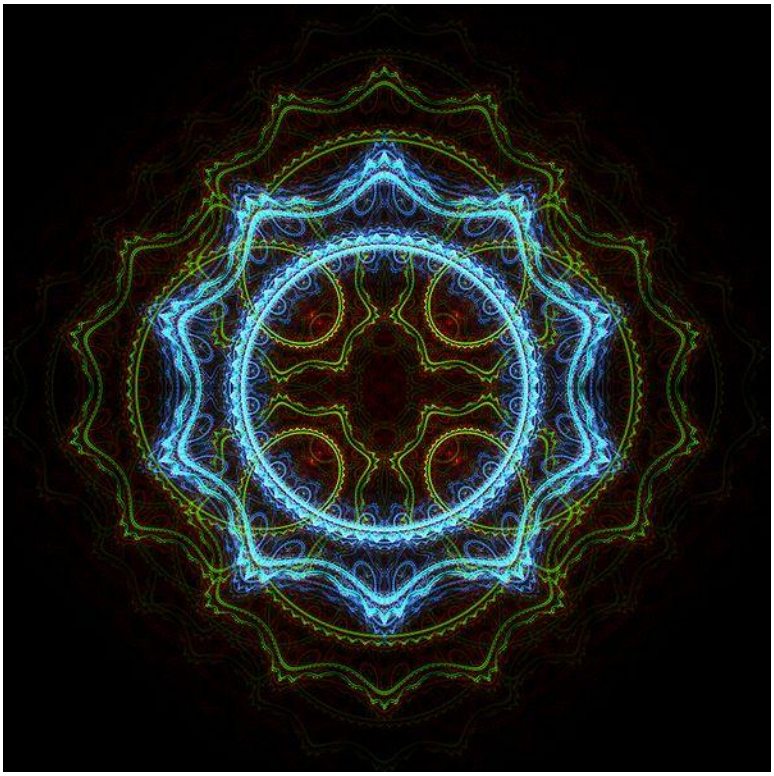
DEPARTMENT OF MATHEMATICS



Graduate Studies Handbook

Master of Arts in Mathematics: Traditional Track and Teaching Option

Revised August 5, 2011.

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Welcome

Dear Student:

Welcome to the graduate program in Mathematics at California State University, Fresno. You have taken your first step towards a greater mastery of mathematics, a field that is not only a discipline, in and of itself, of breadth, depth, and beauty, but is also an indispensable tool for science, engineering, economics, business, and many more fields of study. In fact, today's mathematicians are involved in a diverse range of activities, from traditional teaching and classical mathematical research to the economic forecasting, climate modeling, and genetic engineering. As a result, the employment opportunities and challenges for individuals holding an advanced degree in the mathematical sciences are varied and plentiful.

The Department of Mathematics at California State University, Fresno is committed to the highest standards of teaching, and offers courses for mathematics, science, engineering, and liberal studies majors, as well as general education mathematics courses for all majors. The Mathematics Department has 17 tenured and tenure track professors specializing in areas such as pure mathematics, applied mathematics, statistics, and mathematics education.

This handbook has been prepared to help you through your journey as a graduate student, giving an overview of the master's program and describing each of the two options (the traditional track and the teaching option) and their requirements. In addition, the handbook contains various policies of the graduate program, a list of faculty and their areas of research, and a list of graduate courses.

You should meet periodically with the Graduate Coordinator to discuss your progress in the program, as well as any other issues that may arise. The Graduate Coordinator is Dr. Doreen De Leon, and she can be reached by e-mail at doreendl@csufresno.edu, by telephone at 559-279-4009, and in person in her office in the Peters Building, Room 350.

Congratulations on your entry into the graduate program, and best wishes for your success!

Doreen De Leon,
Graduate Coordinator

The Master of Arts in Mathematics – General Information

Introduction

The Department of Mathematics offers two tracks for the Master of Arts degree (M.A.): (1) the traditional M.A. or (2) the M.A. with a Teaching Option.

The traditional M.A. is ideal for candidates who are interested in working in business or industry, teaching at a community college, or earning a doctoral degree in mathematics at some later date. The M.A. with a Teaching Option is best for those who wish to assume a leadership role in high school teaching and beyond or who wish to pursue an advanced degree in mathematics education.

Admission to the Program

In order to be admitted to the program, an applicant must have earned a Bachelor's degree, preferably in Mathematics. In order to achieve classified standing (i.e., full admission), applicants should have undergraduate preparation in mathematics comparable to that of a typical math major at Fresno State and have a 3.0 grade point average in the last 60 units taken. Students lacking this preparation may be admitted conditionally. These students will become classified after meeting additional requirements as set by the graduate coordinator. For example, the student may be required to take certain upper division courses (e.g., abstract algebra, linear algebra, analysis, geometry) before achieving classified status. Coursework required to achieve classified status may not be applied towards credits for the graduate program.

All applicants are required to take the general GRE. Preference will be given to applicants who score 450 or better on the verbal section, and 600 or better on the quantitative section (or the equivalent score on the new GRE exam).

In addition, two letters of recommendation from faculty at the applicant's undergraduate institution are required. Letters should be sent directly to the Graduate Coordinator at:

5245 North Backer Avenue, M/S PB108
Fresno, CA 93740-8001.

To be admitted to the Master of Arts program in Mathematics (either Traditional or Teaching Option), you must first apply to the University through http://www.csumentor.edu. In addition to completing the application online and sending two letters of recommendation to the Graduate Coordinator, you must also send both your

- GRE (general) official scores, and
- one official transcript for each college or university attended

to the:

Office of University Admissions – Graduate/Postbaccalaureate
5150 North Maple Ave., JA 57
Fresno, CA 93740-8026.

If you are admitted as conditionally classified, it is your responsibility to:

- meet with the Graduate Coordinator to discuss any conditions to your full admission (i.e., to achieving classified standing);
- satisfy the noted conditions; and
- have the Graduate Coordinator submit verification that you have met all of the conditions to the Division of Graduate Studies for approval as a student in classified graduate standing.

Support

The Department of Mathematics provides a variety of opportunities for students to assist them in their studies. With fewer than 35 students in the current graduate program, study tracks are facilitated with much greater ease than with larger programs. Graduate students will find that with a rich faculty-to-student ratio, faculty mentoring is individualized and tailor made to their needs. Whether preparing for work in industry, high school and/or community college teaching, or doctoral studies, our faculty is committed to the support of our students.

Financially, students may qualify for aid after the completion of their first semester. Many of our graduate students are supported each semester by Graduate Assistant and Teaching Associate positions, which usually require 10-20 hours of work per week, with pay that ranges approximately from $5,300 to $10,600 per academic year, depending on the total assigned work hours. A limited number of tuition waivers may also be available to outstanding applicants.

Additional information regarding financial support may be found on the Graduate Studies website, http://www.csufresno.edu/gradstudies.

Faculty

Our faculty represents a wide range of theoretical orientations that include most of the major areas in mathematics. They are active in research and have a close working relationship with the National Science Foundation. Since 1992, the department has hosted three conferences supported by the NSF: two were research conferences in the mathematical sciences, and the third was an undergraduate faculty enhancement project. We have 17 outstanding professors, the majority of whom currently teach or have taught graduate courses. They include:

T. Rajee Amarasinghe, Ph.D., Indiana University, Bloomington.
Areas of research: interdisciplinary mathematics, technology in learning mathematics, ethno-mathematics.

Lance Burger, Ph.D., Oregon State University.
Areas of research: teacher education, advanced mathematical thinking, philosophy of mathematics education.

Carmen Caprau, Ph.D., University of Iowa.
Areas of research: quantum topology, knot theory, categorifications of knot invariants.

Larry W. Cusick, Ph.D., University of California, San Diego.
Areas of research: geometry.

Stefaan Delcroix, Ph.D., Rijksuniversiteit, Gent.
Areas of research: finite groups, abstract algebra, coding theory, number theory.

Doreen De Leon, Ph.D., UCLA.
Areas of research: numerical analysis, applied mathematics.

Comlan de Souza, Ph.D., Southern Illinois University.
Areas of research: Fourier analysis, digital signal processing, phase recovery.

Della C. Duncan, Ph.D., Arizona State University.
Areas of research: manifold theory, differential geometry.

Tamas Forgacs, Ph.D., University of Illinois.
Areas of research: several complex variables, differential geometry, health economics, mathematical economics.

Ernesto Franco, Ph.D., University of California, Berkeley.
Areas of research: dynamical systems.

Katherine Kelm, Ph.D., University of Oregon.
Areas of research: algebraic topology, low-dimensional homotopy, CW complexes.

Maria Nogin, Ph.D., University of Rochester.
Areas of research: algebraic topology, cohomology of groups, group extensions; cohomology ring of a group extension; maps of free groups; dynamical topological logics, topological semantics of modal logics.

Adnan Sabuwala, Ph.D., University of Florida.
Areas of research: numerical analysis, numerical finite difference techniques, spectrally matched grids.

Peter Tannenbaum, Ph.D., University of California, Santa Barbara.
Areas of research: combinatorics, error correcting codes, probability theory.

Agnes Tuska, Ph.D., Ohio State University.
Areas of research: use of technology in mathematics education, concept formation, secondary mathematics teacher education.

Oscar Vega, Ph.D., University of Iowa.
Areas of research: algebra translation planes, finite geometries, combinatorics.

Ke Wu, Ph.D., Texas Tech University.
Areas of research: applied statistics, statistical and mathematical computing.

Master of Arts in Mathematics: Traditional Track

Course Requirements

Under the direction of the Graduate Coordinator, each candidate prepares and submits for approval a coherent program of 30 units individually designed within the following framework:

(1) Required courses (9 units):
- Math 251* (Abstract Algebra);
- Math 271 (Real Variables);
- Math 298 (Project).

(2) Elective courses (21 units):
a. At least 12 units (or 4 courses) of graduate level courses (i.e., courses in the 200 series); and
b. 9 units of approved electives (may be graduate level courses or up to 3 pre-approved upper division undergraduate math courses).

Qualifying Exams

It is required that you pass two qualifying exams before you are able to advance to candidacy (discussed below), both of which are offered each semester. These exams may be used to satisfy the University Graduate Writing Skills Requirement. The exams must be taken the first semester upon which you achieve classified standing, or as directed by the Graduate Coordinator. If either qualifying exam is not passed the first time, the exam that is failed must be taken again the following semester. If either qualifying exam is failed two times, you will be placed on academic probation and will be required to seek advisement regarding your status in the program. Please see the Mathematics Department Policy on Qualifying Exams in the Relevant Policies section in this handbook.

Advancement to Candidacy

You must advance to candidacy no later than the semester prior to graduation. It is recommended that you do this within the first 9 to 15 units of your program coursework (which should be completed by the end of the second semester).

To petition for advancement to candidacy you must have:

(1) earned a passing score on both of the Mathematics Department Qualifying Exams (see above for brief description, and the Syllabi for the Qualifying Exams later in this handbook);
(2) achieved classified graduate standing; and
(3) completed at least 9 units of your program at CSUF, maintaining a 3.0 grade point average.

* Please note that Math 251 will only be offered during the spring semester, while Math 271 will continue to be offered during the fall semester.

Once these conditions have been met, the candidate must meet with the Mathematics Graduate Coordinator and complete the "Petition of Advancement to Candidacy" form (to be downloaded from the Division of Graduate Studies' website, http://www.csufresno.edu/gradstudies) in order to apply for advancement to candidacy. The completed form must be submitted within the first six weeks of the semester (at least one semester prior to graduation).

Graduation

The last semester prior to graduation, the candidate must do the following:

(1) Enroll in Math 298. This course is the Master's Research Project that must be completed under the supervision of a faculty member. The course culminates in a written and oral report to the department.
(2) Within the first week, the candidate must file a request through the Division of Graduate Studies for the Master's degree to be granted by filling out and submitting a Graduate Degree Application, which can be obtained from the Division of Graduate Studies in person or on their website at http://www.csufresno.edu/gradstudies.

A set of guidelines for the Master's Project may be found in the Relevant Policies section of this handbook.

Please note that a period of 5 years is allowed for the completion of all requirements for the Master's degree; that is, no coursework older than 5 years may be used to satisfy the requirements.

Department Qualifying Exam Syllabi

Algebra Syllabus

Note: The exam consists of two sections (abstract algebra and linear algebra) with 8 questions per section. Students must answer 5 questions per section. The exam topics are normally covered in Math 151 and Math 152.

Topics: The student is expected to know at least the following topics. Although the list is reasonably comprehensive, it is just an indication of all topics that could be covered in the exam. It is the student's responsibility to prepare adequately for the exam.

Part I (Abstract Algebra):

1. equivalence relations;

2. basic properties of the *gcd* and *lcm* of two integers;

3. groups: both additive and multiplicative, Abelian and non-Abelian. Must know how to check a set (with an operation) is a group, examples and properties of well-known groups ($\mathbb{Z}_n$, D_n, S_n, A_n, Q_8, etc);

4. the order of a group, and of an element in a group; Lagrange's theorem, Euler's theorem;

5. cyclic groups;

6. permutation groups (S_n and A_n); multiplication, even and odd permutations;

7. subgroups: examples of well-known subgroups, checking for a set to be a subgroup of a given group, cosets of a subgroup, index of a subgroup;
8. normal subgroups and factor (quotient) groups;

9. group homomorphisms; kernel and image of a group homomorphism, isomorphisms;

10. first isomorphism theorem and corollaries (the other homomorphism theorems);

11. direct product/sum of groups;

12. rings: must know how to check a set, with two given operations, is a ring (note that for this exam all rings have a unity), examples and properties of well-known rings ($\mathbb{Z}$, $\mathbb{Z}_n$, polynomial rings, matrices, etc), invertible elements, zero-divisors;

13. $\mathbb{Z}$ and $\mathbb{Z}_n$; Chinese remainder theorem;

14. subrings; left, right and two-sided ideals;

15. ring homomorphisms; kernel and image of a ring homomorphism, isomorphisms;

16. basic properties of integral domains, division rings and fields.

Part II (Linear Algebra):

1. vector spaces over $\mathbb{R}$ and $\mathbb{C}$; know how to work with the basic examples of vector spaces: $\mathbb{R}_n$, $\mathbb{C}_n$, matrices, P_n, function spaces, etc.;

2. spanning sets, linearly independent sets, bases; change of basis; dimension;

3. linear transformations; must be able to find a matrix for a linear map in any given pair of bases;

4. kernel and range of a linear map; nullity and rank; dimension formula;

5. matrices: symmetric, diagonal, elementary, echelon form, upper/lower diagonal, block matrices, etc.; matrix algebra: inverses, transposes, etc.;

6. determinants; relation with the invertibility of a matrix;

7. how to solve systems of equations using elementary operations; know how homogeneous systems of equations yield subspaces;

8. eigenvalues (for this exam only real eigenvalues will be considered), eigenvectors, eigenspaces;

9. diagonalization of matrices, including with (maybe) repeated eigenvalues;

10. inner product spaces; Gram-Schmidt orthonormalization process.

Suggested References:

- *Contemporary Abstract Algebra* by Joseph A. Gallian
- *A First Course in Abstract Algebra* by John B. Fraleigh
- *Abstract Algebra* by I.N. Herstein
- *Abstract Algebra* by John Beachy and William Blair
- *A First Course in Abstract Algebra* by Joseph Rotman
- *Linear Algebra* by K. Hoffman and R. Kunze
- *Elementary Linear Algebra* by Ron Larson and David Falvo
- *Linear Algebra* by Steven J. Leon.
- *Elementary Linear Algebra* by David Kolman and Bernard Hill.

Analysis Syllabus

Note: The exam will consist of 12 questions. Students must answer 8 of these questions. The exam topics are normally covered in Math 77 and Math 171.

Topics: The student is expected to know at least the following topics. Although the list is reasonably comprehensive, it is just an indication of all topics that could be covered in the exam. It is the student's responsibility to prepare adequately for the exam.

1. natural numbers, the Archimedean Property;

2. rational numbers, rational zeros theorem, irrational numbers;

3. the real numbers, Completeness Axiom, density of the rational numbers in the real numbers;

4. sequences of real numbers, Cauchy sequences;

5. subsequences, the Bolzano-Weierstrass theorem;

6. infinite series, ratio and root tests, integral test, alternating series test;

7. limits of functions, continuity, uniform continuity;

8. Intermediate Value Theorem;

9. extension of functions, continuous extensions;

10. differentiability of a function of one real variable;

11. the Mean Value Theorem, the mean value theorem for derivatives;

12. L'Hospital's rule;

13. partitions, the Darboux/Riemann integral;

14. integrable functions, non-integrable functions of one real variable;

15. vectors, dot product, cross product and applications to area and volume calculations;

16. equations of lines, planes, normal lines, distances between lines/planes;

17. arc length, curvature;

18. functions of several variables;

19. continuity of functions of several variables;

20. partial and directional derivatives, the gradient of a function;

21. extreme value problems;

22. Lagrange multipliers and applications;

23. multiple integrals in Euclidean, polar, and spherical coordinates; area and volume calculations;

24. change of variables in multiple integrals;

25. vector fields, curl and divergence;

26. surface integrals;

27. Stokes' theorem;

28. line integrals;

29. Green's theorem;

30. Fundamental Theorem of Line Integrals.

Suggested References:

- *Elementary Analysis: The Theory of Calculus* by Kenneth A. Ross
- *An Introduction to Analysis* by William R. Wade
- *Introduction to Analysis* by Edward D. Gaughan
- *Real Analysis: A Constructive Approach* by Mark Bridger
- *Essential Calculus – Early Transcendentals* by J. Stewart (or any calculus book covering vector calculus)

Master of Arts in Mathematics: Teaching Option

The M.A. with a Teaching Option program is for both working secondary mathematics teachers and holders of a bachelor's degree in mathematics who plan to teach. The core curriculum is a combination of graduate level education and mathematics courses specifically designed to enhance the content understanding and advanced level thinking skills needed for leaders in high school mathematics education.

Course Requirements

Under the direction of the Graduate Coordinator, each candidate prepares and submits for approval a coherent program of 30 units individually designed within the following framework:

(1) Required courses (15 units):
- Math 250 (Perspectives in Algebra)
- Math 260 (Perspectives in Geometry)
- Math 270 (Perspectives in Analysis)
- Math 298 (Project)
- CI 250** (Advanced Curriculum Theory and Analysis)

(2) Elective Courses (15 units):
   a. Math Electives (12 units). A combination of upper division (no more than 9 units) and graduate level mathematics courses (i.e., 200 level courses) to be approved by the Mathematics Department Graduate Coordinator; and
   b. Education elective (3 units). Either CI 275 (Advanced Instructional Theories and Strategies)** or an approved CI 280T.

Advancement to Candidacy

You must advance to candidacy no later than the semester prior to graduation. It is recommended that you do this within the first 9 to 15 units of your program coursework (which should be completed by the end of the second semester).

To petition for advancement to candidacy you must have:

(1) earned a total passing score on the three mathematics subtests of the CSET (110, 111, and 112), which exams may also be used to satisfy the University Graduate Writing Skills requirement;
(2) achieved classified graduate standing; and
(3) completed at least 9 units of your program at CSUF, maintaining a 3.0 grade point average.

Once these conditions have been met, the candidate must meet with the Mathematics Graduate Coordinator and complete the "Petition of Advancement to Candidacy" form (to be downloaded from the Division of Graduate Studies' website, http://www.csufresno.edu/gradstudies) in order to apply for advancement to candidacy. The

** CI 250 is usually offered in the fall semester, and CI 275 is usually offered in the spring semester, so you should plan your schedule accordingly.

completed form must be submitted within the first six weeks of the semester (at least one semester prior to graduation).

Graduation

The last semester prior to graduation, the candidate must do the following:

(1) Enroll in Math 298. This course is the Master's Research Project that must be completed under the supervision of a faculty member. The course culminates in a written and oral report to the department.
(2) Within the first week, the candidate must file a request through the Division of Graduate Studies for the Master's degree to be granted by filling out and submitting a Graduate Degree Application, which can be obtained from the Division of Graduate Studies in person or on their website at http://www.csufresno.edu/gradstudies.

A set of guidelines for the Master's Project may be found in the Relevant Policies section of this handbook.

Please note that a period of 5 years is allowed for the completion of all requirements for the Master's degree; that is, no coursework older than 5 years may be used to satisfy the requirements.

Relevant Policies

MATHEMATICS DEPARTMENT POLICY ON QUALIFYING EXAMS

1. There are two qualifying exams, one in Algebra and one in Analysis.

2. Material to be covered for each exam can be obtained from the Mathematics Department office, the Department of Mathematics Graduate Studies Handbook, or the department website.

3. Students must take both qualifying exams the first semester that they reach classified status, or as directed by the Graduate Coordinator.

4. If either qualifying exam is not passed the first time, the exam that is failed must be taken again the following semester.

5. If either qualifying exam is failed two times, the student will be placed on academic probation and will be required to seek advisement regarding his/her status in the program.

6. Three members of the Department graduate committee shall grade each student's exam and deliberate on standards for passing/failing.

7. Results shall be made available to students by e-mail within one week after the qualifying exam has been administered. The student will be able to review their exams in the Department office with one of the three graders. In addition, solutions to the exam (and past exams) can be found online.

8. The qualifying exams will be given on the first two Saturdays of each semester after instruction begins. Only one of the two exams will be offered on a given Saturday.

POLICY ON ACADEMIC PROBATION AND DISQUALIFICATION
Department of Mathematics

According to University policy, a graduate student is immediately disqualified from the University and program when his/her grade point average (GPA) falls below 2.0 in any semester. A student whose GPA falls below 3.0, but is above 2.0, is placed on academic probation. A student who is placed on academic probation for any two semesters (not necessarily consecutive) will be disqualified from the University and program. A disqualified student who wishes to re-enroll in the university and program MUST file a Petition for Readmission with the Mathematics Department.

The relevant GPA to determine standing is the cumulative GPA for graduate students who have not been advanced to candidacy. The program GPA determines the standing of graduate students who have been advanced to candidacy with an approved program on file.

Upon notification of disqualification, the student must make an appointment to meet with the Graduate Coordinator to discuss his/her situation and determine if any extenuating circumstances exist that mitigate the disqualification. If disqualification applies, the student must prepare and file the Petition for Readmission packet, as outlined below, with the Graduate Coordinator.

If disqualification applies, students should file their petition as soon as they receive notification of disqualified status if they want to request to be readmitted in the next semester.

The petition packet must include:

- the Petition for Readmission (form found on the Division of Graduate Studies website);
- a 1-page typed letter of appeal explaining the circumstances that affected the GPA;
- supporting documentation of any extenuating circumstances; and
- strong letters of support from at least 2 graduate program instructors who know the student's work (in sealed envelopes).

The Graduate Coordinator will distribute the petition materials to members of the Department Graduate Committee. Petitions that are filed by the first day of the fall or spring semester will be reviewed at a special meeting of the Graduate Committee scheduled for this purpose during the first week of classes to make it feasible for a student to be reinstated if the petition is approved. If there has been no break in enrollment, no application to the university is required. Petitions submitted after the first day of the semester will be reviewed at least two weeks before the application deadline for the following semester.

The Department Graduate Committee is responsible for making the recommendation on whether a student will be approved or denied for readmission. The Graduate Coordinator will send a decision letter to the student; if readmission is approved, any conditions are specified in this letter. The original petition, signed by the Graduate Coordinator, is submitted to the University Registrar's office with copies to Graduate Admissions and Division of Graduate Studies. A copy of the decision letter, specifying any conditions, is also sent to the Division of Graduate Studies.

The Graduate Coordinator will monitor disqualified readmitted students to ensure that they meet the conditions that they are expected to meet. In addition to specific conditions set by the program in its decision letter, a readmitted disqualified student must meet the University Graduate Committee requirement of earning a term GPA of at least 3.5 in each subsequent term until he/she attains a cumulative GPA of 3.0 (good standing) to

avoid disqualification in the following semester(s). (The University Graduate Committee suggests that readmitted disqualified students generally not take new 200-level courses; they may, however, repeat 200-level courses that they did not pass. Note that graduate students are not eligible for grade substitutions. In addition, no more than 9 units a semester should be attempted. However, the plan/conditions are determined by the Department Graduate Committee.)

A graduate student may appeal the decision of the Department Graduate Committee (e.g., denial of the Petition for Readmission or the conditions of readmission) in writing to the Chair of the Department of Mathematics. This letter should be included in a packet containing the documents provided in the Petition for Readmission. If necessary, further appeals may be made to higher administrative levels in the following sequence after review at each level: Dean of the College of Science and Mathematics, Dean of Graduate Studies, Provost of the University.

Note: Per University policy, disqualified graduate students who choose not to petition for readmission, leave the university, and at some later point, re-apply to Fresno State, will be denied admission based on the disqualification. Such a student must file a Petition for Readmission and should not pursue the "Special Admission" process.

GUIDELINES FOR MASTER'S PROJECT IN MATHEMATICS

The master's research project in mathematics should represent independent investigation of a topic of an advanced nature, including a written project report and an oral presentation.

For the Traditional Track, the master's project should represent independent investigation of a topic in advanced mathematics that is not covered in a standard course. For the Teaching Option, the project should represent independent investigation into either mathematics education or a topic in advanced mathematics that is not covered in a standard course.

Before beginning work on a master's project, the student must form a project committee, in consultation with the Graduate Coordinator and the Project Advisor, consisting of the Project Advisor and two additional faculty members, at least one of whom must be a mathematics department faculty member. The Graduate Coordinator must approve of this committee, and be informed in writing of the nature of the project, before the student enrolls in Math 298.

The Project committee must be kept apprised of the student's progress on the project, including:

1. Being given a description of the nature of the project within the first two weeks of the commencement of the project.
2. Being updated at least (a) at the middle of the semester, and (b) three-quarters of the way through the semester, regarding the student's progress on the project. These updates may be accomplished by providing the committee with a current draft of the written project report or an oral report or presentation.
3. Being given a final draft of the written report (unbound) for review at least one week before the oral presentation.

If the majority of the Project committee members does not approve the project after reviewing the final report due to significant deficiencies, then the student will not be permitted to present his/her project and, thus, will not be able to graduate in the current semester. The committee will provide the student with a list of the deficiencies of his/her project which must be corrected to make the student's project acceptable, and, once these revisions are made, the project will be re-evaluated.

The written report should follow these guidelines:

- The final version (unbound) of the written report must be submitted to the Project committee and the Graduate Coordinator for review at least one week before the oral presentation.
- Three bound copies of the report must be prepared and submitted to the Graduate Coordinator at the time of the oral presentation.
- The bound copies of the written report must contain a signature page that is signed by all three members of the Project committee.
- The format of the title page of the project report and the signature page must be obtained from the Graduate Coordinator.
- The report should be self-contained and understandable to anyone with an advanced mathematical background.
- The report must represent your own, independent work. Plagiarism will not be tolerated.
- The written report must be typeset and double-spaced.
- A well-written report will contain
    - a title page,

- the signature page;
- an abstract;
- a table of contents,
- an introduction,
- a main body,
- a conclusion, and
- a bibliography.

The oral presentation must:

- be approximately a 45 minute presentation that clearly summarizes the project or research done, followed by a question and answer session; and
- demonstrate a thorough understanding of the researched topic.

Graduate Courses

Mathematics Courses

MATH 202. Fundamental Concepts of Mathematics (3)
Prerequisites: MATH 151, 161 and 171. Fundamental notions regarding number theory, number systems, algebra of number fields; functions.

MATH 216T. Topics in Number Theory (3; max total 6)
Prerequisite: MATH 116. An investigation of topics having either historical or current research interest in the field of number theory.

MATH 223. Principles and Techniques of Applied Mathematics (3)
Prerequisite: graduate standing or permission of instructor. Linear spaces and spectral theory of operators.

MATH 228. Functions of a Complex Variable (3)
Prerequisite: MATH 128. Representation theorems of Weierstrass and Mittag-Leffler, normal families, conformal mapping and Riemann mapping theorem, analytic continuation, Dirichlet problem.

MATH 232. Mathematical Models with Technology (3)
Prerequisite: graduate standing in mathematics or permission of instructor. A technology-assisted study of the mathematics used to model phenomena in statistics, natural science, and engineering.

MATH 250. Perspectives in Algebra (3)
Prerequisite: graduate standing in mathematics or permission of instructor. Study of advanced topics in algebra, providing a higher perspective to concepts in the high school curriculum. Topics selected from, but not limited to, groups, rings, fields, and vector spaces.

MATH 251. Abstract Algebra I (3)
Prerequisite: undergraduate abstract algebra. Groups, rings, integral domains, and fields.

MATH 252. Abstract Algebra II (3)
Prerequisite: MATH 251. Rings and ideals, modules, linear and multilinear algebras, representations.

MATH 260. Perspectives in Geometry (3)
Prerequisite: graduate standing in mathematics or permission of instructor. Geometry from a transformations point of view. Euclidean and noneuclidean geometries in two and three dimensions. Problem solving and proofs using transformations. Topics chosen to be relevant to geometrical concepts in the high school curriculum.

MATH 263. Point Set Topology (3)
Prerequisite: MATH 172. Basic concepts of point set topology, set theory, topological spaces, continuous functions; connectivity, compactness and separation properties of spaces. Topics selected from function spaces, metrization, dimension theory.

MATH 270. Perspectives in Analysis (3)

Prerequisite: graduate standing in mathematics or permission of instructor. An overview of the development of mathematical analysis, both real and complex. Emphasizes interrelation of the various areas of study , the use of technology, and relevance to the high school mathematics curriculum.

MATH 271. Real Variables (3)

Prerequisite: MATH 172. Theory of sets; cardinals; ordinals; function spaces, linear spaces; measure theory; modern theory of integration and differentiation.

MATH 290. Independent Study (1-3; max total 6)

See Academic Placement -- Independent Study. Approved for RP grading.

MATH 291T. Seminar (1-3; max total 6)

Prerequisite: graduate standing. Seminar covering special topics in an area of mathematical research. (Formerly MATH 291)

MATH 298. Research Project in Mathematics (3)

Prerequisite: graduate standing. Independent investigation of advanced character as the culminating requirement for the master's degree. Approved for RP grading. Requirements for project.

Curriculum and Instruction Courses

CI 250. Advanced Curriculum Theory and Analysis (3)

Theory and practice of curriculum development, evaluation, and revision. Study of contemporary problems and curriculum approaches to meet societal needs. (2 lecture, 2 lab hours)

CI 275. Advanced Instructional Theories and Strategies (3)

Study and application of contemporary research and theory in teaching and instruction.