

# 3300 Mathematics and Statistics

## Programs Offered:

**Master of Science in Mathematics**

**Concentration in Bioinformatics**  
**Concentration in Biostatistics**  
**Concentration in Discrete Mathematics**  
**Concentration in Scientific Computing**  
**Concentration in Statistics**  
**Concentration in Statistics and Allied Field**

**Specialist in Education in Teaching and Learning with Concentration in Mathematics  
Education (in cooperation with the College of Education)**

**Doctor of Philosophy in Mathematics and Statistics**

**Concentration in Bioinformatics**  
**Concentration in Biostatistics**  
**Concentration in Mathematics**

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The Master of Science (M.S.) degree programs in mathematics provide education at the graduate level in algebra, analysis, applied mathematics, and statistics. Students completing these degrees are prepared for positions in industry, government, business, college teaching, and for advanced study in mathematics.

The M.S. degree in mathematics is offered with no concentration, or with one of six possible concentrations. Four of the concentrations are in statistics, one is in discrete mathematics, and one is in scientific computing. The concentrations in statistics are programs designed for persons who wish to prepare for careers as professional statisticians in industry, business, or government. These programs provide advanced training in applied statistics for those who are presently working in areas that use statistics, as well as for those who plan to enter these areas. The programs present an optimal balance among the broad range of statistical techniques, mathematical methods, and computation. The concentrations in discrete mathematics and scientific computing are designed for persons who wish to combine their study of mathematics with selected areas in discrete mathematics and computer science. Opportunities exist to apply this study to related areas outside the department.

The Ph.D degree program in Mathematics and Statistics includes concentrations in bioinformatics, biostatistics, and mathematics. These concentrations address the critical need for mathematics faculty and the need for highly trained specialists in the areas of bioinformatics and biostatistics. The concentrations in bioinformatics and biostatistics will graduate strong bioinformaticians and biostatisticians with a broad background in applied areas for direct placement in business, industry, governmental institutions and research universities. The mathematics concentration will graduate mathematicians with broad knowledge of core areas of pure and applied mathematics.

Majors are encouraged to consider carefully the career objectives they wish to pursue after graduation. Early selection of these objectives may suggest the degree programs or concentrations that will prepare students for their chosen careers. Faculty who serve as advisers for graduate majors will discuss with majors the degree programs and concentrations available to them.

The Department of Mathematics and Statistics accepts applications for all three semesters. However, in order to be considered for graduate assistantships for the fall semester, applicants must complete the application process in the Office of Graduate Services in sufficient time for the department to receive it by March 1. This process often

takes several weeks. International applicants should allow at least two additional months for processing of applications for admission.

Applicants may obtain additional information about the Department of Mathematics and Statistics by contacting the Directors of Graduate Studies at the addresses above.

## **Master of Science in Mathematics (with thesis)**

### **Additional Admission Requirements**

In addition to the general requirements of the College of Arts and Sciences, the Department of Mathematics and Statistics has the following requirements:

1. A baccalaureate degree in mathematics or its equivalent.
2. Courses in mathematics equivalent to the following:
  - Math 4435/6435 Linear Algebra (3)
  - Math 4441/6441 Modern Algebra I (3)
  - Math 4661/6661 Analysis I (3)

### **Degree Requirements**

1. Twenty-four hours of graduate-level courses (exclusive of 8820 and 8999 courses).
  - a. The following courses are required:
    - Math 8110 Real Analysis I (3)
    - Math 8120 Real Analysis II (3)
    - Math 8200 Advanced Matrix Analysis (3)
    - Math 8220 Abstract Algebra (3)
  - b. One additional three-hour 8000-level course in Mathematics.
  - c. Nine additional hours of graduate-level coursework from the Department of Mathematics and Statistics or in a related field selected in consultation with an adviser and approved by the Director of Graduate Studies. These may include no more than six hours (e.g. two courses) in a related field. Any courses which are used in area 2 of the "Additional Admission Requirements" section of this catalog cannot be applied toward the degree.
2. Six hours of Thesis Research (Math 8999)
3. Additional Requirements
  - a. A thesis
  - b. A thesis defense

## **Concentration in Bioinformatics (with thesis)**

### **Additional Admission Requirements**

In addition to the general requirements of the College of Arts and Sciences, the Department of Mathematics and Statistics has the following requirements:

1. A baccalaureate degree in mathematics, statistics, or its equivalent.
2. Courses in mathematics equivalent to:
  - Math 4435/6435 Linear Algebra (3)
  - Math 4751/6751 Mathematical Statistics I (3)
  - Math 4752/6752 Mathematical Statistics II (3)

### **Degree Requirements**

1. A minimum of 27 hours of graduate-level courses (exclusive of 8820 and 8999 courses). The required courses must come from all of the three core groups.

#### **Statistics Core:**

The following courses are required:

- Stat 8050 Statistics for Bioinformatics (3)
- Stat 8540 Advanced Methods in Biostatistics (3)
- Stat 8561 Linear Statistical Analysis I (3)
- Stat 8670 Computational Methods in Statistics (3)

#### **Biology Core:**

The following courses are required:  
Biol 8630 Advanced Bioinformatics (4)

**Either:**

Biol 6564 Advanced Genetics (4) *or*  
Chem 6600 Biochemistry I (5) *or*  
Chem 6610 Biochemistry II (3)

**Computer Science Core:**

Choose two courses from the following list:  
CSc 6310 Parallel and Distributed Computing (4)  
CSc 6350 Software Engineering (4)  
CSc 6710 Database Systems (4)  
CSc 6730 Scientific Visualization (4)  
CSc 8710 Deductive Databases and Logic Programming (4)

2. Six hours of Thesis Research (Stat 8999)
3. Additional requirements:
  - a. thesis
  - b. thesis defense

**Concentration in Biostatistics (with thesis)**

**Additional Admission Requirements**

In addition to the general requirements of the College of Arts and Sciences, the Department of Mathematics and Statistics has the following requirements:

1. A baccalaureate degree in mathematics, statistics, or its equivalent.
2. Courses in mathematics equivalent to:
  - Math 4435/6435 Linear Algebra (3)
  - Math 4751/6751 Mathematical Statistics I (3)
  - Math 4752/6752 Mathematical Statistics II (3)

**Degree Requirements**

1. Twenty-four hours of graduate-level courses (exclusive of 8820 and 8999 courses).
  - a. The following courses are required:
    - Stat 8440 Survival Analysis (3)
    - Stat 8540 Advanced Methodologies in Biostatistics (3)
    - Stat 8561 Linear Statistical Analysis (3)
  - b. Nine additional hours of Statistics courses at the 8000-level, from the Department of Mathematics and Statistics.
  - c. Six additional hours of graduate-level coursework from the Department of Mathematics and Statistics or in a related field selected in consultation with an adviser and approved by the Director of Graduate Studies. The courses listed as Additional Admission Requirements in section 2 above and other 6000-level Statistics courses are excluded.
2. Six hours of Thesis Research (Math 8999).
3. Additional Requirements
  - a. A thesis
  - b. A thesis defense

**Concentration in Discrete Mathematics (with thesis)**

**Additional Admission Requirements**

In addition to the general examinations of the College of Arts and Sciences, the Department of Mathematics and Statistics has the following requirements:

1. A baccalaureate degree in mathematics or its equivalent.
2. Courses in mathematics equivalent to at least two of the following:
  - Math 4420/6420 Graph Theory (3)

- Math 4435/6435 Linear Algebra (3)  
 Math 4441/6441 Modern Algebra I (3)

### **Degree Requirements**

1. Twenty-four hours of graduate-level courses (exclusive of 8820 and 8999 courses).
  - a. The following courses are required:
 

Math 8200	Advanced Matrix Analysis (3)
Math 8220	Abstract Algebra (3)
Math 8420	Advanced Graph Theory (3)
Math 8440	Combinatorics (3)
  - b. One additional 8000-level course in mathematics
  - c. Nine additional hours of graduate-level coursework from the Department of Mathematics and Statistics or in a “related field” selected in consultation with an adviser, and approved by the Director of Graduate Studies. These may include no more than six hours (e.g., two courses) in a related field. At most one of the courses listed in section 2 of “Additional Admission Requirements” above can be applied toward the degree.
2. Six hours of Thesis Research (Math 8999)
3. Additional requirements
  - a. thesis
  - b. thesis defense

### **Concentration in Scientific Computing (with thesis)**

#### **Additional Admission Requirements**

In addition to the general requirements of the College of Arts and Sciences, the Department of Mathematics and Statistics has the following requirements:

1. A baccalaureate degree in mathematics, computer science, or its equivalent.
2. Courses in mathematics and computer science equivalent to the following:
 

Math 3260	Differential Equations (3)
Math 4435/6435	Linear Algebra (3)
Math 4610/6610	Numerical Analysis I (3)

### **Degree Requirements**

1. Twenty-four hours of graduate-level courses (exclusive of 8820 and 8999 courses).
  - a. The following courses are required:
 

Math 8200	Advanced Matrix Analysis (3)
Math 8610	Advanced Numerical Analysis (3)
Math 8620	Numerical Linear Algebra (3)

 If an equivalent course has not already been taken as part of another program:
 

Math 6265	Partial Differential Equations (3)
Math 6620	Numerical Analysis II (3)
  - b. Six additional hours of 8000-level coursework selected in consultation with an adviser and approved by the Director of Graduate Studies.
  - c. Additional graduate-level courses in mathematics, computer science, or a related field to total 24 hours selected in consultation with an adviser and approved by the Director of Graduate Studies. There are many options for coursework in this area, including:
 

Math 6211	Optimization (3)
Math 6253	Introduction to Operations Research (3)
Math 8510	Applied Mathematics (3)
Math 8530	Topics in Applied Mathematics (3)
CSc 6330	Programming Language Concepts (4)
CSc 6730	Scientific Visualization (4)
CSc 6820	Computer Graphics Algorithms (4)
CSc 8520	Applied Combinatorics and Graph Theory (3)
2. Six hours of Thesis Research (Math 8999)
3. Additional Requirements
  - a. A thesis

- b. A thesis defense

### **Concentration in Statistics (with thesis)**

#### **Additional Admission Requirements**

In addition to the general requirements of the College of Arts and Sciences, the Department of Mathematics and Statistics has the following requirements:

1. A baccalaureate degree in mathematics, statistics, or its equivalent.
2. Courses in mathematics equivalent to:
  - Math 4435/6435    Linear Algebra (3)
  - Math 4751/6751    Mathematical Statistics I (3)
  - Math 4752/6752    Mathematical Statistics II (3)

#### **Degree Requirements**

1. Twenty-four hours of graduate-level courses (exclusive of 8999 courses).
  - a. The following courses are required:
    - Math 8200        Advanced Matrix Analysis (3)
    - Stat 8561        Linear Statistical Analysis I (3)
  - b. Twelve additional hours of Statistics courses at the 8000-level, from the Department of Mathematics and Statistics.
  - c. Six additional hours of graduate-level coursework from the Department of Mathematics and Statistics or in a related field selected in consultation with an adviser, and approved by the Director of Graduate Studies. The courses listed as Additional Admission Requirements in section 2 above and other 6000-level Statistics courses are excluded.
2. Six hours of Thesis Research (Math 8999).
3. Additional Requirements
  - a. A thesis
  - b. A thesis defense

### **Concentration in Statistics (non-thesis option)**

#### **Additional Admission Requirements**

In addition to the general requirements of the College of Arts and Sciences, the Department of Mathematics and Statistics have the following requirements:

1. A baccalaureate degree in mathematics, statistics or its equivalent
2. Courses in mathematics equivalent to:
  - Math 4435/6435    Linear Algebra (3)
  - Math 4751/6751    Mathematics Statistics I (3)
  - Math 4752/6752    Mathematics Statistics II (3)

#### **Degree Requirements**

1. Thirty-six hours of graduate-level courses (exclusive of 8999 courses).
  - a. The following courses are required
    - Math 8200        Advanced Matrix Analysis (3)
    - Stat 8561        Linear Statistical Analysis I (3)
  - b. Eighteen additional hours of Statistics courses at the 8000-level from the Department of Mathematics and Statistics.
  - c. Twelve additional hours of graduate-level coursework. At least six of these from the Department of Mathematics and Statistics, and at most six hours in a related field selected in consultation with an adviser and approved by the Director of Graduate Studies. The courses listed as Additional Admission Requirements in section 2 above and other 6000-level statistics courses are excluded.
  - d. At most three hours of the 36 can be in Stat 8820.
2. Additional Requirements
  - a. A general examination
  - b. A research paper or written report of a laboratory experience. This requirement can be satisfied by taking Stat 8820 Research.

## **Concentration in Statistics and Allied Field**

### **Additional Admission Requirements**

In addition to the general requirements of the College of Arts and Sciences, the Department of Mathematics and Statistics have the following requirements:

1. A baccalaureate degree in mathematics, statistics, or its equivalent.
2. Courses in mathematics equivalent to:
  - Math 4435/6435    Linear Algebra (3)
  - Math 4751/6751    Mathematical Statistics I (3)
  - Math 4752/6752    Mathematical Statistics II (3)

### **Degree Requirements**

1. Thirty-six hours of graduate-level courses (exclusive of 8999 courses).
  - a. The following courses are required:
    - Math 8200        Advanced Matrix Analysis (3)
    - Stat 8090        Applied Multivariate Statistics (3)
    - Stat 8561        Linear Statistical Analysis I (3)
    - Stat 8630        Experimental Designs (3)
  - b. Twelve additional hours of graduate Statistics courses, at least six hours of which must be taken at the 8000-level from the Department of Mathematics and Statistics. The courses listed as Additional Admission Requirements in section 2 above and other 6000-level Statistics courses are excluded.
  - c. Twelve hours of graduate courses in an allied field a single area of application selected in consultation with an adviser and approved by the Director of Graduate Studies.
  - d. At most three hours of the 36 can be in Stat 8820.
2. Additional Requirements
  - a. A general examination
  - b. A research paper or a written report of a laboratory experience. This requirement can be satisfied by taking Stat 8820 Research.

## **Doctor of Philosophy in Mathematics and Statistics**

### **Admission Requirements**

In addition to the general requirements of the College of Arts and Sciences, the Department of Mathematics and Statistics have the following requirements for students who wish to enter into the Ph.D. program, regardless of concentration:

1. A baccalaureate degree in mathematics, statistics, or a related field with a grade point average of 3.0 out of 4.0. Students with a grade point average of 2.75 will be considered for conditional admission.
2. Three letters of reference,
3. Recent GRE scores,
4. A statement describing study plans.
5. Applicants from non-English speaking countries must achieve a satisfactory score on the Test of English as a Foreign Language (TOEFL).

Students must have completed courses in mathematics equivalent to the following with a grade of B or higher:

- Math 4435/6435    Linear Algebra (3)
- Math 4661/6661    Analysis I (3)
- Math 4662/6662    Analysis II (3)

### **Degree Requirements**

Each of the concentrations requires 54 hours of coursework and 30 hours of dissertation research.

Students must take four of the five following common core courses (12 credit hours):

- Math 8110        Real Analysis I (3)
- Math 8200        Advanced Matrix Analysis (3)
- Stat 8600        Probability Theory (3)
- Stat 8561        Linear Statistical Analysis I (3)
- Math 9116        Teaching College Math Sciences (3)

### **Concentration in Bioinformatics**

1. The following courses are required (12 credit hours):
  - Math 8515 Mathematical Neuroscience (3)
  - Math 8510 Applied Mathematics (3)
  - Stat 8050 Statistics for Bioinformatics (3)
  - Stat 8581 Statistical Theory I (3)
2. Students must take at least 9 credit hours selected from the list below (9 credit hours).
  - Math 6010 Mathematical Biology (3)
  - Math 6275 Applied Dynamical Systems (3)
  - Math 8520 Applied Combinatorics & Graph Theory (3)
  - Math 8540 Advanced Topics in ODEs and Dynamical Systems (3)
  - Stat 8561 Linear Statistical Analysis I (3)
  - Stat 8582 Statistical Theory II (3)
  - Stat 8610 Time Series Analysis (3)
3. Students must take at least 21 credit hours that should be selected from other graduate level courses in the Department of Mathematics and Statistics and courses from other departments listed below. The total number of required hours of coursework is 54; if Stat 8561 is taken as part of the core and used to also satisfy the 9 required hours above, a student must take additional coursework in Mathematics and Statistics or from the list below.
  - Biol 6564 Advanced Genetics (4)
  - Biol 7900 Genetics (3)
  - Biol 8010 Neurobiology I, Cellular Neurobiology (4)
  - Biol 8020 Neurobiology II, Integrative Neurobiology (4)
  - Biol 8220 Molecular Cell Biology (4)
  - Biol 8410 Advanced Microbiology (4)
  - Biol 8610 Physiology and Genetics of Prokaryotes (4)
  - Chem 6450 Molecular Modeling Methods (3)
  - Chem 8360 Protein Structure and Function (3)
  - Chem 8370 Nucleic Acid Structure and Function (3)
  - Chem 8510 Biophysical Chemistry (4)
  - Chem 8620 Advanced Topics in Biochemistry (3)
  - CSc 8510 Theory of Computation (4)
  - CSc 8630 Bioinformatics (4)
  - CSc 8711 Database on the web (4)
4. Dissertation Research (30 hours of Math 9999 or Stat 9999)

### **Concentration in Biostatistics**

1. The following two courses should be included if they are not selected in the core courses:
  - Stat 8600 Probability Theory (3)
  - Stat 8561 Linear Statistical Analysis I (3)
2. The following courses (27 credit hours) are required:
  - Stat 8440 Survival Analysis (3)
  - Stat 8540 Advance Methodologies in Biostatistics (3)
  - Stat 8562 Linear Statistical Analysis II (3)
  - Stat 8581 Statistical Theory I (3)
  - Stat 8582 Statistical Theory II (3)
  - Stat 8678 SAS programming (3)
  - Stat 8700 Categorical Data Analysis (3)
  - Stat 8800 Statistical Consulting (2)
  - Ph 7011 Epidemiology for Public Health (3)
3. At least 15 credit hours should be selected from other graduate-level courses in the Department of Mathematics and Statistics and courses from other departments listed as follows:
  - Biol 6564 Advanced Genetics (4)
  - Biol 7800 Molecular Cell Biology (3)

Biol 7900	Genetics (3)
Biol 8010	Neurobiology I: Cellular (4)
Biol 8220	Molecular Cell Biology (4)
Biol 8630	Bioinformatics (4)
CSc 6520	Design & Analysis-Algorithms (4)
CSc 6810	Artificial Intelligence (4)
CSc 8220	Advanced Computer Networks (4)
CSc 8221	Optical/Wireless Networks (4)
CSc 8530	Parallel Algorithms (4)
CSc 8710	Deductive Databases and Logic Programming (4)
CSc 8711	Databases and the Web (4)
CSc 8810	Computational Intelligence (4)
Ph 7010	Foundation of Public Health Administration & Policy (3)
Ph 7011	Epidemiology for Public Health (3)
Ph 7170	Research in Health Policy (3)
Ph 7270	Intermediate Epidemiologic Methods (3)
Ph 7300	Urban Health (3)
Ph 7530	Prevention Effectiveness & Economic Evaluation (3)

4. Dissertation Research (30 hours of Math 9999 or Stat 9999)

### Concentration in Mathematics

1. The mathematics concentration requires that a student chooses three of the following six areas as subjects for the qualifying exam and take the two required courses for the topic if they were not taken as part of the common core. The qualifying exam is comprised of three separate written exams on each of the three chosen areas. The exam is administered by the department.

- Analysis: Math 8110 Real Analysis I and Math 8120 Real Analysis II
- Matrix Theory: Math 8200 Advanced Matrix Analysis and Math 8620 Numerical Linear Algebra
- Algebra: Math 8220 Abstract Algebra and Math 8221 Abstract Algebra II
- Discrete Mathematics: Math 8420 Advanced Graph Theory and Math 8440 Combinatorics
- Applied Mathematics: Math 8150 Applied Mathematics and Math 8610 Advanced Numerical Analysis
- Collegiate Mathematics Education: Math 9126 Epistemology of Advanced Mathematical Concepts and Math 9136 Learning Theories Relevant to Collegiate Mathematics Education

2. For breadth and specialization a student following the concentration in mathematics will take at least 8 additional courses (24 hours) chosen from the following. At least three but no more than four should be 8000 and/or 9000-level courses within the student's chosen area of specialization. Students are not permitted to take 6000 or 7000-level courses in an area in which they have taken a qualifying exam. Topics courses can be taken more than once if the topic is different. The total number of hours of coursework should not be less than 54 hours. If there is overlap between courses taken for the qualifying exam and the common core, then additional courses from the following list should be taken to meet the requirement for 54 hours. Two of the 8000-level courses within the student's specialty will be chosen by the student as the basis for the candidacy exam. No student will be permitted to take a candidacy exam based on a course that was used for a qualifying exam.

#### Analysis:

Math 6250	Complex Analysis (3)
Math 6258	Vector Calculus (3)
Math 6265	Partial Differential Equations (3)
Math 6661	Analysis I (3)
Math 6662	Analysis II (3)
Math 8310	Theory of Functions of a Complex Variable (3)

**Matrix Theory:**

Math 6435	Linear Algebra (3)
Math 8210	Topics in Applied Matrix Analysis (3)
Math 8201	Combinatorial Matrix Theory (3)

**Algebra:**

Math 6441	Modern Algebra I (3)
Math 6442	Modern Algebra II (3)
Math 6444	Polynomials (3)
Math 6450	Theory of Numbers (3)
Math 6455	Error Correcting Codes (3)
Math 6460	Cryptography (3)
Math 8230	Topics in Algebra (3)
Math 8240	Introduction to Commutative Algebra and Algebraic Geometry (3)
Math 8250	Commutative Ring Theory (3)

**Discrete Mathematics:**

Math 6420	Graph Theory (3)
Math 8520	Applied Combinatorics and Graph Theory (3)
Math 8450	Probabilistic Method in Combinatorics (3)

**Applied Mathematics:**

Math 6010	Mathematical Biology (3)
Math 6211	Optimization (3)
Math 6253	Introduction to Operations Research (3)
Math 6275	Applied Dynamical Systems (3)
Math 6610	Numerical Analysis I (3)
Math 6620	Numerical Analysis II (3)
Math 6650	Inverse and Ill-posed Problems (3)
Math 6671	Transforms in Applied Mathematics (3)
Math 8530	Topics in Applied Mathematics (3)
Math 8540	Advanced Topics in Ordinary Differential Equations and Dynamical Systems (3)

**Collegiate Mathematics Education**

Math 6301	College Geometry (3)
Math 6371	Modern Geometry (3)
Math 6381	General Topology (3)
Math 6250	Complex Analysis (3)
Math 6258	Vector Calculus (3)
Math 6265	Partial Differential Equations (3)
Math 6661	Analysis I (3)
Math 6662	Analysis II (3)
Math 6435	Linear Algebra (3)
Math 6441	Modern Algebra I (3)
Math 6444	Polynomials (3)
Math 6450	Theory of Numbers (3)
Math 7820	Historical and Cultural Development of Mathematics I (3)
Math 7821	Historical and Cultural Development of Mathematics II (3)
Math 9166	Internship in Teaching College Mathematics (3)
Math 9185	Research Seminar in Undergraduate Mathematics Education (3)
Math 8120	Real Analysis II (3)
Math 8310	Theory of Functions of a Complex Variable (3)
Math 8540	Ordinary Differential Equations and Dynamical Systems (3)
Math 8320	Functional Analysis (3)
Math 8210	Topics in Applied Matrix Analysis (3)
Math 8620	Numerical Linear Algebra (3)

Math 8201	Combinatorial Matrix Theory (3)
Math 8220	Abstract Algebra I (3)
Math 8221	Abstract Algebra II (3)
Math 8230	Topics in Algebra (3)
Math 8440	Combinatorics (3)
Math 8420	Probabilistic Combinatorics (3)
CSc 6810	Artificial Intelligence (4)
EPRS 8500	Qualitative/Interpretative Research in Education (3)
EPRS 8510	Qualitative Research in Education II (3)
EPRS 8520	Qualitative Research in Education III (3)
EPRS 8530	Quantitative Methods and Analysis in Education I (3)
Phil 6330	Philosophy of the Mind (3)
Phil 6530	Philosophy of Language (3)
Psyc 8010	Research Methods in Psychology (3)
Psyc 8015	Theories of Development (3)
Psyc 8540	Advanced Cognitive Psychology (3)
Psyc 8551	Cognitive and Linguistic Development (3)
Stat 8630	Experimental Designs (3)

3. In addition to the above courses, students may satisfy the breadth requirement by taking the following.

Math 6381	General Topology (3)
Math 8515	Mathematical Neuroscience (3)

4. Dissertation Research (30 hours of Math 9999 or Stat 9999)

**Transfer credit hours:** Students can transfer at most 24 semester credit hours to the program with the approval of the appropriate Graduate Director of the Department. Petition documents include the transcript, the course syllabus, exams and course notes or the textbook.

**Qualifying exam:** Students must pass a qualifying exam set by the appropriate graduate committee in accordance with any further requirements specified in the previously described concentrations. Students who fail the exam on the first attempt may take it only one more time. Students must pass the qualifying exam within two calendar years of admission.

**Candidacy exam:** Students must pass an oral candidacy exam before a committee that includes at least two final members of the student's dissertation committee. The candidacy exam is set by the committee and covers course material within the student's area of specialization or a proposed topic of thesis research. The details are determined by the committee in a manner consistent with any guidelines stated above for the student's concentration. A student must advance to candidacy by the fourth year. The candidacy exam can be taken only twice.

**Dissertation Committee:** The student and his/her dissertation adviser shall form a dissertation committee. The committee should consist of at least four faculty members. For students in the bioinformatics and biostatistics concentrations, one committee member should be from another department such as the Institute of Public Health, the Department of Biology or another institution.

**Final dissertation defense:** Upon completion of the research, the student must defend his/her dissertation publicly.