regular/stipend earnings. Therefore, it is very important that GTAs and GRAs plan ahead! ALL the taxes for the entire contribution will be withheld from your September paycheck for fall semester and February paycheck for spring semester. These taxes can be significant and you should plan for around \$300 each September and February to be withheld from your check.

The graduate health insurance contribution is directly applied to the student's financial account; it is not paid to an insurance provider for insurance coverage. From a compliance perspective, this is the process that must be utilized.

Graduate Assistants are not offered a pre-tax option on the CSU health insurance contribution because Graduate Assistants are classified as students – not as employees. Graduate Assistants are students first and foremost and are categorized as such. There are many differentiating factors between Graduate Assistants and employees: the type of work they engage in, how they are paid (stipend), the policies that pertain to them, the benefits they receive and how those benefits are paid out. In order to be eligible for a pre-tax option, there must be an employer/employee common law relationship that exists – per federal guidelines. Because students do not have such a relationship with CSU, they are not eligible for a pre-tax option.

#### **Health Insurance Contribution Criteria**

- Appointed to a 25% (10 hours per week) or more assistantship (GTA, GRA, GSA) by the end of the regular add/drop period.

**AND**

- Enrolled in CSU's Student Health Insurance Plan (SHIP)

**AND**

- Enrolled in 5 or more resident-instruction credits (Audits, Continuous Registration, and CSU Online Credits\* do not meet the Resident Instruction enrollment criteria for this policy).

While eligible GAs do not need to apply for the health contribution from the Graduate School, GAs ***MUST Opt Into*** the Student Health Insurance Plan (SHIP) to receive the contribution. Follow the CSU Health Network Website policies and instructions on the [CSU Health Network Website](#) to enroll in SHIP.

#### **Benefit variation depending on the number of semesters employed**

- If the student meets the Graduate Assistantship eligibility requirements in both the fall and spring semesters, the CSU health insurance contribution will cover 100% of the fall, spring and summer health insurance premiums.
- If the student meets the Graduate Assistantship eligibility requirements for only one semester, the CSU health insurance contribution will cover only the insurance premium for that semester.

*The summer premium will NEVER be covered when a student serves as a (GTA, GRA, GSA) for only one semester. However, because the spring/summer tuition is combined for insurance purposes, the cost of the summer premium is subtracted from the CSU health care contribution for those students appointed as a Graduate Assistant in the spring semester.*

## **6. Graduate Student Travel Policy:**

Graduate students traveling to a conference or workshop may request departmental travel support to supplement other funds. Students are encouraged to seek funding from the conference or organization if available and plan ahead for application dates. All travel must be pre-approved and a Pre-Travel document must be filled out and turned in to the department finance office.

\$1000 per fiscal year (July 1 – June 30) is available for graduate student travel.

Eligible students will receive

\$500 – if presenting a paper or poster at the conference

\$250 – if attending, but not presenting

### **Travel procedure – Before you go**

1. A [Pre-Travel](#) form is required even if the travel is not being paid through CSU (except in-state travel). Email the completed Pre-Travel form to [math\\_travel@colostate.edu](mailto:math_travel@colostate.edu)

This must be done before you book your flight, but you can register for the conference before completing this form. When traveling as a CSU grad student/employee the Pre-Travel form acts as your insurance in case of incident while traveling.

Important information required on the Pre-Travel form:

- The reason for travel is vital! Please provide a description of your travel and be sure to explain how your travel is a benefit to the University or research.
- Explain fully what GTA responsibilities (teaching, grading, office hours, proctoring exams) will be missed and who will cover for you. Travel without this information will be disapproved.

- Account/Funds paying for expenses section of the form must be completed. If you don't know the account number at least give a description for us to use, ie; grad account. We have around 200 accounts so we will not guess, you must let us know.
  - International travel requires a minimum two-week advance notice before travel. The section on International Travel must be fully completed and must include all requested information.
2. Airfare must be booked through one of the CSU approved travel agents that can be found [here](#).
    - When making your reservation let the agent know that CSU Mathematics will be paying for your flight. They will then contact the finance office for approval.
    - The finance office must have your completed pre travel form before they will approve the airfare.
  3. Rental Cars can only be reserved through one of these rental car agencies:

Name	Phone #	Code
Avis Rent a Car	800-525-7521 x 31695	A514145
Budget Rent a Car	720-527-0261	T143828
Hertz Corp	303-944-5728	65579
Enterprise Rent-A-Car & National Car Rental	720-275-5184	XZ12450

**Travel procedure – After you return**

1. A [Post-Travel](#) form is required along with itemized receipts showing proof of payment when reimbursement is requested.
2. If you are not requesting a reimbursement you can [email](#) the finance office and let them know to close out the travel.
3. Travel reimbursement requests must be submitted in a timely manner. Any travel not processed, and through all the approvals 60 days after your travel end date will be taxed.
4. Per diem does not require receipts but please list the amount you are requesting or write yes if you are wanting full per diem.
5. Per diem is only allowed for overnight trips. Meal reimbursements are allowed for the actual cost of meals up to the maximum allowable per diem rate without receipts. Employees are allowed 75% of the applicable per diem rate on the first and last day of travel no matter what time the travel begins or ends. The university will use the per diem rates established by the state controller. **Day Trips (Single day travel) which start and end on the same day are not eligible for meal reimbursements.**

## 7. The Mathematics Graduate Committee

**Mathematics Graduate Committee:** The Mathematics Graduate Committee is responsible for the administration of the graduate programs offered by the Department. Its responsibilities include making recommendations of admission or denial of admission to the Graduate School for each applicant to the mathematics graduate program, making decisions on GTA offers, and making proposals for faculty review and action regarding graduate course offerings and other aspects of the graduate programs.

The Graduate Committee consists of the following members:

- Jennifer Mueller (Graduate Director and Committee Chair)
- Anton Betten
- David Aristoff
- Chris Peterson
- Sophia Bragdon (Graduate Student Representative)
- Bryan Elder (Graduate Coordinator)

**The Graduate Coordinator,** Bryan Elder, [elder@math.colostate.edu](mailto:elder@math.colostate.edu) is the initial point of contact for the graduate program, and is responsible for the processing of graduate applications, forms, and contracts, as well as providing information on graduate program requirements.

**The Graduate Director,** Professor Jennifer Mueller [mueller@math.colostate.edu](mailto:mueller@math.colostate.edu), is Chair of the Graduate Committee and provides information on academic aspects of the program, including course offerings and information on research areas of faculty. The Graduate Director also serves as temporary academic advisor for incoming students.

**The Graduate Student Representative (GSR),** Sophia Bragdon - is another point of contact for students in the program and serves as a liaison between the graduate students and the Graduate Committee.

## 8. Dismissal policy for Graduate Students

**Procedures regarding dismissal:** The following is a list of reasons for dismissal, with procedure:

**Cumulative GPA falls below 3.00:** Graduate students may be dismissed by the Graduate School if cumulative GPA falls below 3.00. The rules, procedures and appeals process for such dismissals are specified in the Graduate and Professional Bulletin, and the Department of Mathematics will use these rules, procedures and appeals process if a graduate student's cumulative GPA falls below 3.00.

**Advisor makes unsatisfactory progress determination:** If a student's advisor and advisory committee determine that progress towards degree completion is unsatisfactory, and that satisfactory progress towards degree completion cannot reasonably be anticipated, then a recommendation to this effect must be made in writing and presented to the student and the Graduate Committee.

According to Graduate School policy, this written recommendation must include substantive justification for dismissal in lieu of probation. If the Graduate Committee

concur with the recommendation to dismiss, then, according to Graduate School rules, it must be referred to the department chair for approval and the Vice-Provost for Graduate Studies for final action.

Appeals may be made through the existing Graduate School appeals procedure contained in the Graduate and Professional Bulletin:

<http://graduateschool.colostate.edu/faculty-staff/bulletin.aspx>).

**Failures on Part I of Departmental Qualifying Examination:** If a Ph.D. student receives two Fail ratings for any final examination included in that student's Suite of Qualifying courses, the student may be dismissed from the program. The Qualifying Examination Committee will consider whether the student should be dismissed from the program, or put on probation. If a QEC decides on a recommendation of dismissal in lieu of probation, the QEC will recommend dismissal of the student to the Graduate Director and the Department Chair in writing. The student will be notified of the QEC's recommendation of dismissal in writing as soon as possible after the decision is made, and will have ten days to prepare an appeal, if so desired, which will be made to the Graduate Director and the Department Chair. The final departmental decision on dismissal will be made by the Department Chair. The student may make a formal appeal of the departmental decision, according to the Graduate School appeals procedure described in the Graduate and Professional Bulletin. Any formal appeal must be made within the time limits specified in the Graduate and Professional Bulletin.

**If a Ph.D. student does not fulfill other conditions, determined by a QEC and specified in writing to the student, that the student must satisfy to successfully complete Part I, then the student may be dismissed from the program.**

The Qualifying Examination Committee will consider whether the student should be dismissed from the program, or put on probation. If a QEC decides on a recommendation of dismissal in lieu of probation, the QEC will recommend dismissal of the student to the Graduate Director and the Department Chair.

The student will be notified of the QEC's recommendation of dismissal in writing as soon as possible after the decision is made, and will have ten days to prepare an appeal, if so desired, which will be made to the Graduate Director and the Department Chair. The final departmental decision on dismissal will be made by the Department Chair. The student may make a formal appeal of the departmental decision, according to the Graduate School appeals procedure described in the Graduate and Professional Bulletin. Any formal appeal must be made within the time limits specified in the Graduate and Professional Bulletin.

**If a Ph.D. student fails to complete Part II of the Qualifying Examination in a timely fashion, then the Graduate Director and the student's advisory committee, together, may recommend that the student be dismissed from the program.**

If dismissal is recommended, the student will be informed of the decision in writing, and will have ten days to prepare an appeal, if so desired, which will be made to the Graduate Director, the student's advisor, and the Department Chair. The final departmental decision on dismissal will be made by the Department Chair.

The student may make a formal appeal of the departmental decision, according to the Graduate School appeals procedure described in the Graduate and Professional Bulletin.

Any formal appeal must be made within the time limits specified in the Graduate and Professional Bulletin.

### **Failure of the Preliminary Examination (PhD students) or the Final Examination (PhD and MS students)**

According to Graduate School rules, a student may repeat a failed Preliminary or Final Examination once. Failure to pass the second exam results in dismissal from the Graduate School. See the Graduate and Professional Bulletin for further details on University policies here.

## **9. Annual Progress Evaluation**

**Advisor Review:** In the spring of each academic year the Graduate Coordinator will initiate the annual Graduate Student Progress review process. Each graduate student will be asked to carefully review the information contained in the progress report and to then schedule a meeting with their advisor to assess progress towards degree completion, whether an MS or a PhD.

It is the responsibility of the student to schedule and complete this review with his or her advisor in a timely fashion. The advisor will note the results of the review in writing, using the annual progress report system. Copies of all advisor reviews will be placed in the student's file.

**Evaluation of Progress towards completion of Part I of the Qualifying Examination (for Ph.D. students):** The Graduate Director will inform each student, in writing, of progress towards the completion of Part I at the end of each semester in which such progress has been expected or made. A copy of this letter will be placed in the student's file.

Each student must complete Part I of the Qualifying Examination by the end of the fifth semester after admittance to the Ph.D. program. Students who enter the Ph.D. program with an M.S. degree are encouraged to complete Part I by the end of the third semester after admittance to the Ph.D. program.

**Evaluation of Progress towards completion of Part II of the Qualifying Examination (for Ph.D. students):** After the selection of a permanent advisor, the student together with the Ph.D. advisor, and sometimes in consultation with additional faculty, will devise a second evaluation to be completed by the student before the preliminary examination, and after the completion of Part I of the qualifying examination.

This evaluation must be completed within two academic years following the passing of Part I of the qualifying examination. The student should demonstrate proficiency on material approximately at the 600-level. An MS completed at CSU will fulfill Part II, but students coming in with an MS need to fulfill this requirement locally.

## **10. CSU Policy: Acceptable Use for Computing and Networking Resources**

**Purpose of this policy:** Computing and data systems, equipment and services at Colorado State University are valuable and limited resources that serve a large number and variety of Users. Misuse of these resources can result in loss of integrity,

functionality, speed, bandwidth and reliability of the University's information systems, as well as violations of other laws and policies (such as those concerning conflicts of interest, privacy, etc.). The purpose of this policy is to establish what constitutes acceptable use of these resources in order to assure that they are available to everyone as needed for the University's business needs.

**Application of this policy:** This policy applies to all students, faculty and staff, affiliates, and all other persons and organizational units having access to the University's technology and information systems ("Users").

**Policy Statement:** All Users have the responsibility to make use of the Resources in an efficient, ethical, and legal manner. The Resources are to be used in a manner consistent with the instructional, research, and administrative objectives of the University community in general, and for the purposes such Resources were provided. Access to the Resources is a privilege and imposes upon Users certain responsibilities and obligations, as further described in this policy.

**Policy Provisions:** Access to the Resources is granted subject to CSU System and university policies and local, state, and federal laws. Acceptable use is always ethical, reflects academic honesty, integrity, and shows restraint in the consumption of shared Resources. It demonstrates respect for intellectual property, protection of sensitive information, ownership of data/information, copyright laws, system security mechanisms, and an individual's rights to privacy and to freedom from intimidation and harassment. Activities inconsistent with these objectives are inappropriate and may jeopardize continued use of the Resources. The University may take any action it deems necessary to protect the Resources from systems and events that threaten or degrade operations, or that otherwise violate this policy.

It is important that you become familiar with this entire policy, especially the sections on "Policy Provisions" and "Examples of Inappropriate Conduct Using University Resources". The full policy can be found here:

<http://policylibrary.colostate.edu/policy.aspx?id=704>

## 11. CSU Policy: Family Educational Rights and Privacy Act (FERPA)

**Purpose of this policy:** Colorado State University respects the rights of its students and is committed to protecting the privacy of their Education Records. The University complies with the Family Educational Rights and Privacy Act (FERPA) (20 U.S.C. §1232g) and regulations (34 C.F.R. Part 99). This policy describes the student's rights and responsibilities with respect to the privacy of Education Records and the methods by which FERPA privacy requirements are to be observed.

**Application of this policy:** This policy applies to the Education Records of Colorado State University students who are enrolled, or who were formerly enrolled, regardless of their age or parental dependency, including records related to the student's application for admission. At CSU, a student is considered to be enrolled and covered under FERPA on the first day of classes of the student's first term of enrollment. FERPA does not apply to records of applicants for admission who are denied acceptance or, if accepted, do not attend the institution.

**Policy Statement:** It is CSU's policy that a student's Personal Identifiable Information (PII) will be disclosed only when (i) required by law; (ii) properly authorized by the student; or (iii) authorized by law and the University determines that the information should be disclosed. Nothing in this policy supersedes the requirements of FERPA.

**Policy Provisions:** Provides extensive information about student rights and responsibilities regarding their education records.

It is important that you become familiar with this entire policy, especially the sections on "Policy Provisions" and "Responsibilities of CSU Faculty and Staff". The full policy can be found here:

<http://policylibrary.colostate.edu/policy.aspx?id=591>

## 12. CSU Policy: Graduate Student Parental Leave

**Purpose of this policy:** CSU is committed to promoting its Graduate Assistants' ability to maintain a positive work-life balance by providing Parental Leave when enrolled in a Master's or Ph.D. program.

**Application of this policy:** This policy applies to all Eligible Graduate Assistants (defined below). It does not apply to any other employment classification at CSU.

**Policy Statement:** Providing Parental Leave to an Eligible Graduate Assistant promotes enhanced work-life integration while pursuing a graduate degree at Colorado State University. It is the policy of the university to provide Parental Leave to new parents to support academic success and caring and bonding with a new child. New Parents have the option of requesting leave from their academic requirements and their assistantship responsibilities for Parental Leave purposes.

### **Policy Provisions:**

#### **Use of Parental Leave**

Parental Leave is available for use by an Eligible Graduate Assistant who is the new Parent of a child by birth or adoption, including the child's mother or father, or the spouse, domestic partner or civil union partner of either, at the time that the leave period commences (and for as long as the Parental Leave is to continue).

An Eligible Graduate Assistant becomes a Parent of a child for purposes of this policy at the time of the child's birth or adoption. Foster care placement is not included within this policy. Parental Leave is not available during the period preceding the birth or adoption, even if the absence is due to expected arrival. An Eligible Graduate Assistant may use only one Parental Leave period per birth or adoption. The number of children born or adopted does not increase the amount of Parental Leave. Parental Leave is never eligible for payment upon separation from employment.

Parental Leave must be used in one continuous block of time, not intermittently. During Parental Leave, the Eligible Graduate Assistant must be enrolled in the minimum number of credits required to hold a graduate assistantship. The Eligible Graduate Assistant is not



considered to be on a leave of absence while continuously enrolled as a student paying tuition.

The timing of the leave with continued stipend and tuition support is required to coincide with the Eligible Graduate Assistant's funding contract with the appropriate academic department or unit. The Primary Caregiver in either birth or adoption will be granted paid Parental Leave for up to six weeks immediately following the birth of a child or the adoption of a child for whom that Parent has Primary Caregiving responsibilities. The Parental Leave period must be completed within six weeks of the birth or adoption but does not extend past the end of the contract term (e.g. 12-month, 9-month or summer). If the birth or adoption occurs prior to the beginning of the contract term, any remainder of the six-week period that occurs during the next contract term may be taken.

The Non-Primary Caregiver in either birth or adoption will be granted up to three weeks of paid Parental Leave. The leave must be taken while under contract in the same academic year, or, in the case of a spring birth or adoption, during the following summer session if the GA is under contract.

### **Advance Notice, Work Plan and Approval**

Eligible Graduate Assistants must submit two required Parental Leave forms. First, a Request for Graduate Assistant Parental Leave Application must be submitted to the academic department head for signature after consulting with and gathering signatures from the student's assistantship supervisor, major advisor, and program director (if applicable). The academic department head is responsible for providing the completed Graduate Assistant Parental Leave Application Form to Human Resources after the appropriate signatures have been gathered. Second, a Health Care Provider Certification Form with the estimated date of delivery, or a letter from the adoption agency with an estimated adoption date, must be submitted directly to Human Resources. Both forms are required to be submitted at least ten weeks prior to the anticipated leave date or as soon as reasonably possible in the event of adoption. These forms can be found [here](#).

Eligible Graduate Assistants on Parental Leave will be released from their academic requirements and assistantship duties during the leave time. As such, one work plan will be developed to address the issues within each of the two respective areas. The department and unit, as appropriate, shall maintain the work plans in the student's file. First, the Graduate Assistant and the Graduate Assistant's instructors will develop an Academic Work Plan that covers the academic requirements and coursework expectations related to the credit(s) the Graduate Assistant is enrolled in. This work plan will include modified due dates for assignments as appropriate. The Academic Work Plan must be signed by the Graduate Assistant and the instructors and approved by the academic department head and kept as part of the student record in the department. Second, Assistantship Supervisors and the Graduate Assistant will develop an Assistantship Duties Work Plan to prearrange necessary adjustments in assistantship activities and responsibilities that will support the transition of assistantship duties to others. The Assistantship Duties Work Plan must be signed by the Graduate Assistant and the assistantship supervisor and approved by the unit head in which the Graduate Assistant holds the assistantship appointment and kept as part of the student record in the unit. Work plans should be developed as far in advance as possible, but no less than ten weeks prior to the leave. Exceptions may be made in extenuating circumstances.

Eligible Graduate Assistants are also required to submit requests for any desired additional unpaid leave beyond that provided in this policy. Such extension requests are outside of this Parental Leave Policy and must be approved by the academic department head; and, if the student's assistantship appointment is in a unit other than his or her academic department, then the unit head must also approve. This request is not routed to Human Resources.

### **Return to Work Expectations**

After the end of the Parental Leave period, it is expected that the Graduate Assistant will return to normal assistantship duties and graduate studies to complete her/his degree program. CSU encourages faculty to be flexible in their expectations of new parents, so that the demands of graduate study may become balanced with new parental responsibilities. Good communication between the Graduate Assistants and their major advisors and assistantship supervisors will be required in order to assist the Graduate Assistants to ease back into their University activities.

### **International Students**

Eligible Graduate Assistants who are studying at CSU on a visa should consult with the Office of International Student & Scholar Services to talk about their plans for Parental Leave and to determine if these plans are permissible under their visas.

It is important that you become familiar with this entire policy, especially the sections on "Policy Provisions" and "Advance Notice, Work Plan and Approval". The full policy can be found here:

<http://policylibrary.colostate.edu/policy.aspx?id=743>

## Part II: Academic Program Requirements

### 1. Selecting an advisor and committee

Pursuing an MS or PhD degree requires considerable advice from a variety of sources. Initially this advice will come from the Graduate Director who serves as temporary advisor for incoming students. One of the main responsibilities of the temporary advisor is to assist in the initial planning of the degree program.

Entering students will undergo an initial diagnostic interview with the Graduate Director to plan an appropriate program of study. If the student's diagnostic interview identifies a deficiency, the program may be required to include courses to correct this. However, mathematics courses at the 300 level or below will not be counted toward the total credit hour requirement toward any graduate degree in mathematics.

Students must select a permanent advisor, including their committee, by the end of the third semester of residency; in other words, a student in the MS program must choose an MS committee by the end of the third semester in the MS program, and a PhD student should make the selections for the PhD committee by the end of the third semester in the PhD program. The MS with Outside Specialization program, however, has an earlier deadline (see section 2.2 below) If a student receives a MS degree from CSU's program, and then continues to pursue a Ph.D. in mathematics at CSU, the Ph.D. permanent advisor and committee need not be the same as the MS permanent advisor and committee.

The choice of committee is formally made by completing a GS6 form (see Appendix A - 1 below for more information), and must be approved by the Department Chair.

The advisor is the chief source of advice in the planning process and works closely with the student throughout their graduate career on all matters related to the degree program. A close, cordial, and professional relationship is therefore of the utmost importance.

Members of the committee should be chosen on the basis of the student's interests, the student's experience with faculty members, and the advisor's knowledge and expertise. As noted above, the makeup of a graduate committee must be approved by the department head and, of course, agreed to by the potential members themselves. It is the responsibility of the student to secure these approvals and agreements. The purpose of the committee is to make available to the student a broad range of knowledge and expertise. Committee members may aid in general advising of the student and may assist in planning the major elements of the program. The committee administers the final examination for an MS student, as well as the preliminary and final examinations for a PhD student.

The committee must consist of at least three faculty members for a master's degree program and at least four for a doctoral degree program. The members are as follows:

The major, or permanent, advisor, who serves as chairperson of the committee, must hold academic faculty rank as a professor, associate professor, or assistant professor in the Department of Mathematics. There is no exception to the rule that every graduate student in our department must have a principal advisor **who is in our department.**

For the MS degree programs, the committee must include one or more additional members from the Department of Mathematics.

For the PhD degree program the committee must include two or more additional members from the Department of Mathematics.

One member from an outside department who, appointed by the Dean of the Graduate School, represents the Graduate School. The outside committee member appointed by the Dean of the Graduate School must hold a tenured, tenure-track, contract, continuing, transitional, joint, or emeritus/emerita faculty appointment at CSU. The outside member should serve as an impartial external evaluator on the committee, ensuring quality of scholarship and fairness in process.

Non-CSU employees may obtain faculty affiliate appointments in an academic department in order to be eligible to serve on graduate committees. They may also be appointed to such committees through a nomination process that is reviewed and approved by CoSRGE (Faculty Council Committee on Scholarship, Research, and Graduate Education).

Please contact the Human Resource staff member of the appropriate department to determine the appointment designation of a potential committee member.

Co-advisors may be chosen from outside the Department of Mathematics.

## **2. Master of Science Degrees:** Three different Master's Degrees are currently available:

- M.S. in Mathematics
- M.S. in Mathematics with Outside Specialization
- M.S. in Applied and Computational Mathematics

All M.S. degrees require at least 35 credit hours of coursework. Under the direction of the advisor, the committee will plan and supervise the course of study and the writing of the thesis (Plan A) or master's paper (Plan B.) See individual program descriptions in the Graduate Student Handbook or the Mathematics Graduate Program website for more details.

The official Program Code for all three MS degrees is: **MATH-MS**

**Scholastic Standard for all MS degrees:** In addition to the GPA requirements outlined in section 3.1 above, a 3.0 average in all math courses at the 400 level and above must be maintained.

**2.1 MS in Mathematics:** This program is designed for the student who wants to obtain a general education in mathematics at the Master's level. This program is also an appropriate preparation for our Ph.D. program in mathematics. The recommended mathematical preparatory coursework for this program includes junior/senior level coursework in advanced calculus, abstract algebra and linear algebra.

## **General Requirements**

- A minimum of 35 credit hours of course work
- Math courses at the 300 level and below will not be counted towards the 35 hour requirement.
- A minimum of 24 credit hours taken on campus
- At most 6 of the 35 credit hours may be taken outside mathematics.
- Course work outside the department must be at the 300 level or above. Outside courses must be approved in advance by the graduate student's advisor and have some relevance to the student's mathematical program.
- A minimum of 18 hours of coursework in mathematics at the 500 level or above (excluding MATH x99 and MATH 530)
- The Seminar requirement must be satisfied – a maximum of 2 credits may be counted toward the 35 credit hour degree requirement.
- At most 1 hour of MATH 584 (Supervised College Teaching) may be counted towards the 35 credit hour requirement.

## **Course Requirements**

The program must include three out of the six courses:

- MATH 501
- MATH 517
- MATH 545
- MATH 550
- MATH 560
- MATH 566

The program requires two sequences selected from the following options:

- MATH 501-502
- MATH 510-520
- MATH 517-617 or MATH 517-519
- MATH 545-546
- MATH 550-652
- MATH 540-640 or MATH 560-561
- MATH 566-567
- MATH 570-571

(Note: if a sequence is not offered due to enrollment restrictions then students must select amongst the available sequences in any given year.)

The program must include at least one additional course selected from an area of mathematics, as approved by the student's advisor, not represented in the student's choices used to fulfill the requirements above.

## **MS Final Project and Examination**

A final oral examination is required for all MS degrees. The Examination is conducted by the Advisory Committee and is open to faculty and graduate students in the Department as well as other interested parties. The student must complete one of the following options for the MS.

- Thesis (plan A): The student completes a thesis that is not purely expository but reflects an element of originality on the part of the student. The student's program of study must contain a least 6 but not more than 9 credits hours of thesis research (MATH 699)

- The thesis will be submitted electronically through ProQuest. Instruction for submitting a thesis are detailed on the Graduate School's website

<http://graduateschool.colostate.edu/current-students/thesis-dissertation/index.aspx>

- The format of the thesis must strictly adhere to the requirements of the Graduate School. A format Requirements Checklist and sample pages of the Title page, Copyright page, Signature page, and Abstract page are available on the Graduate School website:

<http://graduateschool.colostate.edu/current-students/thesis-dissertation/index.aspx>

- The thesis must be submitted to the Graduate School by published deadlines.

<http://graduateschool.colostate.edu/current-students/student-resources/>

- Paper (plan B): The student writes an expository paper under the direction of the advisor. This paper must be approved by the advisor and the committee. The student's program of study must contain 3 credits hours of thesis research (MATH 699)

- The Expository Paper will not be submitted to the graduate school.

The Graduate Coordinator will assist with room scheduling once the date and time for the defense have been established with your committee.

The student's committee must have adequate time to review the thesis or paper before the final examination. Therefore, the committee must have the thesis or paper at least two weeks (including two weekends) before the final examination which meets the following standards:

- The Paper or Thesis must be in final form
- The Print is letter quality, and a uniform style has been used throughout.
- Figures, printouts, etc. are clear and easy to read.
- Text is double-spaced and printed on only one side of the paper.

Results of the final oral examination will be reported on the GS24. Voting is limited to the members of the student's committee, and a majority vote is necessary to pass the examination. A tie vote is interpreted as failure to pass the examination. All committee members must vote to either Pass or Fail the student; there is no option to withhold a

signature. Committee members who are not academic faculty do not have a vote on the final examination.

If significant revisions to the thesis or expository paper are required by the committee after the final oral examination is complete, a reasonable amount of time must be given for committee members to re-review the thesis once the revisions have been made.

A candidate who fails the final examination may be reexamined once and, for the reexamination, may be required to complete further work. The reexamination must be held not later than 12 months after the first examination. The examination must not be held earlier than two months after the first examination unless the student agrees to a shorter time period. Failure to pass the second exam results in dismissal from the Graduate School.

**2.2 MS in Mathematics with Outside Specialization:** This program is designed for the student who wants to combine a solid background in mathematics with an area of specialization outside the Mathematics Department (e.g. atmospheric sciences, biology, computer science, engineering, physics, statistics, or education) The recommended mathematical preparatory coursework for this program includes junior/senior level coursework in advanced calculus and linear algebra.

### **Permanent Advisor**

Acceptance into the Master's program with outside specialization is subject to having obtained a permanent advisor from among the Mathematics faculty. Incoming students or students who do not yet have a permanent advisor remain in the "general" Mathematics masters program.

The outside area of specialization and the student's MS committee should be chosen as early as possible, preferably by the end of the first year of study. Areas of outside specialization must be approved in advance by the student's committee. The committee must include at least one member from the area of specialization plus at least two members from the Mathematics Department.. Under the direction of the advisor, the committee will plan and supervise the course of study and the writing of the thesis or master's paper.

### **General Course Requirements**

- A minimum of 35 credit hours of course work
- Math courses at the 300 level and below will not be counted towards the 35 hour requirement.
- A minimum of 24 credit hours taken on campus
- A minimum of 9 of the 35 hours taken in an outside area
- 6 hours of course work taken outside the department must be at the 600 level or above.
- A minimum of 18 hours of coursework in mathematics at the 500 level or above (excluding MATH x99 and MATH 530).
- The Seminar requirement must be satisfied – a maximum of 2 credits may be counted toward the 35 credit hour degree requirement.

- At most 1 hour of MATH 584 (Supervised College Teaching) may be counted towards the 35 credit hour requirement.

### **Other Course Requirements**

The program must include three out of the six courses:

- MATH 501
- MATH 517
- MATH 545
- MATH 550
- MATH 560
- MATH 566

The program must include at least one additional course selected from an area of mathematics, as approved by the student's advisor, not represented in the student's choices used to fulfill the requirements above.

**MS Final Project and Examination:** Same requirements as for the MS in Mathematics. See section 2.1 above.

**2.3 MS in Applied and Computational Mathematics:** The MS in applied and computational mathematics is a Master's program aimed at providing the graduate with the skills needed to deal with problems which typically arise in science, business, and industrial situations.

### **General Course Requirements**

- A minimum of 35 credit hours of course work
- Math and outside courses at the 300 level and below will not be counted towards the 35 hour requirement. MATH 530 does not count toward the 35 credit hour requirement.
- A minimum of 24 credit hours taken on campus
- A minimum of 9 of the 35 hours taken in an area of application outside mathematics (such as physics, biology, engineering, etc.) including at least 3 credit hours of statistics. The area and courses must be approved by the graduate student's advisor.
- 6 hours of course work taken outside the department must be at the 500 level or above.
- A minimum of 18 credit hours of coursework in mathematics at the 500 level or above (excluding MATH x99).
- The Seminar requirement must be satisfied, a maximum of 2 credits may be counted toward the 35 credit hour degree requirement.

### **Other Course Requirements**



**Numerical Analysis:** Students must take two courses from the following list:

- MATH 550
- MATH 561
- MATH 651
- MATH 652

**Sequence Requirement:** Students must take at least one sequence from the following list:

Mathematical modeling is the term used to refer to the process of formulating in mathematical context a problem arising in some area of applications. Each student is required to complete at least two one-semester courses in modeling. Mathematics courses which may be used to satisfy this condition include the following:

- MATH 510 - 520
- MATH 517 - 617 or 519
- MATH 540 - 640
- MATH 535 - 540
- MATH 545 - 546
- MATH 560 - 532 or 561

**Modeling and Methods:** Students must take at least two courses from the following list:

- MATH 532
- MATH 540
- MATH 535
- MATH 545
- MATH 633

**MS Final Project and Examination:** Same requirements as for the General MS in mathematics. See section 2.1 above.

### 3. Doctor of Philosophy Degree

The Ph.D. in Mathematics is a comprehensive program requiring considerable coursework and an original dissertation in Mathematics consisting of publishable research. Each student's course of Ph.D. study is planned individually by the student, the student's adviser, and the student's graduate committee. This planning allows the student and adviser to develop specific programs in any of a large number of areas of mathematics.

The Ph.D. degree requires at least 72 semester credits beyond the bachelor's degree. Additional requirements for the doctorate consist of a series of milestone examinations including a two part Qualifying Examination, a preliminary Examination and a Final Dissertation Defense. The Ph.D. preliminary examination, administered by the student's Ph.D. committee, is a written and/or oral examination taken near the end of the course work and at the beginning of the work on the dissertation. All dissertations must be successfully defended in an open final oral examination.

The official Program Code for the Ph.D. degree is: **MATH-PhD**

Entering students will have a diagnostic and advising interview with the Graduate Director to plan an appropriate program of study.

#### **General Requirements:**

- A minimum of 72 credit hours beyond the bachelor's degree – all at the 300 level or above.
- Two thirds of the course work should be in mathematics.
- Course work in mathematics must be at the 400 level or above in order to be used towards the 72 credit hour requirement.
- 3.0 GPA must be maintained in all course work.
- 3.0 GPA must be maintained in all mathematics courses at the 400 level or above, excluding work in seminars and doctoral research.
- No more than 24 credit hours of research/thesis may be counted towards the 72 credit hour requirement.
- The Seminar Requirement must be satisfied – at most two additional credits beyond the two allowed for the MS may be counted towards the 72 hour requirement.
- At most 1 hour of MATH 584 (Supervised College Teaching) may be counted towards the 72 credit hour requirement.
- MATH 530 may not be counted toward the 72 hour requirement.

Students entering with a master's degree in mathematics may receive up to 30 credit hours towards the 72 credit hour requirements. For these students, a minimum of 42 credits must be earned at CSU after admission to a doctoral program, and at least 21 credits beyond the master's degree must be earned in courses numbered 500 or above. For students enrolled in a continuous master's/Ph.D. program at Colorado State University, all courses taken during the master's program may be applied to the doctoral degree, even if the total master's degree credits exceed 30.

It must be stated on the Ph.D. program of study that all credits earned on the MS will be counted toward the PhD; furthermore, this must be approved by the student's advisory committee, the Department of Mathematics, and the Graduate School. For more detailed

information on university-wide Ph.D. requirements, please consult the Graduate School website:

<http://graduateschool.colostate.edu/>

**Breadth Requirement:** To fulfill the breadth requirement for the Ph.D., all students will be required to take and pass, with a grade of B- or higher, at least 14 mathematics courses (each three or more credits) at the 500 level or above excluding:

- MATH 530
- MATH 695
- MATH 699
- MATH 798
- MATH 799

Students entering with a master's degree in mathematics from another institution may use courses approved to count towards the 72 credit hour requirement to also count towards this requirement.

At least two courses must be chosen from each of the lists below. This breadth requirement may be completed over the course of the student's graduate program. Credit earned for comparable courses taken at other institutions may be evaluated by the Graduate Director, at the student's request, to determine suitability for substitution for particular course(s) in the lists below.

<b>List I</b>	<b>List II</b>	<b>List III</b>
MATH 501	MATH 517	MATH 510
MATH 502	MATH 519	MATH 520
MATH 566	MATH 617	MATH 535
MATH 567	MATH 618	MATH 540
MATH 570	MATH 619	MATH 545
MATH 571	MATH 717	MATH 546
MATH 601	MATH 718	MATH 560
MATH 602		MATH 561
MATH 666		MATH 620
MATH 667		MATH 621
MATH 672		MATH 640
MATH 673		MATH 645
		MATH 646

### **Departmental Qualifying Examination**

The departmental Ph.D. qualifying exam consists of two examinations, parts I and II.

## **Part I of the Qualifying Examination**

### **Purpose of Part I of the Qualifying Examination**

The student will complete Part I of the Qualifying Examination in order to present evidence of performance at an appropriate level to the faculty. This evidence will be used as a basis for judging the candidate's qualifications for continuing in the Ph.D. program in mathematics.

### **The Suite of Qualifying Courses: Overview**

Each student seeking to pursue a Ph.D. in Mathematics will propose a Suite of Qualifying Courses. The Graduate Committee will review each proposal. There are Standard Suites of courses that are automatically approved. A student may alternatively propose a Special Suite of courses.

### **What is a Proposal for a Suite of Qualifying Courses?**

A Suite proposal always consists of

1. A list (Suite) of specified courses that the student has completed, or will complete, during his or her graduate studies,

AND

2. For each course on the list, a specification of the documentation that will be provided by the student for assessment purposes. If the course is a QE course\*, this documentation **MUST** be the student's completed final examination in the course.

\*A QE course (Qualifying Examination course) is any course in a Standard Suite.

There are two types of Suites of Qualifying Courses (described below): Standard Suites and Special Suites.

### **How is a Suite proposal made?**

1. The student, together with a proposal mentor, will complete the [Suite Proposal form](#) and return it to the Graduate Coordinator. Note that the Graduate Director will act as the default proposal mentor for all Standard Suite proposals.
2. The signature of the proposal mentor, indicating support for the proposal, is necessary to complete each Suite Proposal.
3. The Graduate Committee will review the proposal for approval.
4. Each approved Special Suite Proposal will be announced to the faculty.

More details on policies and procedures for the review of Suite proposals are included in the [departmental policies and procedures manual](#).

### **What is a Standard Suite of Qualifying Courses?**

The following four groups of Suites of courses are those recognized as Standard Suites through which a graduate student may complete Part I of the Qualifying Examination for the PhD program.

#### **Analysis/Algebra/Geometry Suites**

MATH 517, MATH 566  
plus two of MATH 519, MATH 567, MATH 570, MATH 617

#### **Applied, Computational, Interdisciplinary Suites in Algebra/Geometry**

MATH 517, MATH 566  
plus one of MATH 519, MATH 560  
plus one of MATH 519, MATH 540, MATH 560, MATH 561, MATH 567

#### **Applied, Computational, Interdisciplinary Suites in Analysis, Differential Equations and Dynamical Systems**

MATH 517, MATH 560  
plus one of MATH 540, MATH 545, MATH 617  
plus one of MATH 510, MATH 519, MATH 540, MATH 545, MATH 546, MATH 561, MATH 617, MATH 618, MATH 640

#### **Combinatorics/Algebra Suites**

MATH 501, MATH 517, MATH 566  
plus one of MATH 502, MATH 560, MATH 567

Using one of the Standard Suites as Part I of the Qualifying Examination is the appropriate choice for most students in the program.

The Graduate Director will act as the default proposal mentor for all Standard Suite proposals. The Graduate Director will automatically approve all Standard Suite proposals, if properly made.

### **What is a Special Suite of Qualifying Courses?**

Any other sort of Suite is a Special Suite. Special Suites may include QE courses.

For example,

A student who has successfully completed a graduate-level course, comparable to one of the QE courses at another university, may request that this course be included in a Special Suite, OR that a more advanced CSU course in the same area, or a closely related one, be included in a Special Suite.

A student's CSU proposal mentor may recommend the inclusion of a particular graduate level course (not necessarily a CSU course) in a Special Suite to the student. Such a course does not have to be a mathematics course. It must be a graduate-level course. A proposal for a Special Suite must specify the documentation that the student will

submit to allow assessment of performance in each non-QE course in the Suite.

### **How does a student complete Part I of the Qualifying Examination?**

Once a student's Suite of Qualifying Courses is approved by the Graduate Committee, the student must provide the assessment documents specified in the student's Suite Proposal to a Qualifying Examination Committee (The role of the QEC is defined in the [department policies and procedures manual](#) ) after each course in the Suite is completed. A student must receive a Pass- rating or higher from a QEC for each course in his or her Suite in order to complete that component of his or her Part I Examination. For more details on policies and procedures for assessment and evaluation of courses in Suites, consult the [department policies and procedures manual](#).

Each student must complete Part I of the Qualifying Examination by the end of the fifth semester after admittance to the Ph.D. program. Students who enter the Ph.D. program with an M.S. degree are encouraged to complete Part I by the end of the third semester after admittance to the Ph.D. program.

### **Qualifying Examination (QE) course syllabi:**

The Faculty approved QE course syllabi can be found in appendix D below.

### **Part II of the qualifying examination:**

After the selection of a permanent advisor, the student together with the Ph.D. advisor, and sometimes in consultation with additional faculty, will devise a second evaluation to be completed by the student before the preliminary examination, and after the completion of Part I of the qualifying examination. This evaluation must be completed within two academic years following the passing of Part I of the qualifying examination. The student should demonstrate proficiency on material approximately at the 600-level. An MS completed at CSU will fulfill Part II, but students coming in with an MS need to fulfill this requirement locally.

### **Departmental Preliminary Examination**

At some time after a Ph.D. advisor and committee have been assigned, the student will be required to pass an oral preliminary examination prepared and administered by the student's committee.

This examination must be passed at least one academic year (two semesters; the summer session may be included) before defense of the dissertation. The purpose of this oral examination is to evaluate the student's proposed research project.

Two weeks prior to the examination, the student must provide to the Ph.D. committee a written copy of the dissertation proposal, including a survey of the relevant literature, a description of the problem to be investigated, and an outline of methodology to be considered. The student either passes, passes provisionally (certain additional conditions must be met), or fails. In case the student fails the examination, it may be repeated once subject to Graduate School regulations. After this examination has been passed, the student becomes a Ph.D. candidate.

Doctoral students in the mathematics department at CSU are considered to achieve "candidacy" for the degree upon passage of preliminary examinations.

A written report of the examination will become part of the student's file.

### **PhD Dissertation and Final Examination**

Each Ph.D. candidate must prepare a dissertation containing original mathematical research that is acceptable to the students committee. The student must successfully defend this dissertation in an open oral examination before the committee as well as other interested parties. This examination can be given no sooner than two semesters (including summer) after the student becomes a Ph.D. candidate.

The Dissertation:

- All dissertations will be submitted electronically through ProQuest. Instruction for submitting a thesis are detailed on the Graduate School's website

<http://graduateschool.colostate.edu/current-students/thesis-dissertation/index.aspx>

- The format of the dissertation must strictly adhere to the requirements of the Graduate School. A format Requirements Checklist and sample pages of the Title page, Copyright page, Signature page, and Abstract page are available on the Graduate School website:

<http://graduateschool.colostate.edu/current-students/thesis-dissertation/index.aspx>

- The dissertation must be submitted to the Graduate School by the published deadline.

<http://graduateschool.colostate.edu/for-current-students/>

- PhD students must also submit the [Survey of Earned Doctorates](#) confirmation certificate with the Thesis/Dissertation Submission form.

The Graduate Coordinator will assist with room scheduling once the date and time for the defense have been established with your committee.

The student's committee must have adequate time to review the thesis before the final examination. Therefore, the committee must have the thesis at least two weeks (including two weekends) before the final examination which meets the following standards:

- The Thesis must be in final form
- The Print is letter quality, and a uniform style has been used throughout.
- Figures, printouts, etc. are clear and easy to read.
- Text is double-spaced and printed on only one side of the paper.
- Spiral bound

Results of the final oral examination will be reported on the GS24.

Voting is limited to the members of the student's committee, and a majority vote is necessary to pass the examination. A tie vote is interpreted as failure to pass the examination. All committee members must vote to either Pass or Fail the student; there is no option to withhold a signature. Committee members who are not academic faculty do not have a vote on the final examination.

If significant revisions to the thesis are required by the committee after the final oral examination is complete, a reasonable amount of time must be given for committee members to re-review the thesis once the revisions have been made.

A candidate who fails the final examination may be reexamined once and, for the reexamination, may be required to complete further work. The reexamination must be held not later than 12 months after the first examination. The examination must not be held earlier than two months after the first examination unless the student agrees to a shorter time period. Failure to pass the second exam results in dismissal from the Graduate School.



## Graduate School Forms

**(GS6) Program of Study:** The advisor and committee are appointed through filing a Program of Study (GS6) with the Graduate School, which lists the advisor, committee members, and all courses which will be taken in pursuit of the degree. This is the formal statement of what will be done to fulfill degree requirements. The Program of Study must be filed with the Graduate School before the time of the fourth regular semester registration. Students who fail to meet this requirement may be denied subsequent registration. For Track III Admission students in combined bachelor's/master's degree programs, the GS6 must be filed before the end of the student's first semester after admission to Graduate School.

**Prior** to filling out the GS6, all mathematics graduate students **must** complete the [GS6 program of study worksheet](#) with their intended advisor. Submit the completed worksheet to the graduate coordinator for a preliminary check to assure all degree requirements have been met, and that committee members selected are eligible to serve in the capacity indicated. The GS6 can be completed after the worksheet has been approved. You will access your program of study on RAMweb.

While it is important for a student to plan the Program of Study, together with the advisor and committee, early in the graduate career, it is understood that plans may develop and change. Reconciliation of courses planned on the Program of Study and those actually taken will be made when applying to graduate using the GS25 application for graduation form. Courses which have been taken and for which a grade has been received (A through F, I, S or U) may not be removed from the Program of Study.

Note that when a student who has received an MS degree in mathematics from our program decides to continue in the Ph.D. program, the student must complete a second GS6 form for the Ph.D. program of study, after completing the GS7 form (see section 4.3 below).

**(GS7) Change of Degree Program:** You will access the GS7 form on RAMweb. Students may opt to change degree programs with or without completing the degree in which they are currently enrolled. Students may change degree programs because they are no longer interested in finishing the degree in which they are currently enrolled, or they were originally admitted to a PhD program, but want to first graduate with a master's degree. Any permanent changes to the degree program are recorded through the filing of a GS7.

Continuation to the PhD program after completing the MS is not automatic. Students wishing to continue must have passed the PhD qualifiers part (I), and received approval from the Graduate Director and Department Chair. This will be accomplished by filing the GS7 with the department. Once approved, the GS7 will be sent to the Graduate School.

Once you have completed the GS7 on RAMweb, print the completed form and sign, obtain your advisor (and co-advisor's) signature and bring the form to the graduate coordinator. The department chair's signature will be obtained and a copy made for your department file and deliver to the graduate school for you.

**(GS9A) Change of Committee Member:** You will access the GS9A form on RAMweb. A member of the committee, including the advisor, may resign from the

committee, or be replaced by the student. Any permanent changes in committee membership are recorded through the filing of a GS9A.

**(GS16) Report of Preliminary Examination:** You will access the GS16 form on RAMweb. Once you have completed the GS16 on RAMweb, print the completed form and take it with you to your preliminary examination. Once the examination is complete and the outcome is known it is the responsibility of the student to return the form to the Graduate Coordinator. This must be done in a timely manner as the form is due to the Graduate School within two working days.

**(GS24) Report of Final Examination:** You will access the GS24 form on RAMweb. Once you have filled out the GS24, print the completed form and take it with you to your defense. Once the examination is complete and the outcome is known it is the responsibility of the student to return the form to the Graduate Coordinator. This must be done in a timely manner as the form is due to the Graduate School within two working days.

**(GS25) Application for Graduation:** Students must apply for graduation by submitting form GS25. You will access the GS25 on RAMweb. Deadlines are available on the Graduate School's website. Once you have completed the GS25 on RAMweb, print the completed form and sign, obtain your advisor (and co-advisor's) signature and bring the form to the graduate coordinator. The department chair's signature will be obtained and a copy made for your department file and deliver to the graduate school for you. Reconciliation of courses planned on the Program of Study and those actually taken will be made on this form. Students must be registered for a minimum of 1 credit or CR (see Part I - 2.2 above) during the semester they plan to graduate.

**(GS25B) Departmental Requirement Clearance form:** The Graduate Coordinator will complete this form and forward to the Graduate School once all departmental requirements have been met. It is not necessary for the student to complete this form.

**(GS30) Thesis/Dissertation Submission:** You will access the GS30 on RAMweb. All Master's Plan A students and Ph.D. students submit this form after your final thesis or dissertation has been reviewed and approved by your committee.

The completed and signed form must be submitted to the Graduate School Office by the published deadline date of the student's graduating term and before the electronic submission of the thesis or dissertation.

## **Mathematics Department Staff**

**Assistant to the Chair** – Christie Franklin

If you need assistance with one of the following, contact Christie at 491-6452

- Pre-tenure/post-tenure reviews
- Maintain policy and procedure manual
- Maintain committee agendas and minutes
- Supervise Actuary Examination
- Maintain faculty files, teaching records, and scholarship records

- Faculty and postdoctoral searches coordination
- Assist new hires – faculty and post docs
- Responsible for Weekly Links; maintain website
- Department chair calendar
- Faculty VISA updates

**Undergraduate Coordinator – Paige Kanatous**

If you need assistance with one of the following, contact Paige at 491-3425

- Textbook ordering
- Evening examination and final examination room scheduling
- Math majors/minors
- Override documentation
- Course Syllabi files
- Schedule use of computer lab room 205/206
- Conference/Seminar room reservations and/or catering needs
- Course evaluations/filing/updating
- Weber room reservations
- Semester office hours and class schedules
- Special mailing
- Copier assistance
- Supplies requests
- Assist in the absence of undergraduate and/or graduate coordinators
- Colorado Combined Campaign department representative

**Office Manager - Graduate Coordinator – Bryan Elder**

If you need assistance with one of the following, contact Bryan at 491-7925

- Equipment check in/out
- Substitute teachers for faculty and GTA's
- Room arrangements for thesis defenses
- Graduate school interaction
- Graduate School forms
- Graduate office desk assignments
- Graduate student alumni records
- Graduate application/forms/deadlines/contracts
- International/Visa Process
- Qualifying examination information
- Reference letters
- Maintain department home pages on the website

**Building Proctor – Bryan Elder**

If you need assistance with one of the following, contact Bryan at 491-7925

- Building/office repairs
- Digital Displays
- Problems with building/facility
- Special cleaning needs
- Phone system
- Department construction liaison to facilities management
- Key Manager

After hours or in case of a true emergency, call Facilities Services dispatch at 491-0077.

**Accounting Office** – Sheri Hofeling, Jane Owen-Maul

If you need assistance with one of the following, contact Sheri at 491-7047

- Financial reporting
- Long distance statements
- Salary and hourly payroll, including timesheets
- Purchasing/accounting issues
- Research grants/Start-up accounts/Dept accounts
- Travel – including in-house & pre-travel forms
- Department post-travel
- New hires, including faculty, staff, or student employees
- Arranging computer access (ISIS, ORACLE, CIS, Newton)
- P-CARD
- Scholarships
- Student Hourly Employees/Payroll
- Bi-monthly time sheets

**Systems Administrator** – John Dzuber (Zube)

If you need assistance with one of the following, contact Zube at:

[zube@math.colostate.edu](mailto:zube@math.colostate.edu)

- Assistance with hardware and software purchases
- Computer set-up for new employees; network access; installing computer programs
- General computer/network troubleshooting
- Maintaining department printers and scanners

**Web Master** – Bryan Elder

If you need assistance with one of the following, contact Bryan at 491-7925

or [elder@math.colostate.edu](mailto:elder@math.colostate.edu)

- Maintaining and updating department websites
- Maintaining and updating faculty and graduate website
- Updating and design of current Mathematics website and links

## Miscellaneous

**Copies:** There is a copier in the main office Weber 102 to use for university related business (i.e. teaching or research).

Copyright laws prevent copying more than 10% of a book.

**Faxing:** The fax number to the machine in the main office is 970-491-2161. You may request a fax be sent by completing the fax form and submitting it to any one of the office staff

**Office Supplies:** If you are doing work related to your appointment as a GTA or GRA, we will give you the supplies you need to do this work.

**Parking:** You will need to purchase a parking permit if you wish to park your car in the university parking lots on campus. Commuter students will need to purchase a Z-lot permit. Permits can be purchased at Parking Services, 201 Green Hall. Permits for a one-year period will allow you to park in any lot designated as a Z-lot. As a graduate instructor, you may be able to purchase a “restricted A-lot” parking permit for an additional cost. This permit will allow you to park in limited faculty lots on campus. Check with Parking Services

[\(http://www.parking.colostate.edu/\)](http://www.parking.colostate.edu/)

Bicycling provides a cheap, convenient way to get to campus. Numerous bike racks are located around campus and the Weber building. All bikes must be registered with the University Police Department. Be sure to familiarize yourself with the regulations for bicycling on campus (e.g., you must have lights on your bike for night or evening biking).

**Public Transportation:** *Transfort* and MAX are the bus systems in Fort Collins. Bus passes are free to all full-time students. The service has stops near several student living areas and drops students off in the center of campus at the new bus stop located at the student center. Information about routes is available at

<http://fcgov.com/transfort/>

### **Computers**

Among the first things you should do as a student at CSU is sign up for an electronic identity (eID). The eID is required for many services on campus, including:

- Free CSU Computer Account
- E-mail
- WebCT
- Services for Modem Access
- Use of computers in the mathematics graduate student computer labs

**Office and Phone:** Upon arrival GTAs will be assigned an office and phone number that will be shared with other students. Offices will be assigned to self supported students if available.

**Mailbox:** All graduate students will be issued a mailbox. They are located in Weber 102 in the main office suite.

**Keys:** All graduate students will be issued keys to the main entrance of the Weber building, the mailroom and library. Those students assigned a desk will have keys to their office as well.

Records are maintained in the department’s main office of all keys issued throughout the department. Lost keys must be reported immediately to the Key Manager. The Key Manager will notify Facilities Key Desk and prepare the required paperwork for the lost keys and replacing the lost keys. Upon leaving the university, key holders must return all keys issued in their name to the department Key Manager. Grades and/or paychecks can be withheld until clearance for all keys is received.

**Math email:** You will meet with Zube, Mathematics system administrator, to set up a math email address [yourlastname@math.colostate.edu](mailto:yourlastname@math.colostate.edu). It is strongly recommended

that you use this email in all of your electronic communications with the department given email relay restrictions. Please check your email daily as this will be the primary means of communication within the department.

**Graduate Student Offices - Rules of Common Courtesy:** Please recognize that these are shared offices and rules of common courtesy should apply. Following the rules below, and being courteous and considerate in general, will ensure that everyone has a pleasant experience in the Math Department.

1. Offices are work and study places and a work/study environment has priority over social or recreational activities. Weber 117 would be an appropriate place to carry on lengthy conversations, or to socialize – not shared offices!
2. Office hours should not be held at your desk. Office hours for most courses will be held in the Calculus Center (second floor of TILT) or in a separately scheduled room. If a quick meeting must take place with a student, please do so outside of the graduate student offices.
3. Not everyone considers music appropriate for a work environment. If you would like to listen to music, headphones are highly recommended.
4. Computers are provided for professional use, to include email, website management, grade records, and research. Please be courteous to your fellow students. During business hours, refrain from using the computers for recreational activities (games, web surfing). After business hours, professional activities still have priority. Remember that not all computers have the same capabilities. Just because other computers are not in use, this does not mean that someone else does not need the computer you are using to play.
5. Please clean up after yourself. Let Bryan know if you need supplies for cleaning.
6. Please keep all cell phones on a silent or quiet tone. While not in the office, please either take your phone with you or turn it off. If you need to make/answer a call, please move outside of the office or ask your office mates if it will disturb them to make a quick phone call.
7. University policy is “no pets are allowed in buildings,” and since the office areas are shared space, rules of courtesy reinforce this policy.
8. Please remember to turn off the lights and lock the door when leaving the office if you are the last one present in the office. We do not want personal items, i.e. laptops, books, etc. to be stolen. Also, if a fan is turned on in the office, please remember to turn it off if you are the last person to leave the office.
9. All rules should be discussed with each office at the beginning of every school year to determine what is acceptable for that office.

## **Housing:**

**On-Campus Housing:** The University has on-campus options for both single and family housing.

There are two sets of apartments for single graduate students: Lory Apartments and International House. Both offer one bedroom, and two-bedroom (shared with a roommate) apartments. There is no choice of roommate in the shared apartments, but

odds are you will get to live with someone from another country, as these apartments are well liked by international students.

Two and three bedroom family housing is available at Aggie Village North and South, and University Village East and West.

Information regarding both types of housing is available on the Housing and Dining Services website.

<http://www.housing.colostate.edu/apartments/index.htm>

Graduate students are not guaranteed an apartment, so you should file your application well in advance. These apartments are only rented to graduate students or non-traditional students, so the apartments are extremely quiet.

**Off-Campus Housing:** Finding a place to live in Fort Collins at the beginning of the semester can be difficult. Fort Collins has a fair amount of off-campus housing available; however each fall brings a crowd of students, so try to make rental arrangements as early as possible. The influx usually begins at about mid-July and crescendos until classes begin. As with most college towns, you pay for the convenience of being close to the campus. But remember that the popular advertisement "close to campus" is less meaningful to math graduate students since the majority of apartments are west of the university, and the Weber Building is on the east side of campus.

Off-Campus Student Services, located in the Lory Student Center is an excellent resource to assist you in your search for off-campus housing:

<http://www.ocssral.colostate.edu/>

Here are just a few free services that they offer:

- Assistance in finding a place to live off campus
- Help in finding potential roommates
- Assistance in learning the stages of renting, pre to post-tenancy
- Aid in understanding your rights and responsibilities as a tenant in Fort Collins
- Information on selecting and developing healthy roommate relationships
- Tips on being a good neighbor and building community
- Help with Budgeting
- Transportation information
- Ways to get involved on campus

The classified ads in either the Collegian (the CSU paper) or the Coloradoan (the local Fort Collins paper) are also a great resource for off-campus housing.

## Qualifying Examination Course Syllabi

**Notes:** The words “final examination” always mean the two-hour, in-class, final examination for the course. Thus, in the following, any references to “final examinations” do NOT include any take-home parts of a final examination that are used by an individual instructor to determine a student's course grade.

These Syllabi are those emerging from the various Syllabi Committees formed in late Fall 2009, and were approved by faculty ballot on May 10, 2010.

### MATH 501 - Combinatorics I

The core set of topics for MATH 501 are:

1. Basic counting: binomial coefficients, pigeonhole principle, counting with or without repeats, with or without order; double count; power set; binomial theorem; inclusion-exclusion.
2. Generating functions, recursion, recurrence relations and how to solve them; famous sequences.
3. Advanced counting: inversion techniques, groups and actions, orbits.
4. Equivalence relations, partitions, partially ordered sets, special orderings.
5. Projective planes over finite fields.
6. Graphs and networks (Euler, Hamilton, matchings, optimization).

The MATH 501 final examination (which may serve as a Qualifying Examination) will cover a selection of the above topics.

Optional topics:

The student may expect 1-3 weeks to be devoted to several, but not all, of the following optional topics. These topics will not be covered on the final examination for MATH 501.

1. Logic and set theory.
2. Automata.
3. Algorithms.
4. Structures in projective planes.
5. Special classes of graphs (in particular strongly regular graphs).
6. Structural theory of graphs (isomorphism and reconstruction).
7. Counting graphs using Burnside / Cauchy / Frobenius; Polya theory.



8. The twelvefold way and extensions (as in Richard P. Stanley's text Enumerative Combinatorics, Volume I).
9. Coding theory and the Hamming graph, code constructions, code bounds, Paley graphs, posets and lattices.
10. Stirling numbers.
11. Moebius function.
12. Latin squares, MOLS.

Texts:

Sample Texts: Peter Cameron: Combinatorics; Jonathan Gross: Combinatorial Methods

## **MATH 502 - Combinatorics II**

The core set of topics for MATH 502 include Designs, Graphs, Codes, Geometries and their links:

1. Designs: basic theory - parameters, Fisher's inequality, symmetric designs, incidence matrices, groups of designs.
2. Codes: Hamming distance, rate, block codes, length, error-correction, error-detection, linear codes, generating matrix, parity-check matrix, perfect codes, groups of codes.
3. Graphs: regularity, distance, diameter, girth, bipartite, covers, adjacency matrices, groups of graphs.
4. Geometries: affine and projective spaces and their groups.

The MATH 502 final examination (which may serve as a Qualifying Examination) will cover a selection of the above topics.

Optional topics:

The student may expect 1-3 weeks to be devoted to several, but not all, of the following optional topics. These topics will not be covered on the final examination for MATH 502.

Symmetric functions, association schemes, distance regular graphs, extremal combinatorics, combinatorial algorithms.

Texts:

Sample Texts: van Lint and Wilson: Combinatorics; Cameron and van Lint: Designs, Graphs, Codes and their links; Pless: Coding theory; Taylor: The geometry of the

classical groups; van Lint: Introduction to coding theory; Ling and Xing: Coding theory; Cameron's web notes on projective and polar spaces.

### **MATH 510 - Linear Programming and Network Flows**

The core set of topics for MATH 510 are:

1. Introduction to optimization and problem formulation.
2. The geometry of linear programs.
3. The Simplex method.
4. Duality theory.
5. Sensitivity analysis.
6. Network Flows.
7. Interior point methods.
8. Integer programming.

The MATH 510 final examination (which may serve as a Qualifying Examination) will cover a selection of the above topics.

Optional topics:

The student may expect 1-3 weeks to be devoted to several, but not all, of the following optional topics. These topics will not be covered on the final examination for MATH 510.

1. Game theory.
2. Portfolio selection.
3. Quadratic programming.
4. Convex optimization.
5. Applications, e.g., to Engineering and Agriculture.
6. Matlab Projects

Texts:

Sample Texts: Introduction to Linear Optimization, D. Bertsimas and J.N. Tsitsiklis.

### **MATH 517 - Introduction to Mathematical Analysis**

The core set of topics for MATH 517 are:

1. Metric spaces, compactness, completeness.
2. Sequences, convergence, Cauchy sequences.
3. Series, power series, nonnegative and absolutely convergent series.
4. Continuity, uniform continuity, intermediate value theorem.
5. Sequences and series of functions, pointwise and uniform convergence.
6. Weierstrass approximation theorem, equicontinuity, the Arzela-Ascoli theorem.
7. Differentiation in several variables, partial derivatives, the chain rule.
8. Linearization, mean value theorems, sequences of differentiable functions.
9. Higher order derivatives, power series, Taylor's theorem.
10. Contraction mapping principle, implicit and inverse function theorems.

The MATH 517 final examination (which may serve as a Qualifying Examination) will cover a selection of the above topics.

Optional topic:

This topic will be covered at the instructor's option, and will not be covered on the final examination for MATH 517.

1. Classification of critical points.

Text:

Rudin: Principles of Modern Analysis

## **MATH 519 - Complex Analysis**

The core set of topics for MATH 519, covering a bit less than 12 weeks of the course, are:

2. Functions on the complex plane: convergence, continuous functions, holomorphic functions, power series, integration along curves, Cauchy-Riemann equations.

3. Cauchy's Theorem and its Applications: Goursat's theorem, local existence of primitives, Cauchy's integral formulas, Morera's theorem, sequences of holomorphic functions, holomorphic functions in terms of integrals, Schwarz reection principle, Runge Approximation, Liouville theorem, Maximum modulus.
4. Meromorphic functions and the logarithm: The residue formula, singularities and meromorphic functions, the argument principle, homotopies and simply connected domains, the complex logarithm, fourier series and harmonic functions, Rouché's theorem, Techniques of integration.
5. Entire functions: Jensen's formula, functions of finite order, infinite products, Weierstrass infinite products, Hadamard factorization.
6. Conformal mappings: conformal equivalence, Dirichlet problem, Schwarz lemma, automorphisms of disc, Riemann mapping theorem.

The MATH 519 final examination (which may serve as a Qualifying Examination) will cover a selection of the above topics.

Optional topics:

The student may expect up to a bit more than 3 weeks to be devoted to several, but not all, of the following optional topics. These topics will not be covered on the final examination for MATH 519.

1. Asymptotic evaluation of integrals
2. Bessel functions, Stirling's formula, Poisson integral formula
3. Conformal mappings onto polygons, Schwarz Christoffel integral
4. Covering spaces, monodromy
5. Elliptic functions, complex tori
6. Fourier transform, Paley-Weiner theorem and applications to differential equations
7. Gamma functions\* and their analytic continuation
8. Generalized Cauchy integral formula
9. Ideal fluid flow
10. Laplace transform and applications to differential equations
11. Minimal surfaces
12. Mittag-Leffler theorem
13. Modular character of elliptic functions, Eisenstein series

14. Modular functions
15. Riemann Hilbert problems
16. Riemann zeta function\*, Prime number theorem
17. Sheaf of germs of holomorphic functions
18. Theta functions, two and four squares theorem

\*: Instructors are particularly encouraged to cover the Riemann zeta function and gamma functions if time permits.

Texts:

Suggested textbooks (alphabetical by author): Complex variables by Ablowitz & Fokas, Functions of One Complex Variable by Conway, Complex Analysis by Stein & Shakarchi.

### **MATH 540 - Dynamical Systems and Chaos**

The core set of topics for MATH 540 are:

1. Systems of Differential Equations: (Review) existence and uniqueness of solutions, (review) continuous dependence of solutions on initial conditions and parameters.
2. Autonomous Systems: Phase space, vector fields, orbits and flows; critical points and equilibrium solutions; linearization; periodic solutions; first integrals and integral manifolds; Liouville's theorem.
3. Critical Points: Linear systems: eigenvalues and diagonalization; classification of 2D linear systems; remarks on classification of 3D linear systems; critical points of nonlinear systems; review stable and unstable manifolds.
4. Periodic Solutions: Periodic solutions of 2D systems; Bendixson criterion; Poincaré-Bendixson theorem and applications; existence of periodic solutions in higher-dimensional systems.
5. Introduction to Stability Theory: Examples; stability of equilibrium solutions; stability of periodic solutions; linearization.
6. Linear Systems: Fundamental matrices; systems with constant coefficients; nonautonomous linear systems; systems with periodic coefficients.
7. Stability Theory Continued: Stability of equilibrium solutions by linearization; stability of periodic solutions of autonomous equations; Lyapunov functions; Hamiltonian systems and systems with first integrals.

8. Introduction to Perturbation Theory: Examples; order functions and time scales; Poincaré expansion theorem.
9. Poincaré-Lindstedt Method: Periodic solutions of autonomous 2nd order equations; approximation of periodic solutions on arbitrary times scales; periodic solutions of equations with forcing terms; existence of periodic solutions.
10. Method of Averaging: Lagrange standard form; averaging in the periodic case; averaging in the general case.
11. Relaxation Oscillations: Mechanical systems with large friction; Van der Pol equation; Lotka-Volterra equations.
12. Bifurcation Theory: Poincaré normal forms; averaging and normal forms; center manifolds; bifurcation of equilibrium solutions (saddle-node, transcritical, and pitchfork bifurcation); Hopf bifurcation.
13. Introduction to Iterated Maps: Poincaré maps; stability and bifurcation of periodic orbits.

The MATH 540 final examination (which may serve as a Qualifying Examination) will cover a selection of the above topics.

Optional topics:

The student may expect that about three weeks will be devoted to a selection from the following optional topics. These topics will not be covered on the final examination for MATH 540.

1. Chaotic Dynamics: Lorenz system and Lorenz maps; chaotic 1D maps: quadratic map and tent map; Sharkovsky theorem and Feigenbaum numbers; fractal sets: limit capacity and Hausdorff dimension; correlation dimension, information dimension, dimension spectrum; Lyapunov exponents.
2. Review of other aspects of chaotic dynamics: Smale's horseshoe and symbolic dynamics; homoclinic orbits and Melnikov method; Julia sets; Shilnikov bifurcation; time series embedding; shadowing.
3. Applications of dynamical systems (from supplementary texts).
4. Continued discussion of the method of averaging (adiabatic invariants, resonance manifolds).
5. Continued discussion of bifurcations and normal forms, including codimension-two bifurcations.
6. Hamiltonian systems.
7. Introduction to delay differential equations.
8. Introduction to symbolic dynamics.

9. Chaotic time series analysis and numerical experiments.
10. Coupled cell systems and neural networks.

Texts:

Suggested Textbook: F. Verhulst: Nonlinear Differential Equations and Dynamical Systems, Springer 2006 (3rd edition).

Supplementary texts: S. Strogatz: Nonlinear Dynamics and Chaos, Addison Wesley 1994; M. Kot: Elements of Mathematical Ecology, Cambridge University Press 2001; J.D. Murray: Mathematical Biology, Springer 1989.

### **MATH 545 - Partial Differential Equations I**

The core set of topics for MATH 545 are:

1. Classification of PDEs.
2. Conservation laws.
3. Characteristics.
4. Quasilinear equations, jump condition and propagation of shock waves.
5. Hyperbolic equations: the 1-D wave equation, D'Alembert's solution, method of characteristic parallelograms.
6. Separation of variables.
7. Fundamental solutions and Green's functions.
8. Elliptic Equations: Laplace's equation.
9. Parabolic Equations: Diffusion equation.
10. Maximum and minimum principles.

The MATH 545 final examination (which may serve as a Qualifying Examination) will cover a selection of the above topics.

Optional Topics:

MATH 545 is also a core course for graduate students in the School of Biomedical Engineering. Thus, the course must contain a significant number of biomedical examples. The choice of examples may vary depending upon the instructor, and therefore will not be part of the final examination.

Texts:

Suggested texts: Partial Differential Equations of Mathematical Physics and Integral Equations {Guenther and Lee; Partial Differential Equations of Applied Mathematics {Erich Zauderer; A First Course in Partial Differential Equations with Complex Variables and Transform Methods { H.L. Weinberger.

### **MATH 546 - Partial Differential Equations II**

The core set of topics for MATH 546 are:

1. Variational formulation of PDEs, weak solutions, test functions
2. Weak derivatives, the Sobolev spaces  $W^{k,p}$ .
3. Sobolev embedding theorems.
4. The extension theorem, the trace theorem.
5. Weak solutions of second order elliptic equations, elliptic regularity.
6. Weak solutions of parabolic equations, energy estimates, maximum principles.
7. Distributions.
8. Fundamental solutions and Green's functions, application to nonhomogenous problems
9. Fourier transforms.
10. Viscosity and entropy solutions of hyperbolic equations.

The MATH 546 final examination (which may serve as a Qualifying Examination) will cover a selection of the above topics.

Texts:

Suggested texts: An Introduction to Partial Differential Equations {Renardy and Rogers; Partial Differential Equations {Evans; Partial Differential Equations: Methods and Applications {McOwen; Introduction to Partial Differential Equations {Folland.

### **MATH 560 - Linear Algebra**

The core set of topics for MATH 560 are:

1. Fundamental Concepts: Vector spaces, subspaces; dependence, span, basis, extension to form a basis; dimension, direct sums; congruence.
2. Duality: Linear functions; annihilators, co-dimension.



3. Linear Transformations: Definition, range, nullspace; algebra of transformations; invertible maps; adjoint operators; annihilators; similarity transformations; projections.
4. Matrices: Bases and representations; vector-wise and block-wise interpretations; composition; rank; adjoint; special matrices; change of bases.
5. Determinant and Trace: Multilinear functions, volume; properties of determinants; Cramers Rule.
6. Spectral Theory: Iterated maps, power methods; eigenvalues, eigenvectors, characteristic polynomials; distinct eigenvalues and independence; Spectral Mapping Theorem; Cayley-Hamilton Theorem; similarity, minimal polynomials; spectral decomposition; diagonalizable matrices; adjoint and commuting matrices, multiplicity.
7. Euclidean Spaces: Inner products, norms, inequalities; orthonormal bases, Gram-Schmidt procedure; representation theorem; orthogonal complements, decompositions; projections, distance; adjoint operators; norm of an operator; isometries, orthogonal maps.
8. Normed Linear Spaces: Norms, distance, balls, P-norms, Holder inequality, equivalence; bounded operators; dual norm, continuity of invertibility; norms of matrices.
9. Unitary Equivalence and Normal Matrices: Unitary matrices, unitary equivalence; Schur decomposition; normal matrices; QR factorization.
10. Jordan Canonical Form
11. Singular Value Decomposition: Polar Decomposition; Singular Value Decomposition; generalized Inverse.

The MATH 560 final examination (which may serve as a Qualifying Examination) will cover a selection of the above topics.

Optional topics:

The student may expect that up to three weeks will be devoted to various optional topics such as spectral theory for self adjoint maps, special matrices such as Toeplitz and circular, and/or PLU decomposition. These topics will not be covered on the final examination for MATH 560.

Texts:

Suggested Textbooks: Linear Algebra, P. Lax, John Wiley and Sons, Inc., 2nd Edition, ISBN 0-471-75156-4;  
 Matrix Analysis, R. Horn and C. Johnson, Cambridge University Press, ISBN 0-521-38632-2 (for Jordan canonical form).

## **MATH 561 - Numerical Analysis I**

The core set of topics for MATH 561 (a course in numerical linear algebra) are:

1. Vector and matrix norms, sparse matrix representations, floating number arithmetic.
2. Condition numbers, stability analysis.
3. Gaussian elimination (GE) with partial pivoting GE applied to digonally dominant, tridiagonal, and banded systems.
4. SPD matrices, Cholesky (CHOL) factorization.
5. Basic iterative schemes and convergence conditions Jacobi, Gauss-Seidel (GS), and SOR iterative schemes.
6. Conjugate gradient (CG) methods.
7. Singular value decomposition (SVD).
8. Least squares problems.
9. Householder reections and QR factorization.
10. Eigenvalues: QR iterations without and with shifts.
11. Krylov subspace methods: Arnoldi iteration and GMRES.
12. Preconditioning.

The MATH 561 final examination (which may serve as a Qualifying Examination) will cover a selection of the above topics.

Optional topics and applications:

The following optional topics can be covered at the instructor's discretion, but will not be covered on the final examination:

1. Tensor products of matrices.
2. Red-black ordering in iterative schemes.
3. Eigenvalues: power methods.
4. Krylov subspace methods: BiCGStab.
5. Krylov subspace methods: Lanczos iteration.

The following optional applications may be covered to enhance students' understanding of the course materials but will not be covered on the final examination:

1. GE: Finite differences for ODE boundary value problems.
2. CHOL:  $L^2$  orthogonal projection into polynomial subspaces.

3. GS: 2-dim Poisson equation boundary value problem.
4. GMRES: Taylor-Hood Q2Q1 finite elements for 2-dim Stokes flow.
5. SVD: Image compression and data compression.

Texts:

Suggested Textbooks: [1] Demmel, "Applied Numerical Linear Algebra", SIAM, 1997;  
 [2] Trefethen, Bau, "Numerical Linear Algebra", SIAM, 1997.

### **MATH 566 - Abstract Algebra I**

The core set of topics for MATH 566 are:

- I. Groups:
  - a) Basic examples, subgroups, cosets, homomorphisms. Note that lots of examples will be given throughout lectures/assignments in all weeks.
  - b) Group Actions.
  - c) Sylow theorems and applications.
  - d) Direct and semi-direct products.
- II. Rings:
  - a) Basic examples, subrings, ideals, homomorphisms.
  - b) Factorization in integral domains.

The MATH 566 final examination (which may serve as a Qualifying Examination) will cover a selection of the above topics; examples discussed in class or homework may also be covered on that examination. Students may also be expected to discuss new examples, in the context of the concepts above, on the final examination.

Texts:

Suggested Texts: Dummit and Foote, Abstract Algebra; Hungerford, Algebra; Artin, Modern Algebra. These texts are typically used for both 566 and 567.

### **MATH 567 - Abstract Algebra II**

The core set of topics for MATH 567 are:

- I. Modules:

- a) Basic definitions and examples, quotient modules, homomorphisms of modules. Note that lots of examples will be given throughout lectures/assignments in all weeks.
- b) Module generation and direct sums.
- c) Finitely generated modules over PIDs and applications.

## II. Fields:

- a) Field extensions and algebraic extensions.
- b) Splitting fields and separability.
- c) Galois theory and applications.

The MATH 567 final examination (which may serve as a Qualifying Examination) will cover a selection of the above topics; examples discussed in class or homework may also be covered on that examination. Students may also be expected to discuss new examples, in the context of the concepts above, on the final examination.

Texts:

Suggested Texts: Dummit and Foote, Abstract Algebra; Hungerford, Algebra; Artin, Modern Algebra. These texts are typically used for both 566 and 567.

## **MATH 570 - Topology I**

The core set of topics for MATH 570 are:

1. Topological spaces, bases and subbases of topologies, metric spaces and metric topologies, continuous functions, subspace topologies, connectedness, compactness (lots of examples given throughout lectures/assignments in all weeks).
2. Function spaces, product spaces, the Tychonoff theorem (full proof not given, but students must understand the product topology for an arbitrary product). Topological groups.
3. Separation axioms. Brief mention of Urysohn's lemma, Tietze Extension Theorem (full proofs not necessarily given), path connectedness.
4. Quotient spaces.
5. Homotopy: general definition, path homotopy, contractibility, the fundamental group, homotopy equivalence. More on quotient spaces {cones, suspensions, joins.
6. Basics of covering space theory.

The MATH 570 final examination (which may serve as a Qualifying Examination) will cover a selection of the above topics; examples discussed in class or homework may also be covered on that examination. Students may also be expected to discuss new examples, in the context of the concepts above, on the final examination.

Texts:

Sample Texts: Topology, Munkres; Topology, Hocking and Young; An Introduction to Algebraic Topology, J.J. Rotman. There are many other suitable texts.

### **MATH 617 - Integration and Measure Theory**

The core set of topics for MATH 617 are:

1. Set theory, sigma-rings and sigma-algebras
2. Finitely additive measures, outer measure and measurable sets
3. Lebesgue measure in one dimension, Borel measures
4. Simple functions, measurable functions, Lebesgue integration
5. Bounded and dominated convergence theorems
6. Product measures
7. Fubini's theorem
8. The Radon-Nikodym theorem
9. Lebesgue measure and integration in finite dimensions
10. Change of variables in finite dimensions

The MATH 617 final examination (which may serve as a Qualifying Examination) will cover a selection of the above topics.

Optional topics:

These topics will be covered at the instructor's option, and will not be covered on the final examination for MATH 617.

1. Riemann Integration.
2. Null sets and Lebesgue's characterization of Riemann integrability.
3.  $L_p$  spaces.
4. Probability spaces, independence, law of large numbers, central limit theorem.

Text:

Inder K. Rana - An Introduction to measure and integration

### **MATH 618 - Advanced Real Analysis**

The core set of topics for MATH 618 are:

1. Banach spaces,  $L_p$  spaces.
2. Linear operators and linear functionals.
3. Hahn-Banach theorem.
4. Dual spaces.
5. Hilbert spaces,  $L_2$  spaces.
6. Fourier analysis.
7. Linear operators and solution of linear inverse problems: adjoint, Baire's theorem, open mapping theorem, uniform boundedness principle, closed graph theorem, Neumann perturbation theorem.

The MATH 618 final examination (which may serve as a Qualifying Examination) will cover a selection of the above topics.

Optional topics

These topics will be included at the instructor's option, and will not be covered on the final examination for MATH 618.

1. Fixed point theory; Banach, Brouwer, Schauder, and Kakutani fixed point theorems.
2. Calculus for nonlinear operators.

Texts:

Real Analysis, Folland; Principles of Functional Analysis, Schechter; Handbook of Analysis and its Foundations; Analysis for Applied Mathematics, Cheney.

### **MATH 640 - Ordinary Differential Equations**

The core set of topics for MATH 640 are:

1. Introduction: Examples of real-world models as differential equations {population dynamics, mechanical systems, electrical circuits, fluid flow; one-dimensional dynamics {phase line, separation of variables; two-dimensional

dynamics{ introduction to phase plane; three-dimensional dynamics{ a glance at possibility of chaotic dynamics.

2. Linear Systems: Matrix ODEs; eigenvalues and eigenvectors, diagonalizability; classification of 2D linear systems; exponentials of linear operators; fundamental solution theorem; complex and multiple eigenvalues; semisimple nilpotent decomposition and matrix exponential; matrix exponential via Cayley Hamilton theorem; linear stability; non-autonomous linear systems and Floquet theory.
3. Existence and Uniqueness of Solutions: set and topological preliminaries in  $\mathbb{R}^n$ -convergence and uniform convergence; function space preliminaries{ metric spaces, contraction maps, Lipschitz functions; existence and uniqueness theorems; Gronwall inequality, continuous dependence on initial conditions and parameters; maximal interval of existence.
4. Dynamical Systems: Definitions{ deterministic dynamical systems, orbits, invariant sets; flows and vector fields; global existence of solutions of first order systems; equilibrium points and linearization, hyperbolic and non-hyperbolic equilibria; stability of equilibria, Lyapunov functions; topological conjugacy and equivalence; Hartman-Grobman theorem; limit sets, attractors, basin of attraction; stability of periodic orbits, Poincaré maps.
5. Invariant Manifolds: Stable and unstable sets; homoclinic and heteroclinic orbits; stable manifolds; local stable manifold theorem; global stable manifolds; center manifold theorem and applications thereof.
6. Phase Plane: Nonhyperbolic equilibria in the plane{ Two zero eigenvalues and non-hyperbolic nodes, imaginary eigenvalues, topological centers; symmetry and reversible systems; index theory in 2D, degree theory in higher dimensions; Poincaré-Bendixson theorem; behavior at infinity{ Poincaré sphere.

The MATH 640 final examination (which may serve as a Qualifying Examination) will cover a selection of the above topics.

Optional topics:

The student may expect that about two weeks will be devoted to topics chosen by the instructor. These topics will not be covered on the final examination for MATH 640.

Sample topics are:

1. Chaotic dynamics.
2. Bifurcation theory.
3. Hamiltonian dynamics.

Texts:

Suggested Textbook: One of J. Meiss: *Differential Dynamical Systems*, SIAM, 2007; L. Perko: *Differential Equations and Dynamical Systems*, Springer, 2001 (3rd ed.).