

Requirements: Mathematics and Statistics

Natural Sciences Division

For more than 2,000 years, mathematics has been a part of the human search for understanding. Mathematical discoveries have come from both the attempt to describe the natural world and the desire to arrive at a form of inescapable truth through careful reasoning that begins with a small set of self-evident assumptions. These remain fruitful and important motivations for mathematical thinking, but in the last century mathematics and statistics have been successfully applied to many other aspects of the human world: voting trends in politics, dating of ancient artifacts, analysis of automobile traffic patterns and long-term strategies for the sustainable harvest of deciduous forests, to mention a few. Today, statistics as a mode of thought and expression is more valuable than ever before. Learning to think in mathematical terms is an essential part of becoming a liberally educated person.

Mathematics and statistics are engaging fields, rich in beauty, with powerful applications to other subjects. Thus we strive to ensure that Kenyon students encounter and learn to solve problems using a number of contrasting but complementary mathematical perspectives: continuous and discrete, algebraic and geometric, deterministic and stochastic, theoretical and applied. In our courses, we stress mathematical and statistical thinking and communication skills. In courses where it makes sense to incorporate technological tools, our students learn to solve problems using computer algebra systems, statistical packages and computer programming languages.

The Kenyon College faculty voted to change from Kenyon units to semester hours. This change will go into effect for all students who start at the College in the fall of 2024. Both systems will be used throughout the course catalog with the Kenyon units being listed first.

New Students

Those students interested only in an introduction to mathematics or statistics or a course to satisfy a distribution requirement may select from MATH 105, 111, 128, STAT 106, 116 and COMP 118.

First-year students who are interested in majoring in mathematics or statistics are encouraged to enroll in MATH 100.

Students wanting to continue the study of mathematics or statistics beyond one year, by pursuing a major or minor or a foundation for courses in other disciplines, usually begin with the calculus sequence MATH 111, 112, 212 and 213.

Students who have already had calculus or want to take more than one math course may choose to begin with STAT 106 and 206 or COMP 118. A few well-prepared students may take MATH 222 or 224 in their first year. Please see the department chair for further information.

MATH 111 is an introductory course in calculus. Students who have completed a substantial course in calculus might qualify for one of the successor courses, MATH 112 or 213. STAT 106 is an introduction to statistics, which focuses on quantitative reasoning skills and the analysis of data. COMP 118 introduces students to computer programming.

To facilitate proper placement in calculus courses, the department offers tests that help students decide which level of calculus is appropriate for them. This and other entrance information is used during Orientation to give students advice about course selection in mathematics and statistics. We encourage all students who do not have Advanced Placement credit to take the placement exam that is appropriate for them. Students who have Advanced Placement credit for STAT 106 should consider enrolling in STAT 206 or 216.

The ready availability of powerful computers has made the computer one of the primary tools of the mathematician and absolutely indispensable for the statistician. Students are expected to use appropriate computer software in many of the mathematics and statistics courses. However, no experience with the software packages or programming is expected, except in advanced courses that presuppose earlier courses in which use of the software or programming was taught.

Pass/D/Fail Policy

In addition to requiring that majors take all MATH/STAT courses for a letter grade, we require that students who wish to declare a MATH/STAT major must petition to have any grades of P in MATH/STAT courses numbered 222 (Foundations) or above changed to a letter grade in order to count the course toward the math/stat major requirements.

Requirements for the Majors

All courses for the major must be taken for a letter grade.

There are three different areas of emphasis within the major: classical mathematics, applied mathematics and statistics. Regardless of one's concentration, all math majors are required to complete the same eight core courses.

Core Requirements

A student must have credit for the following core courses:

- MATH 111, 112, 212, 213 or the equivalent
- One semester of statistics (STAT 106, 116 or the equivalent)
- One semester of computer programming (COMP 118 or PHYS 270)
- MATH 222: Foundations
- MATH 224: Linear Algebra
- MATH 480 Senior Seminar in Mathematics

Beyond the core are three other types of requirements: the "area of focus" requirement, the "depth" requirement and the "breadth" requirement. It is the "area of focus" requirement that determines a student's emphasis within the math major.

Area of Focus Requirement

Every math major is required to take at least three courses from a single column in the table given below. Additionally, at least one of those courses must be a MATH or STAT course at or above the 300 level. (Note: special topics courses may also count toward a major's area of focus, even though they are not listed in the table; the department chair signs off on such courses when appropriate.)

Category I			Category II	
A. Algebraic	B. Continuous/ Analytic	C. Discrete/ Combinatorial	D. Applied	E. Statistical/ Data Science

MATH 335 Abstract Algebra I	MATH 341 Real Analysis I	MATH 336 Probability	MATH 330 Principles of Applied Math	STAT 206 Data Analysis
MATH 435 Abstract Algebra II	MATH 441 Real Analysis II	MATH 328 Coding Theory	MATH 325 Applied Linear Algebra	STAT 436 Mathematical Stats
MATH 327 Number Theory	MATH 360 Topology	MATH 327 Number Theory	MATH 333 Ordinary Differential Equations	STAT 416 Linear Regression
MATH 328 Coding Theory	MATH 230 Geometry	MATH 227 Combinatorics	MATH 347 Mathematical Modeling	STAT 216 Nonparametrics Statistics
MATH 322 Mathematical Logic	MATH 352 Complex Functions		MATH 433 Partial Differential Equations	STAT 226 Statistical Computing in R
	MATH 336 Probability			STAT 306 Topics in Statistics

The major's choice of column determines both the area of emphasis and the area of focus within the major.

1. Classical Mathematics

To earn a math major with an emphasis in classical mathematics, the student must choose an area of focus within Category 1. For example, a math major taking three courses from the first column would have an emphasis in classical mathematics and a focus on algebra.

2. Applied Mathematics

To earn a math major with an emphasis in applied mathematics, the student must take three courses in column D. Applied mathematics is also the area of focus for this student.

3. Statistics

To earn a math major with an emphasis in statistics, the student must take three courses from column E. Statistics is also the area of focus for this student.

Depth Requirement

Majors are expected to attain a depth of study within mathematics or statistics. To this end, every major must take at least two MATH or STAT courses at or above the 300 level. At least one of these 300- or 400-level courses must be within the major's area of focus.

Breadth Requirement

Majors are also expected to attain a breadth of knowledge spanning pure and applied mathematics and statistics. Hence, every major must take courses in at least two different columns that are not the area of focus. (These courses must not also be listed within the area of focus.) A course listed in two columns may be counted only once. Additionally, every major must take at least one course from Category I and one course from Category II.

For instance, a student pursuing a major with an emphasis in classical mathematics and a continuous/analytic focus must choose a course from each of two columns besides column B, and at least one of these columns must be in Category II. Neither of these additional courses can be MATH 336 (Probability) because it is in the student's area of focus.

To summarize, a student earning a major in mathematics will take (or have credit for) at least 13.5 courses: 8.5 core courses, three courses in an area of focus and two additional courses outside the area of focus and spanning Categories I and II. Students with AP credit can place out of some of the introductory core coursework, decreasing the number of required courses to fewer than 13.5.

Senior Capstone

The Senior Capstone begins promptly in the fall of the senior year with independent study on a topic of interest to the student and approved by the department. The independent study culminates in an oral presentation to department faculty in November and a poster presentation open to the Kenyon Community at the end of the fall semester. Juniors should begin thinking about possible topics before they leave for the summer. Evaluation of the Senior Capstone is based on the student's poster and oral presentation. Detailed information on the Senior Capstone is available on the [department website](#).

Suggestions for Majoring

Students wishing to keep open the option of a major in mathematics and statistics typically begin with the study of calculus and normally complete the calculus sequence, MATH 222 and either COMP 118 or STAT 106, by the end of the sophomore year. A major is usually declared no later than the second semester of the sophomore year. Those considering a mathematics and statistics major should consult with a member of the mathematics and statistics department to plan their course of study.

The requirements for the major are minimal. Anyone who is planning a career in the mathematical sciences or intends to read for honors is encouraged to consult with one or more members of the department concerning further appropriate studies. Similarly, any student who wishes to propose a variation of the major program is encouraged to discuss the plan with a member of the department prior to submitting a written proposal.

Students who are interested in teaching mathematics at the high-school level should take MATH 230 and 335, since these courses are required for certification in most states, including Ohio.

Honors

To be eligible to enroll in the "Mathematics Honors Seminar" by the end of junior year, students must have:

- Completed at least two 4-credit hour courses in mathematics and statistics numbered 300 or above, at least one of which must be at the 400 level
- Earned an overall Kenyon GPA of at least 3.33
- A GPA in Kenyon mathematics and statistics courses of at least 3.6
- In the estimation of the mathematics and statistics faculty, a reasonable expectation of fulfilling the requirements to earn honors (listed below)

To earn honors students must:

- Indicate interest in pursuing honors in their capstone proposal (see below for details)
- Complete at least six courses in mathematics and statistics numbered 300 or above, at least two of which must be at the 400 level.
- Pass the Senior Capstone in the fall semester
- Submit a proposal to the department by the last day of classes in the fall semester for the Mathematics Honors Seminar
- Pass MATH 498 (Mathematics Honors Seminar)
- Present the results of independent work in MATH 498 to a committee consisting of an outside examiner and members of the mathematics and statistics department
- Successfully complete an examination written by an outside examiner covering material from MATH 498 and previous mathematics or statistics courses
- Maintain an overall Kenyon GPA of at least 3.33
- Maintain a GPA in mathematics courses of at least 3.6

Based on performance in all of the above-mentioned areas, the department (in consultation with the outside examiner) can elect to award Honors, High Honors or Highest Honors, or not to award honors at all. Also the candidate will receive a course grade in MATH 498 as determined by the course instructor per criteria established in the course proposal and syllabus.

Honors Proposal

A student who intends to pursue honors in mathematics must submit a proposal to the department with details on the content of MATH 498. The proposal should be developed by the student in consultation with the faculty advisor, must be submitted to the department by the last day of classes in the fall semester, and it must contain the following

- An explanation of how the student meets the requirements for the honors, including a list of courses, beyond the core requirements for the major, the student has taken in the department (or abroad) and plans to take in the spring semester
- The GPA in the major and the overall GPA
- The subject of the honors study
- Texts and other resources for the study
- A weekly schedule of topics (with time for examination written by the outside examiner)
- The structure of the independent study
- The evaluation and grading criteria
- A plan to share written work from the honors seminar with their honors advisor

Requirements for the Minor

There are two minors in mathematics and statistics. Each deals with core material of a part of the discipline, and each reflects the logically structured nature of the subject through a pattern of prerequisites. A minor consists of satisfactory completion of the following courses:

Mathematics

- The calculus sequence MATH 111, 112, 212, 213 or the equivalent
- Four other courses offered by the Department of Mathematics and Statistics. COMP 118 and/or COMP 218 may also be used toward this requirement. Of these four other courses, students may count at most one at the 100 level.

Statistics

- STAT 106: Elements of Statistics, STAT 116: Statistics in Sports or an equivalent introductory statistics course
- STAT 206: Data Analysis
- Three courses from the following:
 - MATH 336: Probability
 - STAT 216: Nonparametric Statistics
 - STAT 226: Statistical Computing with R
 - STAT 306: Topics in Statistics
 - STAT 416: Linear Regression Models
 - STAT 436: Mathematical Statistics
 - Students may count at most one statistics course from another department. ECON 205 or PSYC 200 may be substituted for one of the courses listed above.

Our goal is to provide a solid introduction to basic statistical methods, including data analysis, design and analysis of experiments, statistical inference and statistical models using professional software.

Deviations from the list of approved minor courses must be approved by the department. Students considering a minor in mathematics or statistics are urged to speak with a member of the department about the selection of courses.

Transfer Credit

Transfer credit from other institutions, and the applicability of this credit to the major or minor, must be approved by the department chair. Majors may count off-campus studies courses toward the major, with approval of the department chair. Ordinarily, no more than one unit of such credit is allowed. Moreover, transfer credit ordinarily does not count as one of the two 300- or 400-level courses required for the depth requirement or the area of focus.

Academic Program and Requirements

Kenyon's program blends related but distinguishable facets of mathematics: theoretical ideas and methods, modeling real-world situations, the statistical analysis of data, and scientific computing. The curriculum is designed to develop competence in each of these aspects of mathematics in a way that responds to the interests and needs of individual students.

The Senior Capstone

The Senior Capstone in mathematics and statistics is outlined in the [academic course catalog](#). More detailed information is [available through the department](#).

The purpose of the senior capstone is to engage each senior in the exploration and communication of mathematical ideas encountered in 300+ level mathematics/statistics coursework and beyond.

Basic Components

The student independently studies a topic of interest and creates a poster covering their topic. The student gives a 20-minute presentation of the poster to an audience of mathematics and statistics faculty and later participates in the Senior Mathematics & Statistics Poster Symposium, where they share their work with the wider Kenyon community.

Requirements and Important Dates

1. [Student selects a topic.](#)
2. [Student submits a formal proposal describing the proposed topic for their poster and presentation.](#)
3. [Student presents the background and preliminaries of their topic to peers in the Senior Seminar.](#)
4. [Student presents their main results and the implications of those results to peers in the Senior Seminar.](#)
5. [Student completes and submits an electronic version of their poster.](#)
6. [Student presents their poster to mathematics and statistics faculty members.](#)

7. [Students participate in the Senior Mathematics & Statistics Poster Symposium.](#)

1. Student selects a topic.

As this is the capstone experience for the mathematics major, we expect the work to build on earlier intermediate and advanced work in the discipline. In choosing a topic, the student has five options:

1. **Historical Development of a Major "Piece" of Mathematics/Statistics:** The poster presents the historical development of the mathematics/statistics behind a major theorem, theory, algorithm, mathematical model or problem. The presentation must incorporate mathematical/statistical content at the 300+ level.
2. **Examination of a Contemporary Research Problem:** The poster presents a contemporary open problem in mathematics or statistics, summarizing the origin and significance of the problem, and the progress that has been made. The presentation must incorporate mathematical/statistical content at the 300+ level.
3. **Introduction to a 300+ Level Math/Stat Course Topic:** The poster provides a lively presentation of a specific topic from a 300+ level mathematics or statistics course that is accessible to a junior/senior-level mathematics major who has not taken the course.
4. **Summary of Research or Internship:** The poster summarizes mathematical or statistical results stemming from the student's experience in an undergraduate research program or in an internship involving mathematical or statistical ideas at the 300+ course level.
5. **Presentation of a Topic Leading into Honors Study:** The poster describes material the student has learned in preparation for a spring-semester Honors project in Mathematics or Statistics.

[View more details about the topics.](#)

The student's topic should be of suitable difficulty — not too easy and not too hard. If in doubt, the student should consult with faculty members about this. Once the student has a topic and a few print resources (books or articles) in mind, they should approach one or more faculty

members to consult on the suitability of the proposed topic and to discuss ideas for the proposal.

Students should have topic ideas and some resources in hand no later than the first week of the fall semester. (Classes begin Thursday, Aug. 28, 2025.) We encourage students to begin thinking about possible topics in the *spring of their junior year*.

2. Student submits a formal proposal describing the proposed topic for their poster and presentation.

Even though the proposal itself is fairly short, the amount of work that goes into it is much greater. Writing a good proposal requires a reasonably good understanding of the major ideas and technical material involved in the topic. Before attempting to write the proposal:

- The student needs to understand the general motivation behind the topic.
- The student needs to identify the end-goal(s) for the senior capstone.
- The student needs to make sure they have the necessary background and appropriate resources for completing the topic.
- The student needs to be fairly sure the project is doable in the given timeline.

In other words, the student cannot write a reasonable proposal without studying their major resources enough to get a good sense of the topic, its difficulty, and its feasibility. All of this requires a substantial amount of reading and background work prior to writing the proposal. Therefore the preliminary work needs to begin several weeks in advance of this first deadline.

In addition to extensive reading, the student should be consulting with one or more faculty members who will be able to give guidance on end goals and feasibility. It will ordinarily take several discussions with faculty members to really narrow down the goals of the project.

Students should not underestimate the importance of the preparation step or the amount of work that goes into it. This is a big part of the overall senior capstone project and a big deadline.

The proposal must include:

- a description of the topic: this is more than the mere title of the topic. The description should include motivation and describe the basic ideas underlying the topic. It should also state specific end-goals and the nature of the mathematical material that is needed and will be covered. The description should also explain how the topic fits the students' background and interests in mathematics. The student should also be careful to choose a topic that has substantial content and that is also doable in the timeline given for the senior capstone.
- an annotated bibliography saying generally what is in each source and how the student expects the source to contribute to the eventual poster, (these annotations need not be extensive; keep them general and short, but writing them will require the student to have done some reading in the source.)
- a list of courses the student has had that will support study of the topic, and
- a summary of the discussions the student has had with faculty members concerning the topic.

Deadline for the Proposal: Sunday, Sept. 7, 2025, by 4 p.m.

3. Student presents background and preliminary information to peers in the Senior Seminar.

Students present the mathematical background information and preliminary results for their projects in 7- to 10-minute talks to a subset of the seminar class. Seminar students in the audience and the seminar instructor will provide constructive feedback based on this presentation.

Background/Preliminary Presentations: during seminar the week of September 22-26, 2025

4. Student presents main results and the implications of those results to peers in the Senior Seminar.

Students present main results and implications (with significant mathematical content) from their projects in 7- to 10-minute talks to a subset of the seminar class. Seminar students in the audience and the seminar instructor provide constructive feedback based on this presentation.

Results/Implications Presentations: during seminar the week of October 13-17, 2025

5. Student completes and submits an electronic version of their poster.

Students submit complete, electronic but print-ready, versions of their posters. Each poster should be designed to facilitate an accessible, efficient and engaging presentation of the topic to an audience of peers. To this end, the poster should include all components necessary to tell a complete story about the student's project. This may include, but is not limited to, definitions, examples, theorems (and their proofs), applications, and any other critical content.

Visualizations should be incorporated to support the story line and to convey key concepts, when appropriate. The poster will be submitted to the Senior Seminar Moodle page.

General Poster Instructions:

- The poster will be formatted using a template provided in Senior Seminar.
- The poster should be self-contained. The necessary background, basic definitions, and useful examples must be explicitly included so that the audience can understand it without consulting other sources. The poster may, however, assume the general background covered in the core courses in mathematics and (if necessary) the material covered in other math courses the student has taken at Kenyon.
- The poster text should be written so that it is understandable to junior/senior-level mathematics majors.
- The poster should include graphics, data, and/or calculations that facilitate understanding of the topic.
- When using multiple sources for the project, the student will be expected to coordinate and systematize material from these sources. This includes standardizing the notation, which often varies from one source to another.
- Information presented on the poster should be well-organized with appropriate headings, and the student is expected to use correct English and mathematical grammar throughout.

Deadline for Electronic Poster: Friday, Nov. 7, 2025, by 4 p.m.

6. Student presents their poster to mathematics and statistics faculty members.

Each student gives a 20-minute oral presentation of their poster to an audience of Mathematics and Statistics faculty at an assigned date and time. This will be followed by a question and answer session with the faculty members. In this presentation, the student will tell a complete story about the topic they have selected, highlighting the components of their poster.

Poster Presentations: Week of November 10-14, 2025

General Presentation Instructions:

- Like the poster, itself, the presentation should be a self-contained story of the student's results. Any background information necessary to understand the story should be included, beyond the core course content for the mathematics major.
- The student should practice their presentation to ensure that they meet the 18- to 20-minute time requirement.
- After the formal presentation, the student should be prepared to respond to questions posed by the mathematics and statistics faculty members in attendance.
- The presentation will be evaluated on the correctness, completeness, and clarity of the presented material.

7. Student participates in the Senior Mathematics & Statistics Poster Symposium.

All students will participate in the Senior Mathematics & Statistics Poster Symposium. At the Symposium, students will present their work to the wider Kenyon community.

Poster File: Final poster files must be submitted by Friday, Nov. 21, 2025, at 4 p.m.

Poster Symposium: Thursday, Dec. 4, 2024, from 11:10 a.m. - 1 p.m.

Evaluation of the Capstone

The department will evaluate each senior capstone poster and presentation (the result being either distinction, pass, or failure) using the criteria on this rubric.

The student's work will be rated as exemplary, acceptable, marginally acceptable or unacceptable in each category. An evaluation of "unacceptable" on any component of the senior

capstone may be considered grounds for failure. To achieve distinction on the senior capstone, each component of the evaluation must be judged “exemplary.”

Second Chance to Pass the Capstone

College policy provides each student who fails their senior capstone the first time with a second chance. If the senior capstone poster and/or presentation was found to be unacceptable, the student will be required to construct a poster and make a presentation on a topic chosen by the department. The second poster and presentation will be due during the penultimate week of classes in the spring semester. Other (preliminary) deadlines will be imposed by the department in consultation with the student.

Department Policies

Guidelines for Collaboration on Homework

While using someone else's work or collaborating too closely with a fellow student may benefit your grade initially, it actually hurts you in the long run. Learning to solve problems and write down solutions is an important part of the learning process. One of the best ways to ensure that you understand the concepts and methods being taught is to make sure you can write down a clear and complete solution on your own. Often, actually formulating and expressing the solution is as hard as figuring out how to solve the problem in the first place. Skipping the steps of thinking about and writing up solutions on your own will deprive you of this opportunity to practice and improve your skills and will make future classes and assignments more difficult.

On homework and other out-of-class assignments, the line between acceptable and unacceptable levels of collaboration can be hard to find. Syllabi often contain statements such as, “While you are encouraged to discuss problems with other students, the solutions that you write up and turn in must be your own work.” The guidelines below will attempt to clarify exactly what this statement means, what types of collaboration are acceptable, and which are not.

The goals of having you turn in written homework solutions to be graded are first, to give you a chance to express yourself mathematically, and second, to give you feedback on your understanding and progress. If you are not doing your own work, then neither of these goals can be met.

Avoiding Problems with Homework

Here are some suggestions for how you can avoid inappropriate collaboration on take-home assignments:

When you start working on a problem, you need to spend time thinking individually about what the problem is saying and what it is asking you to do. Thus, you should not start working with other students before you have given some thought to what the problem is asking. Make some preliminary notes or jot down some ideas about the problem. At that point, you are ready to start talking to others about the problem.

You should never join a group that has made substantially more progress on a problem than you have. Knowing how to get started on a problem takes practice and often takes a good bit of “thinking time.” You cannot circumvent this learning process by having someone else “fill you in” or try to “catch you up.”

Once you are discussing the problem with a group, you may jot notes, draw pictures, and sketch arguments, but be careful not to write out details together. Even if you are a full contributor or participant, this does not constitute “your own expression.” You should discuss the problem to the point where everyone understands the general approach to the question clearly. Then you should try to work out the details and write it up on your own.

If you get stuck, try talking to your professor or classmate again. For example, “I think I am supposed to follow example number 2, but I can't get the homework problem to work out.” A classmate may tell you, “Example 2 doesn't apply because they are using a result that only works for prime numbers.” Since you have spent time thinking about the problem, this may be enough to steer you in the right direction. If not, try showing your work to your professor. They have a lot of experience giving students hints when they are stuck in the middle of a problem.

After a discussion with others, it's great to come away with a hint/note to yourself: “Use Integration by Parts” or “Treat odd and even cases separately”, but your notes to yourself should not be more detailed than that. If your “notes” are a solution or an outline of a solution, that crosses the line. If you get carried away in your discussion and do end up solving a problem

together with a fellow-student at a board or on scrap paper, then erase the board or recycle the scrap paper and work out the problem afresh when writing it up to submit. This is not only more academically honest, but it will be of much greater help to you in learning the material.

Remember that you need to be able to explain anything you turn in as your own work. If you can't explain every detail of your solution and the techniques you used to solve the problem, this is a sign that you were working with others too closely.

Document any acceptable collaboration, including a BIG HINT or partial solution that was obtained from another person.

Do not look at another student's work if you get stuck on an assignment.

Do not try to find the same (or a very similar) problem in any other source, including other students, the internet, another text, a solution manual, or the back of the book, even if you think it's just to help you get started.

You really are encouraged to talk to classmates, but for things like discussing assignments in a big picture way to understand what approach might be appropriate, or giving or receiving help on how to solve minor computational or syntax errors. Anything more specific should be done on your own or with the professor.

Based in part on the Academic Honesty Policy Guidelines of the Mathematics and Computer Science Department, St. Joseph's University, Philadelphia.

Department Class Attendance Policy

The Department of Mathematics and Statistics at Kenyon College views active engagement and participation of all students an essential part of the learning process. Therefore, regular attendance is expected. It is impossible to fully make-up a missed class because it is not possible to recreate the class dynamic and the interactions that take place between the students and the instructor. Thus, a student should not miss a class unless there is a legitimate excuse.

When a student must miss a class, the following must happen:

If a student knows that they need to miss a class in advance (for example for an official athletic event of the college, a doctor appointment, a religious holiday, etc.) then they need to contact the professor in advance to make arrangements for the missed work. If there is an assignment due that day, the student should turn in the assignment before leaving campus, unless the student and the professor agree on a different arrangement.

If an unforeseen emergency requires an absence, then the student should contact the professor as soon as possible to make arrangements for the missed class and work.

In-class participation is a crucial part of the learning process in all courses offered by the department. Thus, it is the department's general policy that if a student misses 20% of classes during the semester for any reason, whether excused or not, then the student shall be expelled from the course. **Individual instructors may slightly modify this number, but unless otherwise stated by the instructor, if a student misses 20% of the classes for a semester, then they shall be automatically expelled from a course.**

We also expect all students to arrive at the classroom on time, that is before the class starts, and remain in the classroom until the class is dismissed or the official class time is over. Entering or leaving the classroom while class is in session is disruptive; hence, we expect students to minimize these behaviors. If there are special circumstances that require a student to be late to the classroom or to take breaks during class, they are advised to talk to the instructor in advance.

Statement on the Use of AI Tools

The department of Mathematics and Statistics recognizes the availability and widespread use of generative AI tools in education, industry, research, and other areas as well as rapid developments in AI technology. The department also recognizes that AI tools carry significant potential benefits and potential harms for learning. Beyond the direct impact on learning, the use of AI raises important ethical questions, including environmental costs, bias reinforcement, issues of data attribution and intellectual property, privacy concerns and more. As members of a liberally educated community, we encourage students to engage critically with these broader

implications of AI technology. With this statement, we aim to guide our students in the thoughtful and appropriate use of AI in mathematics, statistics, and computing courses.

Our stance on generative AI mirrors our longstanding approach to the use of mathematical software in teaching and learning. Learning is a process that takes place in the mind of the learner and it cannot be outsourced. If employed properly, external tools such as AI can be used to help the process of learning. However, improper or inappropriate use of external tools can be detrimental if they are used in ways that circumvent this process. In particular, they should never replace critical thinking, problem-solving, and the construction of meaning. Additionally, the use of AI should never be a substitute for genuine inquiry.

The role of software tools varies widely across our curriculum. Some courses integrate software tools extensively, while others may involve minimal or no use at all. This variability reflects the differing goals and pedagogical approaches of individual courses and instructors. The same principle applies to generative AI tools. Therefore, students should pay close attention to the AI policy of each course and consult their instructors for guidance, rather than assuming a uniform policy across the department — or the College. Even within a single course, appropriate use of AI may differ from one assignment to another. In the event of uncertainty about the AI policy for a course or assignment, students are encouraged to seek clarification from their course instructor.

Faculty Policy on Writing Letters of Recommendation

This document outlines the guidelines and expectations for students requesting letters of recommendation from faculty in the Department of Mathematics and Statistics. Students' adherence to these guidelines will help faculty manage their time and workload, enabling them to write strong, personalized letters that increase the likelihood of a positive outcome.

Selecting Letter Writers

When considering whether or not Professor X is the right person to write a letter for you, you should consider the following:

Did you take a course with Professor X and did they get to know you in and out of class? A letter of recommendation should come from a professor who knows your abilities well. In general, the better someone knows you, the better they will be able to speak to aspects of your character and abilities that do not show up on a transcript (work ethic, intellectual curiosity, collaboration skills, etc.).

Did you do well in Professor X's course(s)? Were you consistently on time and professional? Did you engage in the class discussions and activities? Did you visit office hours? Did you demonstrate a healthy level of independence in your work? Did you submit your assignments in a timely fashion? Did your work reveal your abilities and potential?

Is Professor X the best person to speak about your abilities, skills and/or potential regarding the position to which you are applying? For example, if you are applying for a statistics-related position, then you will want at least one (and probably two) letter-writers who can say something meaningful about your statistical work. If you are applying for graduate school, then you should seek out letter-writers who can speak about your upper-level proof-based coursework or a mentor who has witnessed your research first hand.

Timing of Requests

Faculty will consider letter requests that are made **at least 2 weeks prior** to your first letter deadline and **preferably 3**. At the time of your request you should be prepared to supply the following information:

Title and type of position/opportunity (e.g., internship, scholarship, fellowship, grad application); when applying to a variety of different graduate programs, be sure to provide the letter writer with a complete list of the programs (including the title of the graduate degree sought at each institution, e.g., Masters of Applied Statistics, Masters of Data Science, etc.).

Description of the position/opportunity (e.g., provide a link to the ad or program description).

Information about the letter submission process, including deadlines and links/addresses for submission.

An updated CV or resume.

A copy of your personal statement, research statement and/or cover letter, if relevant.

A list of the courses you took with the letter-writer, including the respective semester and year of each course.

A brief description of any achievements/experiences you have had that would be relevant for the position to which you are applying.

Faculty collect this information in a variety of ways. Some require students to fill out a Google form, while others will ask that you send them the information via email. Faculty will explain their process when they agree to write a letter. Whatever the process, please provide this information at least 2 weeks prior to your first deadline.

Quantity of Requests

Ordinarily, students request no more than 15 letters from a single faculty member during a 12-month period (8-12 is more common for students pursuing admission into graduate school). Math/stats faculty will not submit more than 20 letters for an individual student during a single academic year. Applicants are better served by putting more effort into tailoring their application materials to a smaller number of programs.

Considering Faculty Time

Faculty are typically juggling multiple responsibilities — teaching, grading, research, meetings, mentoring and writing letters for multiple students. A strong, personalized recommendation letter takes time, and there are many things you can do to help your letter-writers, providing them with the time and bandwidth needed to write a strong letter (as opposed to a rushed or generic one):

Consider the timing of your request. For example, the last day of spring break is probably not the best time to ask for a letter that has an impending deadline because faculty will likely be gearing up for the second half of the semester. No doubt, they would have appreciated the

ability to write the letter over their break when time wasn't as scarce. Likewise, if you know you have a letter due in early January, then please notify your letter writers prior to winter break.

If a faculty member has written a letter for you in the past, do not assume you can forgo the 2-week advanced notice. Faculty are busy, and you want to give them ample time to update the content and perhaps tailor it to the current position/opportunity to which you are applying.

Please ensure the letter solicitations (from employers or universities) come to faculty well in advance of the deadlines. Even when the professor is submitting a second letter for you, they need time to carry out the submission process. Many submission portals come with detailed forms that require faculty to answer additional questions. Do not operate at the last minute and assume a faculty member can meet the short deadline you have created for them. Furthermore, please be aware that some portals do not send their requests for letters until you have completed your full application.

If the job or graduate application requires the letter-writer to fill out a form/questionnaire, please complete as much of the form as you can before it is sent to the faculty member; for example, you should certainly fill out your own personal information. If you are requesting a letter for multiple jobs/graduate programs, please provide the letter-writers with a complete list of all of the institutions/programs, including due dates of each letter. Additionally, please work to ensure that letter solicitations arrive in the professor's inbox at the same time. It's much easier for faculty to submit all letters for the same student in one or two sittings, and letter solicitations that arrive in dribbles spread over an extended time period are more likely to get lost in the faculty member's inbox.

If you can see that a letter has not been submitted 3-4 business days before the deadline, then please feel free to send a gentle reminder to the letter writer. It is your responsibility to check with the program or organization to make sure that the letter has been received.

Waiving Your Right

Universities give students the option to waive their rights to view letters of recommendation, and the choice students make is visible to the letter writer. The choice is likely visible to the

admissions committees, as well, and some committee members will question the accuracy of any letter that is visible to the applicant. (How candid can a letter writer be knowing that the applicant will read what was written about them?) To protect the integrity of the process, faculty in the Mathematics and Statistics Department require that students waive their right to view their letters. If you have concerns about what a faculty member will write in your letter, don't hesitate to ask that faculty member. The vast majority of students waive their right to view letters of recommendation, and faculty generally decline requests to write if they don't feel they can write a positive letter.

If a letter of recommendation must be submitted via email, then please provide the letter writer with the appropriate email address. Letter writers will not make their letters available to the student for submission. Faculty will insist on sending the letter themselves.

Following Up

After you have learned about the outcome of your application process, please follow up with your letter writers to let them know where things stand. Faculty are invested in the success of their students, and they will care about the outcome of your applications; they will appreciate any news that you share — positive or negative. Communicating your gratitude in a professional manner is also good practice.

Math Placement

Calculus

Because of the large variety of both course offerings and student backgrounds, there is a separate [Calculus placement page](#) which will assist you in determining which course is right for you

Statistics

- If you have taken **little or no statistics**, you should start in Elements of Statistics, Math 106. This course introduces the nature of statistical reasoning, graphical and descriptive

statistical methods, design of experiments, sampling methods, probability, probability distributions, sampling distributions, estimation, and statistical inference.

- If you took the **AP Statistics Exam and scored 3**, you may or may not be ready to take further courses in statistics. Our recommendation is that you begin in Math 106, but you may obtain permission to take more advanced courses by talking to Brad Hartlaub, hartlaub@kenyon.edu or 740-427-5405.
- If you took the **AP Statistics Exam and scored 4 or 5**, you are qualified to begin in either Nonparametric Statistics (Math 216, Fall) or Data Analysis (Math 206, Spring).
- If you took IB, A-levels, Abitur, French Baccalaureate, etc., have transfer credits from another college or university, or have any other questions, you should contact Brad Hartlaub, hartlaub@kenyon.edu or 740-427-5405.

Computer Science

- If you have taken **little or no computer science**, you should start in **Introduction to Computer Programming**, Math 118. This course assumes absolutely no programming background. It covers basic program structure, variables, functions, classes, strings, and arrays in the C++ programming language.
- If you took the **AP Computer Science A Exam and scored 3**, you may or may not be ready to take further courses in computer science. Our recommendation is that you begin in Math 118, but you may obtain permission to take more advanced courses by talking to Noah Aydin, aydinn@kenyon.edu or 740-427-5674.
- If you took the **AP Computer Science A Exam and scored 4 or 5**, you are qualified to begin in our more advanced computer science courses. There are none offered this fall, but you are encouraged to talk to Prof. Noah Aydin or Prof. Bob Milnikel about your options.
- If you took the AP Computer Science AB exam, IB exams, A-levels, Abitur, French Baccalaureate, etc., have transfer credits from another college or university, or have any other questions, you should contact Noah Aydin (aydinn@kenyon.edu or 740-427-5674).

If you still have questions, or if you are trying to place into more advanced courses, please contact Judy Holdener (holdenerj@kenyon.edu or 740-427-5266).

Courses in Mathematics and Statistics

The Kenyon College faculty voted to change from Kenyon units to semester hours. This change will go into effect for all students who start at the College in the fall of 2024. Both systems will be used throughout the course catalog with the Kenyon units being listed first.

Courses in Mathematics

Seminar in Contemporary Mathematics

MATH 100 CREDITS: 0.25/2

The seminar in contemporary mathematics provides an introduction to the rich and diverse nature of mathematics. Topics covered vary from one semester to the next (depending on faculty expertise) but typically span algebra and number theory, dynamical systems, probability and statistics, discrete mathematics, topology, geometry, logic, analysis and applied math. The course includes guest lectures from professors at Kenyon, a panel discussion with upper-class math majors and opportunities to learn about summer experiences and careers in mathematics. The course goals are threefold: to provide an overview of modern mathematics, which, while not exhaustive, exposes students to some exciting open questions and research problems in mathematics; to introduce students to some of the mathematical research being done at Kenyon; and to expose students to useful resources and opportunities (at Kenyon and beyond) that are helpful in launching a meaningful college experience. This course does not count toward any requirement for the major. Prerequisite or corequisite: MATH 212 (or equivalent) and concurrent enrollment in another MATH, STAT or COMP course. Open only to first- or second-year students. Offered every fall semester.

Surprises at Infinity

MATH 105 CREDITS: 0.5/4 QR

Our intuitions about sets, numbers, shapes and logic all break down in the realm of the infinite. Seemingly paradoxical facts about infinity are the subject of this course. We discuss what infinity is, how it has been viewed through history, why some infinities are bigger than others and how a finite shape can have an infinite perimeter. This very likely is quite different from any mathematics course you have ever taken. This course focuses on ideas and reasoning rather than algebraic manipulation, though some algebraic work will be required to clarify big ideas.

The class is a mixture of lecture and discussion, based on selected readings. Students can expect essay tests, frequent homework and writing assignments. This course does not count toward any major requirement. Students who have credit for MATH 222 may not receive credit for this course. No prerequisite. Offered occasionally.

Calculus I

MATH 111 CREDITS: 0.5/4 QR

The first course in the calculus sequence, this course covers the basic ideas of differential calculus. Differential calculus is concerned primarily with the fundamental problem of determining instantaneous rates of change. In this course, we study instantaneous rates of change from both a qualitative geometric and a quantitative analytic perspective. We cover in detail the underlying theory, techniques and applications of the derivative. Elementary differential equations and their applications are also introduced, along with the basics of anti-differentiation. Students who have 4 credit hours for calculus may not receive credit for MATH 111. This counts toward the core course requirement for the major. Prerequisite: solid grounding in algebra, trigonometry and elementary functions. Offered every semester.

Calculus II

MATH 112 CREDITS: 0.5/4 QR

This is the second course calculus sequence, this course focuses on integration, including Riemann sums, the Fundamental Theorem of Calculus, techniques of integration, numerical methods, and applications of integration. This study leads into the analysis of differential equations by separation of variables, Euler's method, and slope fields. This counts toward the core course requirement for the major. Prerequisite: MATH 111 or the equivalent. Offered every semester.

History of Mathematics in the Islamic World

MATH 128 CREDITS: 0.5/4 QR

This course examines an important and interesting part of the history of mathematics and, more generally, the intellectual history of humankind: the history of mathematics in the Islamic world. Some of the most fundamental notions in modern mathematics have their roots here, such as

the modern number system, the fields of algebra and trigonometry, and the concept of algorithm, among others. In addition to studying specific contributions of medieval Muslim mathematicians in the areas of arithmetic, algebra, geometry and trigonometry in some detail, we examine the context in which Islamic science and mathematics arose, and the role of religion in this development. The rise of Islamic science and its interactions with other cultures (e.g., Greek, Indian and Renaissance European) tell us much about larger issues in the humanities. Thus, this course has both a substantial mathematical component (60-65 percent) and a significant history and social science component (35-40 percent), bringing together three disciplines: mathematics, history and religion. The course counts toward the Islamic Civilization and Cultures concentration but does not count toward any math major requirement.

Prerequisite: solid knowledge of algebra and geometry.

Sequences and Series

MATH 212 CREDITS: 0.25/2

This seven-week course focuses on the concept of convergence of infinite sequences and series of real numbers, with a focus on their applications to Calculus, culminating in an exploration of Taylor series representations of functions. Topics include evaluation of improper integrals, convergence and divergence of sequences, tests for convergence of series, polynomial approximations of functions, power series, and Taylor's Theorem.

This course meets for the first seven weeks of the semester and counts toward the core course requirement for the major. Prerequisite: Math 112 or AP score of 5 on Calculus AB exam or an AB sub-score of 5 on the Calculus BC exam. Students with an AP score of 4 on the Calculus AB exam are encouraged to take the Calculus placement exam. Offered every semester.

Multivariable Calculus

MATH 213 CREDITS: 0.5/4 QR

This course examines differentiation and integration in three dimensions. Topics of study include functions of more than one variable, vectors and vector algebra, partial derivatives, optimization, and multiple integrals. Some of the following topics from vector calculus also are covered as time permits: vector fields, line integrals, flux integrals, curl and divergence. This counts toward

the core course requirement for the major. Prerequisite: MATH 112 or a score of 5 on the AB calculus AP exam, or an AB sub-score of 5 on the BC calculus AP exam. Offered every semester.

Foundations

MATH 222 CREDITS: 0.5/4 QR

This course introduces students to mathematical reasoning and rigor in the context of set-theoretic questions. The course covers basic logic and set theory, relations — including orderings, functions and equivalence relations — and the fundamental aspects of cardinality. The course emphasizes helping students read, write and understand mathematical reasoning. Students are actively engaged in creative work in mathematics. Students interested in majoring in mathematics should take this course no later than the spring semester of their sophomore year. Advanced first-year students interested in mathematics are encouraged to consider taking this course in their first year. This counts toward the core course requirement for the major. This course cannot be taken pass/D/fail. Prerequisite: MATH 213. Offered every semester.

Linear Algebra

MATH 224 CREDITS: 0.5/4 QR

This course focuses on the study of vector spaces and linear functions between vector spaces. Ideas from linear algebra are useful in many areas of higher-level mathematics. Moreover, linear algebra has many applications to both the natural and social sciences, with examples arising in fields such as computer science, physics, chemistry, biology and economics. In this course, we use a computer software system, such as Maple or Matlab, to investigate important concepts and applications. Topics to be covered include methods for solving linear systems of equations, subspaces, matrices, eigenvalues and eigenvectors, linear transformations, orthogonality and diagonalization. Applications are included throughout the course. This counts toward the core course requirement for the major. Prerequisite: MATH 213. Generally offered three out of four semesters.

Combinatorics

MATH 227 CREDITS: 0.5/4 QR

Combinatorics is, broadly speaking, the study of finite sets and finite mathematical structures. A great many mathematical topics are included in this description, including graph theory; combinatorial designs; partially ordered sets; networks; lattices and Boolean algebras; and combinatorial methods of counting, including combinations and permutations, partitions, generating functions, recurring relations, the principle of inclusion and exclusion, and the Stirling and Catalan numbers. This course covers a selection of these topics. Combinatorial mathematics has applications in a wide variety of nonmathematical areas, including computer science (both in algorithms and in hardware design), chemistry, sociology, government and urban planning; this course may be especially appropriate for students interested in the mathematics related to one of these fields. This counts toward the discrete/combinatorial (column C) elective requirement for the major. Prerequisite: MATH 212 or a score of 5 on the BC calculus AP exam. Offered every other year.

Euclidean and Non-Euclidean Geometry

MATH 230 CREDITS: 0.5/4 QR

The "Elements" of Euclid, written over 2,000 years ago, is a stunning achievement. The "Elements" and the non-Euclidean geometries discovered by Bolyai and Lobachevsky in the 19th century form the basis of modern geometry. From this start, our view of what constitutes geometry has grown considerably. This is due in part to many new theorems that have been proved in Euclidean and non-Euclidean geometry but also to the many ways in which geometry and other branches of mathematics have come to influence one another over time. Geometric ideas have widespread use in analysis, linear algebra, differential equations, topology, graph theory and computer science, to name just a few areas. These fields, in turn, affect the way that geometers think about their subject. Students consider Euclidean geometry from an advanced standpoint but also have the opportunity to learn about non-Euclidean geometries. This counts toward the continuous/analytic (column B) elective requirement for the major. Prerequisite: MATH 222. Offered every other year.

Mathematical Problem Solving

MATH 231 CREDITS: 0.25/2

Looking at a problem in a creative way and seeking out different methods toward solving it are essential skills in mathematics and elsewhere. In this course, students build their problem-solving intuition and skills by working on challenging and fun mathematical problems. Common problem-solving techniques in mathematics are covered in each class meeting, followed by collaboration and group discussions, which are the central part of the course. When offered in the fall semester, the course culminates with the Putnam exam on the first Saturday in December. Interested students who have a conflict with that date should contact the instructor. This does not count toward any requirement for the major. Prerequisite: MATH 212 or a score of 5 on the BC calculus exam.

Introduction to Differential Equations

MATH 233 CREDITS: 0.5/4

This course is an introduction to ordinary differential equations (ODEs). The course discusses techniques for finding, analyzing, and interpreting solutions of ODEs using exact methods, numerical methods, series solutions and qualitative approaches. We discuss first- and second-order differential equations, as well as first-order systems of differential equations. Applications are woven throughout the course. Other topics, as time permits. This course counts toward the computational/modeling (column D) elective requirement for the major. Prerequisite: MATH 224.

Mathematical Biology

MATH 258 CREDITS: 0.5/4 QR

In biological sciences, mathematical models are becoming increasingly important as tools for turning biological assumptions into quantitative predictions. In this course, students learn how to fashion and use these tools to explore questions ranging across the biological sciences. We survey a variety of dynamic modeling techniques, including both discrete and continuous approaches. Biological applications may include population dynamics, molecular evolution, ecosystem stability, epidemic spread, nerve impulses, sex allocation and cellular transport processes. The course is appropriate both for math majors interested in biological applications and for biology majors who want the mathematical tools necessary to address complex, contemporary questions. As science is becoming an increasingly collaborative effort, biology

and math majors are encouraged to work together on many aspects of the course. Coursework includes homework, problem-solving exercises and short computational projects. Final independent projects require the development and extension of an existing biological model selected from the primary literature. This course builds on (but is not limited by) an introductory-level knowledge base in both math and biology. Interested biology and math majors lacking a prerequisite are encouraged to consult with the instructor. This counts toward the computational/modeling/applied (column D) elective requirement for the major. Prerequisite: STAT 106 or MATH 111 or 112 (or any math or statistics AP credit of 4 or 5), and either BIOL 115 or 116. Offered every other year.

Mathematical Logic

MATH 322 CREDITS: 0.5/4

This course is a mathematical examination of the formal language most common in mathematics: predicate calculus. We examine various definitions of meaning and proof for this language and consider its strengths and inadequacies. We develop some elementary computability theory en route to rigorous proofs of Godel's Incompleteness Theorems. Concepts from modal logic, model theory and other advanced topics are discussed as time permits. This counts toward the algebraic (column A) elective for the major. Prerequisite: MATH 222. Offered occasionally.

Applied Linear Algebra

MATH 325 CREDITS: 0.5/4

This is a second course focusing on the use of linear algebra to solve large-scale data and image problems. Applications may include, but are not limited to, tomography to reconstruct a 3-D image of a brain, regression to model climate data, prediction of long-term behavior of populations, fractal generation, image-blurring and edge detection, algorithmic approaches to suggest movies to users, linear classifiers to identify cancer risk, and linear optimization for resource allocation. Linear algebra concepts and tools are developed as needed to address the presented problems. In addition to extensions of topics from the first linear algebra course, this course includes a selection of topics from the following list: abstract vector spaces, orthogonal subspaces and projection operators, norms and inner products, Markov matrices, matrix

decompositions (LU, Cholesky, Schur, SVD), and support vector machines. Solutions to or simulations of the applied problems presented are implemented in Matlab or similar software. This course counts toward the applied focus (column D) elective for the major. Prerequisite: Math 224.

Number Theory Seminar

MATH 327 CREDITS: 0.5/4 QR

Patterns within the set of natural numbers have enticed mathematicians for well over two millennia, making number theory one of the oldest branches of mathematics. Rich with problems that are easy to state but fiendishly difficult to solve, the subject continues to fascinate professionals and amateurs alike. In this course, we get a glimpse at both the old and the new. In the first two-thirds of the semester, we study topics from classical number theory, focusing primarily on divisibility, congruences, arithmetic functions, sums of squares and the distribution of primes. In the final weeks, we explore some of the current questions and applications of number theory. We study the famous RSA cryptosystem, and students read and present some current (carefully chosen) research papers. This counts toward either a discrete/combinatorial (column C) or an algebraic (column A) elective requirement for the major. Prerequisite: MATH 222, prerequisite or corequisite: MATH 212. Offered every other year.

Coding Theory and Cryptography

MATH 328 CREDITS: 0.5/4 QR

Coding theory (the theory of error-correcting codes), and cryptography are two important applications of algebra and discrete mathematics to information and communications systems. While coding theory is concerned with the reliability of communication, the main problem of cryptography is the security and privacy of communication. Applications of coding theory range from enabling the clear transmission of pictures from distant planets to quality of sound in compact disks and wireless communication. Error correcting codes play a key role in quantum computing. With the ever increasing role of digital communication, online transactions, the general dependence on electronic systems in modern life, and the emergence of quantum computers, the importance of these fields grows each day. In this course, students will learn the basic ideas of coding theory and cryptography, understand their mathematical foundations, and

learn how mathematical tools can be used to devise useful error correcting codes and cryptographic systems. A selection of topics from these two disciplines will be discussed including basics of block coding, linear codes, Hamming codes, cyclic codes, symmetric-key and public-key cryptography, digital signatures, and code-based cryptography. Other than some basic linear algebra, the necessary mathematical background (mostly abstract algebra) is covered within the course. This counts toward either a discrete/combinatorial (column C) or an algebraic (column A) elective requirement for the major. Prerequisite: MATH 222 and MATH 224. Offered every other year.

Principles of Applied Mathematics

MATH 330 CREDITS: 0.5/4

This course provides a survey of several techniques used in applied mathematics. We discuss the mathematical formulation of models for a variety of processes that arise in the natural and social sciences. We derive the appropriate equations to describe these processes and use techniques from calculus, differential equations, linear algebra and numerical methods when needed. This course may touch on topics like dimensional analysis, scaling, kinetic equations and perturbation methods. Students have the opportunity to investigate applications within their fields of interest such as biology, medicine, physics, chemistry and finance. A strong background in calculus is essential; a familiarity with differential equations is recommended but not required. This counts toward the computation/modeling/applied (column D) elective requirement for the major. Prerequisite: MATH 213. Sophomore standing. Offered every other year.

Ordinary Differential Equations

MATH 333 CREDITS: 0.5/4 QR

Ordinary differential equations (ODEs) arise naturally to model systems that occur in physics, biology, chemistry and economics. This course discusses techniques for finding, analyzing, and interpreting solutions of ODEs using analytic, numerical and qualitative techniques. We discuss first-and second-order ODEs, as well as first-order systems of ODEs. Applications are woven throughout the course. Other topics, as time permits. This course counts toward the

computational/modeling (column D) elective requirement for the major. Prerequisite: MATH 224. Offered every other fall.

Abstract Algebra I

MATH 335 CREDITS: 0.5/4 QR

Abstract algebra is the study of algebraic structures that describe common properties and patterns exhibited by seemingly disparate mathematical objects. The phrase "abstract algebra" refers to the fact that some of these structures are generalizations of the material from high school algebra relating to algebraic equations and their methods of solution. In this course, we focus entirely on group theory. A group is an algebraic structure that allows one to describe symmetry in a rigorous way. The theory has many applications in physics and chemistry. Since mathematical objects exhibit pattern and symmetry as well, group theory is an essential tool for the mathematician. Furthermore, group theory is the starting point in defining many other more elaborate algebraic structures including rings, fields and vector spaces. We cover the basics of groups, including the classification of finitely generated abelian groups, factor groups, the three isomorphism theorems and group actions. The course culminates in a study of Sylow theory. Throughout the semester there is an emphasis on examples, many of them coming from calculus, linear algebra, discrete math and elementary number theory. There also are a couple of projects illustrating how a formal algebraic structure can empower one to tackle seemingly difficult questions about concrete objects (e.g., the Rubik's cube or the card game SET). Finally, there is a heavy emphasis on the reading and writing of mathematical proofs. Junior standing is recommended. This counts toward the algebraic (column A) elective requirement for the major. Prerequisite: MATH 222. Offered every other fall.

Probability

MATH 336 CREDITS: 0.5/4 QR

This course provides a calculus-based introduction to probability. Topics include basic probability theory, random variables, discrete and continuous distributions, mathematical expectation, functions of random variables and asymptotic theory. This counts toward either a discrete/combinatorial (column C) or continuous/analytic (column B) elective requirement for the major. Prerequisite: MATH 213. Offered every fall.

Real Analysis I

MATH 341 CREDITS: 0.5/4 QR

This course is a first introduction to real analysis. "Real" refers to the real numbers. Much of our work revolves around the real number system. We start by carefully considering the axioms that describe it. "Analysis" is the branch of mathematics that deals with limiting processes. Thus the concept of distance is also a major theme of the course. In the context of a general metric space (a space in which we can measure distances), we consider open and closed sets, limits of sequences, limits of functions, continuity, completeness, compactness and connectedness. Other topics may be included if time permits. Junior standing is recommended. This counts toward the continuous/analytic (column B) elective requirement for the major. Prerequisite: MATH 212 and 222. Offered every other fall.

Mathematical Models

MATH 347 CREDITS: 0.5/4 QR

This course introduces students to the concepts, techniques and power of mathematical modeling. Both deterministic and probabilistic models are explored, with examples taken from the social, physical and life sciences. Students engage cooperatively and individually in the formulation of mathematical models and in learning mathematical techniques used to investigate those models. This counts toward the computational/modeling/applied (column D) elective requirement for the major. Prerequisite: STAT 106 and MATH 224 or 258. Offered every other year.

Complex Functions

MATH 352 CREDITS: 0.5/4 QR

The course starts with an introduction to the complex numbers and the complex plane. Next, students are asked to consider what it might mean to say that a complex function is differentiable (or analytic, as it is called in this context). For a complex function that takes a complex number z to $f(z)$, it is easy to write down (and make sense of) the statement that f is analytic at z if

$$\lim_{z \rightarrow z_0} \frac{f(z) - f(z_0)}{z - z_0}$$

exists. Subsequently, we study the amazing results that come from making such a seemingly innocent assumption. Differentiability for functions of one complex variable turns out to be very different from differentiability in functions of one real variable. Topics covered include analyticity and the Cauchy-Riemann equations, complex integration, Cauchy's Theorem and its consequences, connections to power series, and the Residue Theorem and its applications. This counts toward the continuous/analytic (column B) elective requirement for the major. Prerequisite: MATH 212 and MATH 224. Offered every other year.

Topology

MATH 360 CREDITS: 0.5/4 QR

Topology is an area of mathematics concerned with properties of geometric objects that remain the same when the objects are "continuously deformed." Three of these key properties in topology are compactness, connectedness and continuity; the mathematics associated with these concepts is the focus of the course. Compactness is a general idea helping us to more fully understand the concept of limit, whether of numbers, functions or even geometric objects. For example, the fact that a closed interval (or square, or cube, or n-dimensional ball) is compact is required for basic theorems of calculus. Connectedness is a concept generalizing the intuitive idea that an object is in one piece: The most famous of all the fractals, the Mandelbrot Set, is connected, even though its best computer-graphics representation might make this seem doubtful. Continuous functions are studied in calculus, and the general concept can be thought of as a way by which functions permit us to compare properties of different spaces or as a way of modifying one space so that it has the shape or properties of another. Engineering, chemistry and physics are among the subjects that find topology useful. The course touches on selected topics that are used in applications. This counts toward the continuous/analytic (column B) elective requirement for the major. Prerequisite: MATH 222 or permission of instructor. Generally offered every two to three years.

Partial Differential Equations

MATH 433 CREDITS: 0.5/4

Partial differential equations (PDEs) arise naturally to model spatially-dependent systems that occur in physics, biology, and finance. This course covers analytic, numerical and qualitative methods for the solution and understanding of PDEs. Topics may include separation of variables, transform methods, nonlinear waves and shocks, and computational methods. This counts toward the computation/modeling/applied (column D) elective requirement for the mathematics major. Prerequisite: MATH 333. Offered every other spring.

Abstract Algebra II

MATH 435 CREDITS: 0.5/4 QR

This course picks up where MATH 335 ends, focusing primarily on rings and fields. Serving as a good generalization of the structure and properties exhibited by the integers, a ring is an algebraic structure consisting of a set together with two operations — addition and multiplication. If a ring has the additional property that division is well-defined, one gets a field. Fields provide a useful generalization of many familiar number systems: the rational numbers, the real numbers and the complex numbers. Topics to be covered include polynomial rings; ideals; homomorphisms and ring quotients; Euclidean domains, principal ideal domains and unique factorization domains; the Gaussian integers; factorization techniques; and irreducibility criteria. The final block of the semester serves as an introduction to field theory, covering algebraic field extensions, symbolic adjunction of roots, construction with ruler and compass, and finite fields. Throughout the semester there is an emphasis on examples, many of them coming from calculus, linear algebra, discrete math and elementary number theory. There also is a heavy emphasis on the reading and writing of mathematical proofs. This counts toward the algebraic (column A) elective requirement for the major. Prerequisite: MATH 335. Offered every other spring.

Real Analysis II

MATH 441 CREDITS: 0.5/4 QR

This course follows MATH 341. Topics include a study differentiation and (Riemann) integration of functions of one variable, sequences and series of functions, power series and their properties, iteration and fixed points. Other topics may be included as time permits. For example: a discussion of Newton's method or other numerical techniques; differentiation and

integration of functions of several variables; spaces of continuous functions; the implicit function theorem; and everywhere continuous, nowhere differentiable functions. This counts toward the continuous/analytic (column B) elective requirement for the major. Prerequisite: MATH 341.

Offered every other spring.

Senior Seminar in Mathematics

MATH 480 CREDITS: 0.25/2

The senior seminar in mathematics provides a structure to aid students in successfully completing the Mathematics and Statistics Capstone requirement. Students who participate in a 3-2 program ordinarily take this course in their junior year. Students with December anticipated graduation dates take the seminar in their sixth semester (in the third semester before graduation). This schedule makes it possible for students who do not succeed in their first try at the capstone to take full advantage of the “second chance” option without delaying their graduation timeline.

Students who do not successfully complete their capstone in the fall semester will be assigned NG (no grade) at the end of the senior seminar. This designation will change to a CR when the student successfully completes the capstone, usually at the end of the following semester. This course is a core requirement for the mathematics major. Prerequisite: MATH 222 and at least one 300+-level course in Mathematics or Statistics. The course is offered every fall semester. The course is credit/no credit.

Individual Study

MATH 493 CREDITS: 0.25-0.5/2-4

Individual study is a privilege reserved for students who want to pursue a course of reading or complete a research project on a topic not regularly offered in the curriculum. It is intended to supplement, not take the place of, coursework. Individual study cannot be used to fulfill requirements for the major. To qualify, a student must identify a member of the mathematics department willing to direct the project. The professor, in consultation with the student, creates a tentative syllabus (including a list of readings and/or problems, goals and tasks) and describes in some detail the methods of assessment (e.g., problem sets to be submitted for evaluation

biweekly; a 20-page research paper submitted at the course's end, with rough drafts due at given intervals; and so on). The department expects the student to meet regularly with his or her instructor for at least one hour per week. All standard enrollment/registration deadlines for regular college courses apply. Because students must enroll for individual studies by the end of the seventh class day of each semester, they should begin discussion of the proposed individual study by the semester before, so that there is time to devise the proposal and seek departmental approval. Individual study courses may be counted as electives in the mathematics major, subject to consultation with and approval by the Department of Mathematics and Statistics. Permission of instructor and department chair required. No prerequisite.

Senior Honors

MATH 498 CREDITS: 0.25/2 QR

This course consists largely of an independent project in which students read several sources to learn about a mathematical topic that complements material studied in other courses, usually an already completed depth sequence. This study culminates in an expository paper and a public or semi-public presentation before an audience consisting of at least several members of the mathematics faculty as well as an outside examiner. Permission of department chair required. Prerequisite: senior standing and the completion of at least one two-semester sequence at the junior-senior level.

Courses in Statistics

Elements of Statistics

STAT 106 CREDITS: 0.5/4 QR

This is a basic course in statistics. The topics covered are the nature of statistical reasoning, graphical and descriptive statistical methods, design of experiments, sampling methods, probability, probability distributions, sampling distributions, estimation and statistical inference. Confidence intervals and hypothesis tests for means and proportions are studied in the one- and two-sample settings. The course concludes with inference-regarding correlation, linear regression, chi-square tests for two-way tables and one-way ANOVA. Statistical software is used throughout the course, and students engage in a wide variety of hands-on projects. This

counts toward the core course requirement for the major. Students with credit for STAT 116 cannot take STAT 106 for credit. No prerequisite. Offered every semester.

Statistics in Sports

STAT 116 CREDITS: 0.5/4 QR

Appropriate applications of statistical methods have changed the way some Major League Baseball teams manage the game. (See "Moneyball: The Art of Winning an Unfair Game.") Statistics are used in other sports to evaluate the performance of individual players or teams. The focus of this course is on the proper application of statistical models in sports. Students use appropriate methods to examine interesting questions such as: Are there unusual patterns in the performance statistics of "steroid sluggers" such as Barry Bonds and Mark McGwire or pitchers such as Roger Clemens? Other possible topics include the impact of a penalty kick in soccer, home-field advantage in football, technological improvements in golf or cycling, and of training methods in marathon running. Although the sport and question of interest change, the focus on proper applications of appropriate statistical methods remains the same. Students analyze data and present their results to the class. Oral and written reports are expected. This counts toward the core course requirement for the major. Students with credit for STAT 106 cannot take STAT 116 for credit. No prerequisite. Offered occasionally.

Data Analysis

STAT 206 CREDITS: 0.5/4 QR

This course focuses on choosing, fitting, assessing and using statistical models. Simple linear regression, multiple regression, analysis of variance, general linear models, logistic regression and discrete data analysis provide the foundation for the course. Classical inference methods that rely on the normality of the error terms are thoroughly discussed, and general approaches for dealing with data where such conditions are not met are provided. For example, distribution-free techniques and computer-intensive methods, such as bootstrapping and permutation tests, are presented. Students use statistical software throughout the course to write and present statistical reports. The culminating project is a complete data analysis report for a real problem chosen by the student. The MATH 106–206 sequence provides a thorough foundation for statistical work in economics, psychology, biology, political science and many

other fields. This counts toward the statistical/data science (column E) elective for the major. Prerequisite: STAT 106 or 116, or a score of 4 or 5 on the AP statistics exam. Offered every semester.

Nonparametric Statistics

STAT 216 CREDITS: 0.5/4 QR

This course focuses on nonparametric and distribution-free statistical procedures. These procedures rely heavily on counting and ranking techniques. In the one- and two-sample settings, the sign, signed-rank and Mann-Whitney-Wilcoxon procedures are discussed. Correlation and one-way analysis of variance techniques also are investigated. A variety of special topics are used to wrap up the course, including bootstrapping, censored data, contingency tables and the two-way layout. The primary emphasis is on data analysis and the intuitive nature of nonparametric statistics. Illustrations come from real data sets, and students are asked to locate an interesting data set and prepare a report detailing an appropriate nonparametric analysis. This counts toward the statistical/data science (column E) elective for the major. Prerequisite: STAT 106 or 116, or a score of 4 or 5 on the AP statistics exam. Offered every other year.

Statistical Computing in R

STAT 226 CREDITS: 0.5/4

This course provides a mathematical introduction to probability and statistics using R statistical software. The primary goal of the course is to learn and apply Monte-Carlo simulation techniques to a wide variety of problems. We focus on solving problems from a numerical point of view, with methods to complete numerical integration, root finding, curve fitting, variance reduction and optimization. Core knowledge of R and basic programming concepts are introduced. Case studies and projects are independently completed throughout the semester. This counts toward the statistical/data science (column E) elective for the major. Prerequisite: STAT 106 or STAT 116. Offered every other year.

Topics in Statistics

STAT 306 CREDITS: 0.5/4

Each offering of this course approaches the study of variability using a particular set of statistical tools (such as Bayesian Analysis, biostatistics, sports analytics, experimental design or statistical machine learning). Specific statistical methodology within a subfield of the discipline is examined. A large component of each offering involves intensive projects in which students are expected to determine which statistical methods are appropriate for a given setting before analyzing data. As part of these projects and daily activities, students use R to analyze data to make inferences about the population characteristics of interest. Additionally, written and oral communication are a regular part of the course. The course may be repeated for credit as long as the subfield is different. That is, students may receive credit for each specific subfield only once. This counts toward the statistical/data science (column E) elective for the major. Prerequisite: any STAT course at the 200 level or higher. Offered every spring.

Additional information for different subfields:

<https://www.kenyon.edu/academics/departments-and-majors/mathematics-statistics/academic-program-requirements/courses-in-statistics/stat-306-topics/>

Linear Regression Models

STAT 416 CREDITS: 0.5/4 QR

This course focuses on linear regression models. Simple linear regression with one predictor variable serves as the starting point. Models, inferences, diagnostics and remedial measures for dealing with invalid assumptions are examined. The matrix approach to simple linear regression is presented and used to develop more general multiple regression models. Building and evaluating models for real data are the ultimate goals of the course. Time series models, nonlinear regression models and logistic regression models also may be studied if time permits. This counts toward the statistical/data science (column E) elective for the major. Prerequisite: STAT 106 or 116, and MATH 224. Offered every other spring.

Mathematical Statistics

STAT 436 CREDITS: 0.5/4 QR

This course follows MATH 336 and introduces the mathematical theory of statistics. Topics include sampling distributions, order statistics, point estimation, maximum likelihood estimation,

methods for comparing estimators, interval estimation, moment-generating functions, bivariate transformations, likelihood ratio tests and hypothesis testing. Computer simulations accompany and corroborate many of the theoretical results. Course methods often are applied to real data sets. This counts toward the statistical/data science (column E) elective for the major.

Prerequisite: MATH 336. Offered every other spring.

Individual Study

STAT 493 CREDITS: 0.25-0.5/2-4

Individual study is a privilege reserved for students who want to pursue a course of reading or complete a research project on a topic not regularly offered in the curriculum. It is intended to supplement, not take the place of, coursework. Individual study cannot be used to fulfill requirements for the major. Individual studies will earn 0.25-0.5 units of credit. To qualify, a student must identify a member of the mathematics department willing to direct the project. The professor, in consultation with the student, creates a tentative syllabus (including a list of readings and/or problems, goals and tasks) and describes in some detail the methods of assessment (e.g., problem sets to be submitted for evaluation biweekly; a 20-page research paper submitted at the course's end, with rough drafts due at given intervals; and so on). The department expects the student to meet regularly with the instructor for at least one hour per week. All standard enrollment/registration deadlines for regular college courses apply. Because students must enroll for individual studies by the end of the seventh class day of each semester, they should begin discussion of the proposed individual study by the semester before, so that there is time to devise the proposal and seek departmental approval. Permission of instructor and department chair required. Individual study courses may be counted as electives in the major, subject to consultation with and approval by the Department of Mathematics and Statistics. No prerequisite.