Graduate Student Handbook

For Masters and Doctoral Students in the

Mathematical Sciences

THIS COPY BELONGS TO:

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DEPARTMENT OF MATHEMATICAL SCIENCES

KENT STATE UNIVERSITY · P.O. BOX 5190 · KENT, OH 44242 · www.kent.edu/math

Updated Fall 2014

I. MASTER OF ARTS (M.A.) AND MASTER OF SCIENCE (M.S.) DEGREE REQUIREMENTS

The Department of Mathematics offers courses and research leading to the degrees of Master of Arts and Master of Science in the following areas:

-Pure Mathematics Program

-Applied Mathematics Program

-Mathematics for Secondary Teachers Program (M.A. only)

A. Pure Mathematics Program

This program is intended for those students who wish to obtain a broad background in graduate mathematics. In particular, it is recommended for those students who may eventually pursue a Ph.D. in mathematics.

At least two of the following sequences must be completed and at least one semester of one of the remaining sequences must be taken.

- MATH 61051-61052 (Abstract Algebra I, II)
- MATH 62051-62052 (Functions of a Real Variable I, II)
- MATH 62151-62152 (Functions of a Complex Variable I, II)
- MATH 66051-66052 (Introduction to Topology I, II)

The M.A. or M.S. degree in Pure Mathematics requires a total of 32 semester hours of graduate coursework, with at least 16 semester hours at the 60000-level. In addition to the requirements listed above, the program requires another ten credits of approved elective graduate-level MATH courses; with prior approval of the Graduate Studies Committee a maximum of six hours may be taken in other departments.

Students must submit a detailed plan of study for approval by their adviser by the time the first 16 semester hours of graduate coursework have been completed.

Candidates for the M.S. degree in Mathematics must write a suitable thesis for which six semester hours of credit are earned. These candidates must show satisfactory performance on a final oral examination covering their thesis topic.

Candidates for the M.A. degree in Pure Mathematics must pass the departmental Qualifying Examination at the master's level. For these candidates this examination will cover the following areas:

- Algebra
- Analysis (Real and Complex).

B. Applied Mathematics Program

This program is intended for those students who wish to pursue a professional graduate program in applied mathematics.
At least two of the following sequences must be completed:

- MATH 62041-64042 (Methods of Applied Mathematics I, II)
- MATH 60051-60052 (Probability I, II)
- MATH 62251-62252 (Numerical Analysis I, II)
- MATH 60061-60062 (Mathematical Statistics I, II)

The M.A. or M.S. degree in Applied Mathematics requires a total of 32 semester hours of graduate coursework. At least 18 of these semester hours must be in MATH courses at the 60000-level or above. The remaining 14 semester hours may be taken from graduate-level coursework in MATH; with prior approval of the Graduate Studies Committee a maximum of six hours may be taken in other departments.

With permission of the adviser, up to 12 semester hours of 50000-level MATH and/or CS courses may be applied toward the total 32-semester hours degree requirement. Candidates who do not have an undergraduate degree in Applied Mathematics should include MATH 52201-52202 (Introduction to Numerical Computing I & II), MATH 50011 (Introduction to Probability Theory and Applications) and MATH 50012 (Introduction to Statistical Concepts) in their program.

Students must submit a detailed plan of study for approval by their adviser by the time the first 16 semester hours of graduate coursework have been completed.

Candidates for the M.S. degree in Applied Mathematics must write and defend a suitable thesis for which six semester hours of credit are earned (only three of these hours will be counted toward the required 18 credits at the 60000-level or above). These candidates must show satisfactory performance on a final oral examination covering their graduate coursework and thesis topic.

M.A. degree candidates in Applied Mathematics must pass the departmental Qualifying Examination at the master's level. These candidates should choose two out of four offered Qualifying Exams:

- Methods of Applied Mathematics
- Numerical Analysis
- Probability
- Statistics

While students entering the Master's Program in Applied Mathematics are not required to have an undergraduate degree in applied mathematics, they are expected to have proficiency in numerical analysis, probability and statistics at the level of MATH 42202 (Introduction to Numerical Computing II), Math 40011 (Introduction to Probability Theory and Applications) and MATH 40012 (Introduction to Statistical Concepts). They are also expected to have taken computer science

course work equivalent to CS 13001 (CS I: Programming and Problem Solving) and CS 23001 (CS II: Data Structures and Abstraction).

C. Mathematics for Secondary Teachers Program (M.A. only)

This program is intended for those students who are certified in the secondary teaching of mathematics and who will normally have at least one year of teaching experience prior to the completion of the degree.

This highly individualized program has no rigid course requirements. Students' programs are designed by an Advisery Committee consisting of members of the Department of Mathematical Sciences and Secondary Education. The committee tries to tailor the coursework to meet each individual student's needs. Through an initial interview, the Advisery Committee helps the student clarify his or her educational objectives and helps to formulate a graduate program that reflects a balance among professional needs, academic training, and related outside interests.

The program consists of 32 semester hours of approved graduate courses, at least 16 of which will be at the 60000-level and 22 of which will be in Mathematics. Students will be expected to take two to three courses in each of the areas of:

- Modern Algebra
- Geometry
- Analysis

Some additional exposure to applied mathematics and current trends in teaching will also be required.

Candidates in this program are expected to pass a final examination in general mathematics.

D. NOTIFICATION OF APPROVED THESIS TOPIC

A "Notification of Approved Thesis Topic" form is to be completed, signed, and filed with the College of Arts and Sciences Graduate office (with a copy given to the Coordinator of Graduate Studies) prior to proceeding with research on the proposed thesis.

II. DOCTOR OF PHILOSOPHY (Ph.D.) REQUIREMENTS

This degree requires a minimum of 60 semester hours beyond the master's degree. Although there are no specific courses that are required for the Ph.D. degree, the breadth of coursework is ensured by the Qualifying Examination, which the student must pass at the doctoral level. (See Section III (B)).

By taking advanced courses and, perhaps, participating in seminars, the student chooses an area of specialization for the dissertation research. This also includes the choosing of an adviser. In establishing this relationship, it is the student's responsibility to ask the professor if he or she is willing and able, at that time, to take on the role of Dissertation Adviser.

The next requirement after the Qualifying Examination is the Candidacy Examination. The purpose of this examination is to ascertain that the student has the background knowledge that will be needed to do research in the proposed area. (See Section III(C)). It must be taken no later than nine months before the date that the student expects to receive the Ph.D. degree. When the Candidacy Examination has been passed, the Coordinator of Graduate Studies forwards this information to the College of Arts and Sciences Graduate office and the student becomes a "doctoral candidate".

Each doctoral candidate must continuously register for 15 credits of Dissertation I until 30 credits are accrued. Upon completion of 30 credits of Dissertation I, a doctoral candidate will continue registration in Dissertation II, each semester including summer, until all the requirements for the degree have been met.

Guidelines for the final writing of the dissertation are found in a Style Guide And Instructions for Typing Theses and Dissertations, which is available from Graduate Studies. We also have an online checklist, which is included in the Style Guide. In addition, the American Mathematical Society publishes a booklet titled, "A Manual for Authors of Mathematical Papers". Copies are available within the Department. The adviser is another source -- perhaps the most important one -- of help for students in their first effort at mathematical exposition.

A doctoral candidate is required to file an "Application for Graduation" with the College of Arts and Sciences Graduate Office at least three months prior to commencement. (See the current Graduate Bulletin for the exact date for any given year.) There is a Graduation Fee plus a Dissertation Fee, which covers the cost of processing and binding two copies for the University Library.

III. GENERAL EXAMINATIONS

A. M.S., and "M.A. for Secondary Teachers"

A student selecting a Master of Science program must write a suitable thesis, for which six semester hours of graduate credit are earned, and defend this thesis at a final oral examination. Students in the Master of Arts for Secondary Teachers Program must take a final examination on the courses they are presenting for the degree.

B. Qualifying Examination

Students working in the Master of Arts Program in Pure Mathematics or Applied Mathematics, and students who wish to pursue the Ph.D. in mathematics must take the Qualifying Examination. Students interested in undertaking a Ph.D. are reminded that the Qualifying Examination constitutes only a breadth requirement in certain core areas. Subsequent to passing the Qualifying Examination, such students must undertake suitable courses in special areas related to their proposed dissertation topic in order to obtain a dissertation adviser. These specialized courses will also contribute to the knowledge necessary to undertake the Candidacy Examination.

In general, the Qualifying Examination in pure mathematics will cover the following areas:

- Algebra
- Analysis (Real and Complex)

The Qualifying Examination applied mathematics will cover two of the following areas:

- Methods of Applied Mathematics
- Numerical Analysis
- Probability
- Statistics

The areas over which a student is tested are to be chosen by the student with the approval of the Graduate Studies Committee. In certain cases, for students who intend to terminate their graduate work at the master's level, additional choices may be allowed, if deemed appropriate by the Graduate Studies Committee.

The student's Examination Committee will consist of five persons: the Coordinator of Graduate Studies and two faculty members from each area. The examination will generally be taken from the topic outlines for each area (See Section VII). Each of the parts of the Qualifying Examination will be judged by two committee members representing the respective area. They will indicate their evaluation by rating the performance on a scale of 0-100.

A full-time student entering a non-thesis master's degree program is expected to take the Qualifying Examination prior to the end of the student's second calendar year at Kent State University. A full-time student entering a Ph.D. program is expected to take the Qualifying Examination prior to the end of the student's first calendar year in the Ph.D. program. Timetables for part-time students or students who transfer graduate credit from another institution will be set in consultation with the Coordinator of Graduate Studies. When an extension of this deadline seems to be necessary, both the student and the student's academic adviser must petition, in writing, the Coordinator of Graduate Studies. Extensions will only be granted by the Coordinator of Graduate Studies in consultation with the Graduate Studies Committee. A student is permitted only two attempts to pass the Qualifying Examination.

<u>Passing The Mathematics Qualifying Examination</u>

In order to obtain an M.A. degree in Mathematics, a student is required to pass the qualifying exam at the Master's level. This means that the student must:

1. Obtain a total rating of at least 100 and a score no lower than the minimum rating of 50 in each exam, or
2. Obtain a total rating of at least 80 and a score no lower than the minimum rating of 40 in each field, and a majority vote in favor of passing by his/her Examination Committee for the final examination taken.

Students who wish to pursue the PhD in Mathematics must pass the qualifying exam at PhD level. This means that the student must:

1. Obtain a total rating of at least 140 and a score no lower than the minimum rating of 60 in each field, or
2. Obtain a total rating of at least 120 and a score no lower than the minimum rating of 50 in each field, and a majority vote in favor of passing by his/her Examination Committee for the final examination taken.

C. Candidacy Examination

Students who have passed the Qualifying Examination at the Ph.D. level are expected to continue to broaden their general mathematical background and to take courses in their areas of special interest. Before starting substantial work on a dissertation, the student is required to take the Candidacy Examination. This examination will be a comprehensive examination in the field of the major subject, and will be a substantially deeper test than the Qualifying Examination. The format of the Candidacy Examination will be determined by the student's Candidacy Examination Committee, which consists of a faculty member who has consented to act as a potential dissertation adviser for the student, plus two additional faculty members from the student's general research interest area. The Candidacy Examination Committee must be approved by the Graduate Studies Committee. The Graduate Studies Committee will use the recommendation of the Candidacy Examination Committee to determine if the student will be admitted to candidacy for the PhD. The Candidacy Examination must be passed no later than nine months before the Ph.D. is awarded in order to ensure that the student satisfies the University requirement of earning 30 credits of Dissertation I after the Candidacy Examination has been passed.
It is expected that a full-time graduate student entering the graduate program with a bachelor's degree will normally pass the Candidacy Examination prior to the end of the student's fourth calendar year at Kent State University. A full-time graduate student entering the Ph.D. program with a master's degree is normally expected to pass the Candidacy Examination prior to the end of the student's third calendar year at Kent State University. Timetables for part-time students or students who transfer graduate credit from another institution will be set in consultation with the Coordinator of Graduate Studies. When an extension of this deadline seems to be necessary, both the student and the student's academic adviser must petition, in writing, the Coordinator of Graduate Studies. Extensions will only be granted by the Coordinator of Graduate Studies in consultation with the Graduate Studies Committee.

D. Dissertation Topic and Prospectus

All students writing a dissertation are required to file a "Notification of Approved Dissertation Topic and Prospectus" form which is to be signed by members of the Dissertation Committee and submitted to the College of Arts and Sciences Graduate office with a copy for the Coordinator of Graduate Studies. The dissertation prospectus normally includes an outline of the parameters of a projected dissertation topic, indicating a clear statement of the problem to be undertaken, the procedure or methodology to be used in the research, a preliminary review of the literature

substantiating the need for the study, and where appropriate, a discussion of the principal sources for acquiring information. Affirmation of completion of the prospectus will be contained in the "Dissertation Topic Approval" form. Each member of the Dissertation Committee will be required to approve the prospectus and indicate such approval on the "Dissertation Topic Approval" form.

E. Dissertation and Final Examination

Two separate committees will be involved with the progress, completion, and examination of the doctoral candidate's dissertation. These are

1. The Dissertation Committee, and
2. The Examining Committee

(1) THE DISSERTATION COMMITTEE: This committee is composed of graduate faculty members and is appointed by the candidate's department when the candidate has developed an appropriate dissertation topic and has an approved adviser. This committee will consist of a minimum of:

- The adviser, who will act as Chairman of the Committee.
- Two additional members from the candidate's department.
- One faculty member from a discipline outside the department.

The adviser and at least two of the remaining three must be members of the Graduate Faculty who have been approved to direct dissertations. (List available from the Division of Research and Graduate Studies.) If a co-adviser is desired, he or she should be included in the above members. If, for warranted reasons, it is desirable to have a person on the committee who does not meet the above qualifications, special permission must be obtained from the Office of Graduate Affairs. When the Dissertation Committee has been formed, a "Notification of Dissertation Topic" form should be filed in the Division, with a copy for the Coordinator of Graduate Studies.
Responsibilities of the Dissertation Committee: This committee is responsible for the progress of the candidate's dissertation and will keep in touch with his or her research. When the adviser believes the dissertation is ready for preliminary approval, it will be circulated in easily legible form among the members of the Committee. At the time that the entire dissertation is first circulated to the Dissertation Committee, the College of Arts and Sciences Graduate office must be notified to request the appointment of the Graduate Faculty Representative to serve on the Examining Committee.
The adviser will allow a minimum of a ten-day period for reading of the dissertation and will then convene the Dissertation Committee (without the candidate) for the purpose of evaluating it. The Graduate Faculty Representative should be notified of this meeting and invited to attend. Recommended revisions will be noted by the adviser and communicated to the candidate, and when, in the opinion of the adviser and the candidate, the appropriate revisions have been made, the adviser will inform the department and the Division of Research and Graduate Studies.

(2) THE EXAMINING COMMITTEE: The Examining Committee will consist of the Dissertation Committee (at least four persons, as previously defined) plus the Moderator and a Graduate Faculty Representative.
The Moderator: The Moderator will be selected by the College of Arts and Sciences Graduate office from the members of the Graduate Faculty. (List available from the Division of Research and Graduate Studies.) He or she will not be a faculty member in the department of the candidate's major.
Duties of the Moderator: The principal duties of the Moderator are to preside and to moderate. He or she should see to it that all participants act in a civilized, polite, and proper manner. He or she should be familiar with the procedures of the Oral Defense, and he or she has the authority to suspend the examination should a situation arise which would not be conducive to a fair examination.
Graduate Faculty Representative: The Representative of the Graduate Faculty will be appointed by the Division of Research and Graduate Studies after consultation, when appropriate, with the adviser or department chairperson. To qualify, he or she must have directed a dissertation to completion. (List available from the Division of Research and Graduate Studies.) The Representative may be a member of the candidate's department and is expected to be familiar with the general content area of the dissertation.
Duties of the Graduate Faculty Representative: This person represents the Graduate Faculty by noting whether or not the nature of the questioning and of the responses meets highly respectable scholarly standards. If he or she has some reservations in regard to this, the reservations should be presented immediately to the Division of Research and Graduate Studies. The Graduate Faculty Representative is expected to question the candidate and to vote on the passing of the Final Examination.

F. The Final Oral Defense:

The Adviser will designate the time and place of the Final Oral Defense and notify all members of the Examining Committee. The Oral Defense is open to any member of the University wishing to attend, and therefore, a facility adequate to meet this requirement should be provided. The Oral Defense should be scheduled to allow a minimum of ten days for all of the Examining Committee to look over the dissertation. In the absence of the Dissertation Adviser, the Oral Defense may not be held. If it is a matter of long-term absence or enduring illness of the Adviser, the Chairperson of the department, in consultation with the appropriate administrator, should make appropriate arrangements for a substitute.
The dissertation must be in final form (not merely a late draft, but also, not necessarily the final typed copy) prior to the Final Oral Defense. If, in the opinion of more than one member of the Examining Committee, the dissertation is not in acceptable final form, the Oral Defense will not be held. This is to be determined by vote prior to the Final Oral Defense and without the candidate or others being present. If a negative vote occurs, the candidate may be called in to provide clarification. Acceptable form refers to the substance and usefulness of the dissertation, as well as the quality of the writing. However, it is permissible to number pages in pencil in order to reduce the cost of possible final changes, which may grow out of the Oral Defense.

A rescheduling of the Oral Defense, if necessary, will occur when, in the opinion of the Adviser and the candidate, the dissertation has been modified to incorporate the suggested changes. The dissertation must be acceptable, with no more than one dissenting vote, before the rescheduled Final Oral Defense can be held. If the dissertation is not in suitable form at this second scheduled Final Oral Defense, the Division of Research and Graduate Studies will be so notified. Further action then becomes the responsibility of the Division.

The Final Oral Defense will be open to the University community. Notification of the time and place of the Oral Defense should be provided to the Division of Research and Graduate Studies so that it may be announced in a suitable publication. Copies of the abstract of the dissertation should be available in the candidate's department and the Division prior to the Oral Defense, and at the Oral Defense, itself, to familiarize members of the Graduate Faculty with the methodology and findings.

The candidate will open the Oral Defense with a brief presentation of his or her findings, after which the members of the Examining Committee will question the candidate in an order to be determined by the Moderator. When, in the opinion of the Moderator, members of the Examining Committee have had an adequate opportunity to question the candidate, the Moderator may open the examination to appropriate questions from others present.

Questions dealing with the substance, meaning, and usefulness of the research in the dissertation are of greatest propriety. Questions or comments dealing with punctuation or grammatical minutiae, spelling, etc., are out of order; such comments should be written out and privately submitted to the Adviser.

If, in the opinion of the Moderator or upon motion duly passed by a majority of the Committee, it is deemed desirable to discontinue the Oral Defense, the Moderator may recess the Oral Defense until a time mutually agreeable to the Moderator, the Adviser, the candidate, and the Division of Research and Graduate Studies. When the questioning has run its course, the Moderator will adjourn the Oral Defense, and the room will be cleared of everyone except the members of the Examining Committee. Parliamentary procedure will be observed to determine the success or failure of the candidate, with the Moderator acting as chairman without a vote.

The candidate should be evaluated both (a) upon the overall quality and significance of his or her dissertation, and (b) upon the oral defense of his or her findings.

A candidate passes the Oral Defense if he or she passes with no more than one dissenting vote. All members of the Examining Committee (except the Moderator) will sign the "Report of Final Examination" form, recording their votes. Committee members may vote "yes" or "no", but they may not abstain.

The Moderator and Department Chairperson must sign the "Report of Final Examination" form, which is then forwarded to the Division of Research and Graduate Studies with a copy given to the Coordinator of Graduate Studies.

G. Dissertation (Filing of Dissertation for Graduation)

All students writing a dissertation must file two copies of the dissertation with the Office of Graduate Affairs according to the deadlines listed in the current catalog. Each dissertation must be typed according to the guidelines in the current "Style Guide and Instructions for Typing Theses and Dissertations." Copies of the "Guide" are available from the Office of Graduate Affairs.

When the student is satisfied with the final preparation of his or her dissertation, he or she will need to file the "Dissertation Preparation Approval" form and the final copies of the dissertation in the Graduate Studies office. Submission of the student's dissertation must be by the published deadline. Deadline dates may be obtained from the Office of Graduate Affairs.

IV. GRADUATE APPOINTMENTS

A. Categories of Appointments

In the Department of Mathematical Sciences, there are three types of service appointments and two non-service appointments:

- GRADUATE ASSISTANT - Available to both doctoral and master's students, these appointments carry a stipend that is paid for teaching, grading, tutoring or systems work.
- RESEARCH ASSISTANT - This type of appointment is supported by a research grant from an extramural source (government or industry). The duties consist of assisting in the research of the graduate faculty member who is the principal investigator. The stipend is the same as that of a graduate assistant.
- TEACHING FELLOW - This is available to students who hold a master's degree and who are known to be effective and reliable teachers. The stipend is the same as that of a doctoral-level graduate assistant.
- UNIVERSITY FELLOW - The Department has one such appointment for full-time study with no service obligation. A University Fellow must be a doctoral student who is working on his or her dissertation.
- TUITION SCHOLAR - Tuition scholarships, covering tuition and fees, may be given to a limited number of graduate students. Registration in 8-15 graduate credits of mathematics or computer science courses each semester is required (also, see (J)).

B. Residency Requirement

Graduate appointees may fulfill residency requirements for degrees in one of the following ways:
-Master's degree students will automatically meet residency requirements by complying with course load requirements for graduate appointees. Doctoral students will meet residency requirements:

- in the normal way by enrolling for at least 11 hours in each of two successive semesters prior to being admitted to candidacy.
- by successfully completing 22 semester hours over three successive semesters. The Summer Session (ten weeks) may be one of the three semesters.

C. Time Limits

All students admitted to the College of Arts and Sciences are subject to time limits for completion of their degree. Time limits are listed under the appropriate headings in the Graduate Catalog. For example, a master's degree must be completed within six years, and the doctoral degree must be completed within ten years.
Students may request, in writing, an extension of one year over the listed time limits. Such requests should be sent to the Coordinator of Graduate Studies. Departments must notify the College of Arts and Sciences if such an extension is granted. Requests of more than one year over the time limit must be approved by the Office of Graduate Affairs.

D. 139/173 -Hour Rule

Students who have entered graduate study at Kent with a master's degree from another institution and who have completed 139 Kent State University semester hours are no longer eligible for graduate appointment support, including graduate assistantships, teaching fellowships, research assistantships, and University Fellowships. Students who have entered graduate study at Kent without a master's degree from another institution and who have achieved 173 Kent State University semester hours are no longer eligible for graduate appointment support. Tallying the total number of hours should include courses with letter grades, and courses with "grades" of Incomplete, In Progress, and Not Reported. Hours withdrawn do not count in this total.
A full-time program of study is eight to sixteen graduate-level credits per semester. Every student who uses University facilities and faculty expertise must be registered. Also, a student who has passed the Candidacy Examination is required to maintain continuous registration for Fall Semester, Spring Semester, and Summer Sessions until his or her degree is completed. A graduate student who has entered into doctoral candidacy and is within the University's maximum time limits for completion of the degree, may carry a program of one or more graduate-level credits involving research, under the direction of the candidate's dissertation adviser, and be considered as full-time.

E. Other Employment

Full-time service appointees MAY NOT accept any other paid employment within the University during the tenure of their appointments.

F. Course load Requirement

All graduate appointees must comply with course load requirements as follows:

- Full-time Appointment - at a range of 8 to 12 hours per semester.
- Half-time or Quarter-time Appointment at a range of 4 to 6 hours per semester.
  (A Quarter-time Appointee is one who devotes up to ten hours per week in service time and is not expected to have primary instructional responsibilities for courses).

There are sometimes temporary variations of these course loads for the Fall Semester; the Coordinator of Graduate Studies will advise the appointees of these changes, if any.

G. Regular Course Requirement

1. During each semester of the academic year, a master's-level graduate appointee is required to take at least two regular courses, excluding individual study, seminars, research, or College Teaching of Mathematics. Students registered for Thesis I or Thesis II can replace regular course hours by thesis hours. Exceptions must be approved by the Graduate Studies Committee or the Coordinator of Graduate Studies, prior to the student registering for the courses.
2. During each semester of the academic year, a doctoral-level appointee who has not achieved doctoral candidacy is required to take at least one regular course, excluding individual study, seminars, research, or College Teaching of Mathematics. Exceptions must be approved by the Graduate Studies Committee or the Coordinator of Graduate Studies, prior to the student registering for the courses.

H. Course in College Teaching of Mathematics

New graduate appointees should schedule MATH 60094/70094 during the Fall Semester of their first year. Students may earn as much as seven hours of credit in this course; however, only two credit hours may be applied to degree requirements.

I. Service Assignments

A graduate appointee holding a full-time appointment has a service requirement of 20 hours per week. This requirement may be satisfied by teaching, tutoring, grading, or computer systems work. The service assignment for each graduate appointee,

most of whom teach, is based on the needs of the Department. These needs may vary from semester to semester.
In general, graduate appointees will teach a teaching load of ten semester hours per academic year with a maximum of six hours in a single semester as part of their service requirement. A six-hour load will normally consist of two sections of the same three-hour course. Each semester hour assigned is expected to result in three hours of actual working time (preparation, instruction, grading) each week of the semester. University policy requires all instructors, including graduate appointees, to hold five office hours each week.
Most teaching assignments for graduate appointees are made in the following courses or closely related courses:

- MATH 10041 Elementary Probability and Statistics
- MATH 11008 Explorations in Modern Mathematics
- MATH 11009 Modeling Algebra
- MATH 11010 Algebra for Calculus
- MATH 11012 Intuitive Calculus
- MATH 11022 Trigonometry
- MATH 12001 Algebra and Trigonometry

An example of a standard combination of courses for new students would be one section of MATH 11010 in the Fall and Spring Semesters.
Typically, students will also be assigned to work as assistants in the Mathematics Emporium or in the Mathematics Scale-Up lab. These are large labs for teaching remedial mathematics or large sections of freshman courses in an interactive active learning environment. The student's role as an assistant in these labs is to help students with in-class assignments, and to assist with general course management, either in or out of the lab. For each hour per week assigned to one of the large labs, students are expected to work up to one and a half hours per week.
Graduate appointees, who do not teach, may be assigned tutoring duties of 20 hours per week. Alternatively, some graduate appointees satisfy the service requirement during a semester by grading one or two courses, depending on the level and nature of the course. A combination of tutoring and grading is also possible.

J. Tuition Scholarships

Tuition scholarships, covering tuition and fees, are given to graduate appointees. Tuition and fees for research assistants are covered by the particular research grant of the graduate faculty member who is the principal investigator, while tuition and fees for graduate assistants and teaching fellows are the responsibility of the departmental budget. A University Fellow's tuition and fees come out of the Division of Graduate Studies budget line. Tuition scholarships can also be awarded to students who do not carry a graduate assistantship.

K. Summer Support

Students who have been in the graduate program for one year are eligible for financial support during the summer sessions. Since the budget for this purpose is limited, preference is given to students who have passed the Qualifying Examination at the Ph.D. level. The purpose of summer support is to provide a means for graduate students to study on a twelve-month basis. Service requirements during the summer are minimal and usually consist of tutoring or grading. Research assistants and students who accept a summer graduate appointment involving a service requirement are required to be in residence during the entire time period over which their duties extend. Thus, students will not be released from their duties because of vacation plans. Students who need to be released from their duties for a short period of time due to academic reasons, such as attending a conference, should make a special request to the Coordinator of Graduate Studies.

L. Eligibility

All graduate appointees must be in good standing in the Office of Graduate Studies Affairs and be enrolled in a specific degree program. In particular, special non-degree students and those admitted on a conditional basis are not eligible to hold a graduate appointment.

V. SCHOLASTIC CONCERNS

A. Advising

Each graduate student's schedule of classes for each semester should be approved by the Graduate Studies Committee or by the student's adviser. This can be done by scheduling a short advising session in the preceding term with the Graduate Studies Committee.

B. Satisfactory Progress

Part of the advising procedure will include monitoring the student's academic progress, the quality of work, and progress toward meeting deadlines for taking required examinations. Graduate students are expected to maintain a 3.0 average in all work attempted at Kent State University. Failure to do so makes the student liable to dismissal. A graduate student who receives more than seven hours of "C" or lower grades, or more than four hours of grades lower than "C", is subject to dismissal. When the Department has determined that the number of "IP"'s or Incompletes on a student's record indicates poor progress toward completion of a degree, it may recommend dismissal of the student to the Office of Graduate Affairs. It may also recommend dismissal in those cases where the student has failed to meet deadlines with respect to taking the Qualifying Examination or the Candidacy Examination.

C. Graduate Student Grievance Procedures

1. A student who has a grievance concerning a graduate course must first contact the professor in charge of the course in order to try and resolve the dispute.
2. If the student is dissatisfied after Step 1, the student then contacts the Coordinator of Graduate Studies.
3. If the Coordinator of Graduate Studies is unable to reach a solution satisfactory to the student, the student will then contact the Chairperson of the Department.
4. If, after Step 3, the student's grievance still exists, the student will contact the Office of Graduate Affairs.
5. A graduate student who has a grievance concerning policy of the Department should start the grievance procedure at Step 2.

D. Schedule of Core Course Sequences

Since the enrollment in 60000/70000-level courses is small, some sequences are offered on an alternate year basis according to the following pattern:

In academic years where the Fall Semester is an...	
even-numbered year	**odd-numbered year**
Abstract Algebra I, II	Abstract Algebra I, II
Functions of a Real Variable I, II	Functions of a Real Variable I, II
Algebraic Number Theory/Analytic Number Theory	Introduction to Topology I, II
Functions of a Complex Variable II, I	Functions of a Complex Variable II, I
Probability I, II	Mathematical Statistics I, II
Structure of Rings & Algebras I, II	Adv. Group Theory/Character Theory
Numerical Analysis I, II	Methods of Applied Mathematics I, II
Numerical Solutions of Large Sparse Systems/Numerical Solutions of Nonlinear Systems	Numerical Solutions of ODE's/Numerical Solutions of PDE's
Selected Topics in Analysis	Selected Topics in Analysis

VI. MISCELLANEOUS

A. Departmental Facilities

Every graduate appointee will be assigned office space. An office is generally shared with several other graduate students.
Instructional related copying privileges are available to each graduate appointee. Copying of personal materials will be done at the student's cost. Copying facilities are available commercially, as well as at various offices of the Campus Printing Services, at a cost of roughly five cents per page.

B. Committees and Colloquia

One graduate student is elected each year by his or her peers to serve on the Graduate Student Council. Also, the departmental Undergraduate Studies Committee and the Graduate Studies Committee will ask a graduate student to serve on their committee.

The Department of Mathematical Science sponsors a series of colloquia during the academic year. These talks, covering many areas of mathematics, have several purposes: to acquaint the audience with the frontiers of research in a particular topic; to give an exposition of some problem, study, or topic of wide interest; or to give an historical perspective and/or survey of some problem, study, or topic of wide interest.

Graduate students benefit from the colloquium series by being exposed to mathematicians and computer scientists, from outside the University, who may be actively involved in problems or topics in which they are interested or have worked. In addition, graduate students will, in some colloquia, be exposed to topics of mathematics that are not emphasized within the Department. Thus, the colloquium series helps to reinforce and broaden the student's graduate education and experience. For these reasons, graduate student attendance at department colloquia is strongly urged.

C. Absence Policy

Any absence, which constitutes missing required lectures of registered courses, or results in a neglect or absence of assistantship duties, requires the student to notify the department. If a student is to be absent during a semester:

- There must be adviser approval. Adviser approval is to be obtained through the Graduate Assistant Absence Authorization Form.
- All absences must have approval from the Graduate Studies Committee.
- There must be a written plan of work to be carried out during the absence.
- There must be regular reports from the student, as well as the adviser, which give some evidence of progress, and evidence of regular communication with the adviser.
- Any missed duties must be made up appropriately before or after the absence.

VII. QUALIFYING EXAMINATION AREAS

The following information (topic outlines, suggested courses, recommended information) is to serve as a general guideline in helping students prepare for the area examinations. Copies of past examinations are available to students (see the Graduate Secretary) in order to further indicate topics for which they may be responsible.

A. ALGEBRA

Groups: Homomorphism theorems, permutation groups, automorphisms, finitely generated Abelian groups, products of groups, group actions, Sylow theorems, *p*-

groups, nilpotent groups, solvable groups, normal and subnormal series, Jordan-ölder Theorem, special subgroups (e.g., commutator subgroup, Frattini subgroup, etc.).
Rings: Matrix rings, polynomial rings, factor rings, endomorphism rings, rings of fractions, localization and local rings, prime ideals, maximal ideals, primary ideals, integral domains, Euclidean domains, principal ideal rings, unique factorization domains, Jacobson radical, chain conditions, modules, factor modules, irreducible modules, Artinian and Noetherian rings and modules, semisimplicity.
Fields: Algebraic extensions, algebraic closures, normal extensions and splitting fields, separable and purely inseparable extensions, theorem of the primitive element, Galois theory, finite fields, cyclotomic extensions, cyclic extensions, radical extensions and solvability by radicals, transcendental extensions.
Linear Algebra: Matrix theory, eigenvalues and eigenvectors, characteristic and minimal polynomials, diagonalization, canonical forms, linear transformations, vector spaces, bilinear forms, inner products, inner product spaces, duality, tensors.
Suggested Courses:

- MATH 61051 / 71051: Abstract Algebra I
- MATH 61052 / 71052: Abstract Algebra II

Suggested References:

- N. Jacobson, Lectures in Abstract Algebra, Vols. I, II, III, D. Van Nostrand Co.
- N. Jacobson, Basic Algebra I and II, Freeman.
- S. MacLane and G. Birkhoff, Algebra, Chelsea.
- T. Hungerford, Algebra, Springer-Verlag.
- S. Lang, Algebra, Addison-Wesley.
- M. Hall, The Theory of Groups, Macmillan.
- J. Rose, A Course on Group Theory, Cambridge University Press.
- J. Rotman, The Theory of Groups: An Introduction, Allyn and Bacon.
- E. Artin, Galois Theory, University of Notre Dame Press.
- Hoffman and Kunze, Linear Algebra, Prentice-Hall.

B. ANALYSIS – consisting of Complex and Real Variables

-COMPLEX VARIABLES
Preliminaries: Review of basic notions of complex numbers, Argand diagram, etc. Review of basic necessary topological properties of C.
Basic Complex Variables Theory: Including Cauchy-Riemann equations, power series, integral formulae and their applications, (e.g., maximum modulus theorem, Schwarz's lemma, etc.)
Singularities: Analytic continuation, residues, and applications, (e.g., Rouche's theorem, argument principle, etc.)
Additional Topics: Including infinite products and applications, Mobius transformations, conformal mapping.
Suggested Courses:

- MATH 62151 / 72151: Functions of a Complex Variable I
- MATH 62152 / 72152: Functions of a Complex Variable II

Suggested References:

- L. Ahlfors, Complex Analysis, McGraw Hill.
- J. Conway, Functions of One Complex Variable, Springer-Verlag.
- W. Rudin, Real and Complex Analysis, McGraw Hill.

-REAL VARIABLES

Preliminaries: The student is expected to be familiar with those topics normally covered in a one-year, senior-level course in analysis. These topics include: real and complex numbers and their properties, properties of the metric space R^n, continuity, differentiability, Riemann integration, Riemann-Stieljes integration, sequences and series of functions.

Set Theory: One-one functions, cardinal numbers, partial order, countability, Zorn's lemma.

Metric Spaces: Open and closed sets, convergent sequences, functions and continuity, semi-continuity, separable spaces, complete spaces, compact spaces, Baire category theorem.

Measure Spaces: Lebesgue outer measure, Borel sets, algebras, measurable sets and non-measurable sets, measure spaces.

Measurable Functions and Integration: Properties, approximation by simple functions, Egoroff's theorem, monotone convergence theorem, convergence in measure, Fatou's lemma, Lebesgue dominated convergence theorem, signed measures, Lebesgue differentiation theorem, Hahn decomposition theorem, Radon-Nikodym theorem, Lebesgue decomposition theorem, Fubini's theorem, Tonelli's theorem, Stone-Weierstras theorem, Ascoli-Arzela theorem.

L_p-Spaces: Minkowski and Holder inequalities, Riesz representation theorem.

Banach Spaces: Hahn-Banach theorem, uniform boundedness principle, open mapping theorem, closed graph theorem.

Hilbert Spaces: Geometrical aspects, projection, Riesz-Fischer theorem.

Suggested Courses:

- MATH 62051 / 72051:Functions of a Real Variable I
- MATH 62052 / 72052: Functions of a Real Variable II

Suggested References:

- H. L. Royden, Real Analysis, MacMillan.
- W. Rudin, Principles of Mathematical Analysis, McGraw-Hill.

C. METHODS OF APPLIED MATHEMATICS

Preliminaries: The student is expected to be familiar with the major topics (at the advanced undergraduate, beginning graduate level) in linear algebra, advanced

calculus, introductory partial differential equations, and introductory complex variables.

Exam topics may include (but are not limited to):

Dimensional Analysis and Scaling: Buckingham Pi Theorem, characteristic scales, well-scaled problems. Perturbation Methods and Asymptotic Expansions: asymptotic sequences and series, regular perturbations, Poincare'-Lindstedt method, singular perturbations, boundary layer analysis, WKB approximations, asymptotic expansions of integrals.

Calculus of Variations: first and second variations, Euler-Lagrange equations, first integrals, isoperimetric problems.

Integral Equations and Green's Functions: Volterra and Fredholm integral equations, degenerate kernels, Green's functions, Fredholm Alternative.

Partial Differential Equations: well-posed problems, maximum principles, energy argument (Lyapunov functions), orthogonal expansions, Fourier Transforms, heat kernel.
Suggested Courses:

- MATH 41021 / 51021: Theory of Matrices
- MATH 42041 / 52041: Advanced Calculus
- MATH 42045 / 52045: Introduction to Partial Differential Equations
- MATH 42048 / 52048: Introduction to Complex Variables (for preliminary material)
- MATH 62041 / 72041: Methods of Applied Mathematics I (for core material)
- MATH 62042 / 72042: Methods of Applied Mathematics II (for core material)

Suggested References:

- James P. Keener, Principles of Applied Mathematics: Transformation and Approximation, 2/e, Westview Press, 2000.
- C. Lin and L. A. Segel, Mathematics Applied to Deterministic Problems in the Natural Sciences, SIAM Classics, 1988.
- J. David Logan, Applied Mathematics, 4/e, Wiley, 2013.

D. NUMERICAL ANALYSIS

Preliminaries: The student is expected to be familiar with those topics normally covered in a one-year, senior-level course in numerical methods, including computer arithmetic, solving linear systems of equations (by direct methods), polynomial interpolation, numerical quadrature methods, linear least-squares data fitting, solving non-linear equations, and basic numerical methods for ODE initial-value problems.

Error Analysis: Floating-point arithmetic, roundoff-error analysis, mathematical conditioning.
Interpolation: Lagrange formula, Neville's algorithm, Newton formula and divided differences, error in polynomial interpolation, Hermite interpolation, trigonometric interpolation, discrete Fourier analysis, fast Fourier transform, interpolation by spline functions.
Integration: Newton-Cotes formulas, Peano kernel theorem, Euler-Maclaurin summation formula, asymptotic expansions, extrapolation and Romberg integration, Gaussian quadrature, orthogonal polynomials.
Systems of Linear Equations: Gaussian elimination, LU-decomposition, Cholesky decomposition, backwards error analysis, matrix and vector norms and condition numbers.
Linear Least-Squares: Orthogonalization, Gram-Schmidt, Householder and Givens transformations, QR-factorization, condition of linear least-squares problems, pseudoinverse.
Eigenproblems: Matrix normal forms (Jordan, Schur), similarity reduction to tri-diagonal or Hessenberg forms, power method, inverse iteration, Rayleigh quotients, LR-method, QR-method, singular value decomposition.
Suggested Courses:

- MATH/CS 42201 / 52201: Introduction to Numerical Computing I
- MATH/CS 42202 / 52202: Introduction to Numerical Computing II
- MATH 62251 / 72251: Numerical Analysis I
- MATH 62252 / 72252: Numerical Analysis II

Suggested References:

- Conte and de Boor, Elementary Numerical Analysis: an Algorithmic Approach, McGraw-Hill.
- Dahlquist and Bjorck, Numerical Methods, Prentice-Hall.
- Golub and Van Loan, Matrix Computations, 3rd ed., Johns Hopkins.
- Kahaner, Moler, and Nash, Numerical Methods and Software, Prentice-Hall.
- Stewart, Introduction to Matrix Computations, Academic Press.
- Stoer and Bulirsch, Introduction to Numerical Analysis, 3rd ed., Springer.
- Trefethen and Bau, Numerical Linear Algebra, SIAM.

E. PROBABILITY

Probability Theory: Distribution functions, random variables, expectation, independence, convergence concepts, law of large numbers, characteristic functions, the central limit theorem, conditional expectation, martingales, Brownian motion.
Suggested Courses:

- MATH 60051 / 70051: Probability I
- MATH 60052 / 70052: Probability II

Suggested References:

- P. Billingsley, Probability and Measure, John Wiley.
- K. L. Chung, A Course in Probability Theory, Academic Press.

F. STATISTICS

Statistics: Sufficient statistics, uniformly minimum variance unbiased estimates, maximum likelihood, method of moments, Bayes, minimax and least-square estimates, interval estimation, testing simple and composite hypotheses, Neyman-Pearson lemma, sequential tests, Wald's sequential probability ratio test.
Suggested Courses:

- MATH 60061 / 70061: Mathematical Statistics I
- MATH 60062 / 70062: Mathematical Statistics II

Suggested References:

- F. J. Bickel and K. A. Doksum, Mathematical Statistics: Basic Ideas and Selected Topics, Holden Day.
- E. L. Lehmann, Theory of Point Estimation, Wiley Interscience.
- E. L. Lehmann, Testing Statistical Hypotheses, Wiley Interscience.