Term Information

Effective Term   Autumn 2018

General Information

Course Bulletin Listing/Subject Area   Mathematics
Fiscal Unit/Academic Org   Mathematics - D0671
College/Academic Group   Arts and Sciences
Level/Career   Undergraduate
Course Number/Catalog   3345H
Course Title   Honors Foundations of Higher Mathematics
Transcript Abbreviation   Hon Fnd High Math
Course Description   A systematic introduction to problem solving and proof-writing through interesting, non-trivial mathematics. This class serves as a bridge between a problem-oriented Calculus class and the more conceptual classes in the math major. Additionally, this class exposes students to some of math's greatest intellectual successes.
Semester Credit Hours/Units   Fixed: 3

Offering Information

Length Of Course   14 Week
Flexibly Scheduled Course   Never
Does any section of this course have a distance education component?   No
Grading Basis   Letter Grade
Repeatable   No
Course Components   Lecture
Grade Roster Component   Lecture
Credit Available by Exam   No
Admission Condition Course   No
Off Campus   Never
Campus of Offering   Columbus

Prerequisites and Exclusions

Prerequisites/Corequisites   C- or better in 2153, 2162.xx, 2173, or 2182H; or credit for 254.xx, 263.xx or 263.01H.
Exclusions
Electronically Enforced   Yes

Cross-Listings

Cross-Listings

Subject/CIP Code

Subject/CIP Code   27.0101
Subsidy Level   Baccalaureate Course
Intended Rank   Freshman, Sophomore, Junior

Requirement/Elective Designation

Required for this unit's degrees, majors, and/or minors

Course Details

Course goals or learning objectives/outcomes	• Understanding the basis of mathematical logic • Understand axioms of set theory and properties of sets • Understand the basis of function theory and applications to mathematical objects • Understand and be able to construct coherent mathematical proofs
Content Topic List	• Introduction to set theory • Logic • Techniques of mathematical proof • Introduction to function theory
Sought Concurrence	No

Attachments

• 3345-syllabus.pdf: Non-honors syllabus

  (Other Supporting Documentation. Owner: Husen,William J)

• 3345-schedule.pdf: Non-honors schedule

  (Other Supporting Documentation. Owner: Husen,William J)

• 3345H-syllabus.pdf: Honors syllabus

  (Syllabus. Owner: Husen,William J)

• 3345H-schedule.pdf: Honors schedule

  (Other Supporting Documentation. Owner: Husen,William J)

• 3345H-intended-audience.pdf: Intended audience

  (Other Supporting Documentation. Owner: Husen,William J)

• 3345H-qualitative-difference.pdf: Statement of qualitative difference

  (Statement of Qualitative Difference. Owner: Husen,William J)

• Curriculum_map_master_20180223.pdf: Curriculum map - master

  (Other Supporting Documentation. Owner: Husen,William J)

Comments

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Husen,William J	02/23/2018 11:00 AM	Submitted for Approval
Approved	Husen,William J	02/23/2018 11:01 AM	Unit Approval
Approved	Haddad,Deborah Moore	02/23/2018 12:16 PM	College Approval
Pending Approval	Nolen,Dawn Vankeerbergen,Bernadette Chantal Oldroyd,Shelby Quinn Hanlin,Deborah Kay Jenkins,Mary Ellen Bigler	02/23/2018 12:16 PM	ASCCAO Approval
Pending Approval	Chamberlain,Lindsey Joyce	02/26/2018 11:00 AM	Ad-Hoc Approval

Mathematics 3345H

Meeting Time:

Website:

Instructor:

Office:

Phone Number:

Email:

Office Hours:

Texts: Official text:
A Concise Introduction to Pure Mathematics by Martin Liebeck
Additional Supplemental Texts:
Book of Proof by Richard Hammack (FREE!), explains proof techniques,
Mathematical Reasoning by Ted Sundstrom (FREE!), a very detailed text on the core topics,
Mathematics and Logic by Mark Kac and Stanislaw Ulam, touching briefly on many beautiful mathematical topics while giving a feel for the unity of mathematics,
Proofs from the Book by Martin Aigner and Günter Ziegler, providing many additional topics.

Content: Math 3345H is a Foundations of Higher Mathematics class aimed at strong, enthusiastic students. Its primary goal is to be a systematic introduction to problem solving and proof-writing through *interesting, non-trivial mathematics*. This goal should help the class serve as a bridge between a problem-oriented Calculus class and the more conceptual classes in the math major. Its secondary goal is to generate excitement about mathematics by exposing students to some of math's greatest intellectual successes, many of which do not easily fit into standardized undergraduate classes.
While many students taking this class are interested in majoring in a technical field and have seen Calculus, this class does not rely on much background material. For the most part, the class will make do with high school algebra. Instead, the focus is becoming more fluent in and comfortable with abstraction.

Technology: Use of laptops and tablet devices is permitted. If you think that your use of your devices may be distracting, please sit towards the back of the class. If you must text or surf on your phone, please keep it where no one can see it.

Homework: Homework will be collected weekly at the beginning of class on the due date. No late homework will be accepted. The two lowest homework scores will be dropped. Homework involves routine practice, proof-writing, and some non-trivial problems. Optional bonus problems will be provided for students who want a challenge.

Homework can be handwritten (if legible), word processed, or in some variety of TeX. If wordpressed or in TeX, please use at least 12 point font. Emailed homework will not be accepted except under special circumstances.

Turned-in homework should have your full name and be stapled.

In-class activities: There will be some in-class activities where students work together in groups to solve more difficult problems that combine several concepts.

Writing Project: The writing project is an expository report of eight to ten pages on a mathematical topic not covered in class (some possibilities are among the additional topics below). The intended audience for such a report would be another strong undergraduate student with no training in mathematics besides a typical high school course of study. Students will be graded on the correctness of their mathematics and quality of their exposition.

Bonus: There will be harder bonus problems on the homework and on exams. While they earn extra credit, they give students a chance to distinguish themselves if they might like to request a letter of recommendation from the instructor. Extra credit will be used to decide grades for border cases.

Exams: There will be two in-class midterm exams and a comprehensive final.

Midterm 1	date	in class
Midterm 2	date	in class
Final Exam	date	time

Exams are closed book and closed notes. The exams may contain some problems requiring novel thought.

Makeup midterms will be given only under very special circumstances. If a midterm is missed and the instructor is given prior notice and official documentation of an emergency or illness, the other exams will be re-weighted.

Grading:

Homework and Participation	10%
Writing Project	20%
Midterm exams	40%
Final exam	30 %

Individual test scores will not be re-centered. Raw scores will be used to compute overall course scores. Course grades will be determined by applying cut-offs to the course scores. The instructor will not take personal factors into account when assigning course grades.

Grade Revisions: You may request that homework or exams be regraded. This request must be *in writing* and turned in at the beginning of the class immediately after the work is returned to you. No late grade revision requests will be accepted.

Academic Misconduct: It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-48.7). For additional information, see the Code of Student Conduct at `http://studentlife.osu.edu/csc/`.

CCS: As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life Counseling and Consultation Services (CCS) by visiting `ccs.osu.edu` or calling 614-292- 5766. CCS is located on the 4th Floor of the Younkin Success Center and 4th Floor of the PAES Building. 24 hour emergency help is also available through the National 24/7 Prevention Hotline at 1-800-273-TALK or at `suicidepreventionlifeline.org`.

Diversity:	The Ohio State University affirms the importance and value of diversity in the student body. Our programs and curricula reflect our multicultural society and global economy and seek to provide opportunities for students to learn more about persons who are different from them. We are committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among each member of our community; and encourages each individual to strive to reach his or her own potential. Discrimination against any individual based upon protected status, which is defined as age, color, disability, gender identity or expression, national origin, race, religion, sex, sexual orientation, or veteran status, is prohibited.
SLDS Statement:	The University strives to make all learning experiences as accessible as possible. If you anticipate requiring accommodations based on a disability (including mental health, chronic or temporary medical conditions), you are encouraged to register as soon as possible with the Student Life Disability Services to establish reasonable accommodations. After registration, please make arrangements with me so that they may be implemented in a timely fashion. SLDS contact information: `slds@osu.edu`; 614-292-3307; `slds.osu.edu`; 098 Baker Hall, 113 W. 12th Avenue.

Possible Writing Project topics (if not covered by instructor)

1. Discrete mathematics

   (a) Inclusion/exclusion, counting, and generating functions
   (b) Sperner's Lemma;
   (c) Pick's theorem;
   (d) Planar graphs and Euler's formula;
   (e) Ramsey's theorem;
   (f) Solving recurrences with initial conditions; the Fibonacci recurrence and formulas for F_n;

2. Number theory

   (a) Euler's proof of the infinitude of primes by harmonic series, the zeta function;
   (b) The rational roots theorem and irrationality of non-integer roots of monic integral polynomials;
   (c) Irrationality of e, transcendentality of e and π;
   (d) Liovuille's theorem and examples of transcendental numbers;
   (e) Pythagorean triples and parameterization of the circle;
   (f) Linear Diophantine equations, Pell's equation

3. Set theory

   (a) Algebraic numbers and their cardinality, Cantor's argument for existence of transcendental numbers;
   (b) The Schröder-Bernstein theorem;

4. Geometry

   (a) Platonic solids, definition and classification;
   (b) Tilings of the plane;
   (c) Hilbert's Third Problem and Dehn's invariant;

5. Analysis

   (a) Cantor sets;
   (b) The definition of continuity and nowhere continuous functions;
   (c) Applications of the intermediate value theorem to surjectivity of functions, applications of the mean value theorem to injectivity of functions;

6. Abstract algebra

   (a) Symmetric groups, symmetry groups of geometric figures;
   (b) Solvability of the cubic by discriminants and symmetry breaking in S_3;
   (c) Quadratically constructible numbers and the impossibility of doubling the cube;

(d) Signs of permutations and the 15 puzzle;

7. Applications to economics

   (a) Fixed point theorems;
   (b) Nash equilibria and basic game theory;

8. Computer science

   (a) Examples of NP-complete problems and their equivalences;
   (b) Turing machines and decidability.

Math 3345H Schedule

Topics that are in Math 3345H but not Math 3345 are marked with an asterisk. As per the foundational documents for the class, the instructor is given wide lattitude over which topics to include. Here, the instructor has chosen to make this class about basic number theory leading up to a discussion of cryptography. Consequently, most of the new topics are marked with an asterisk involve number theory.

Date	Topic
Aug. 23 (2 days)	Intro, motivation, Sets
Aug. 28 (3 days)	Intersection, union, implication, basic proofs
Sep. 4 (2 days)	Proof by contradiction, proof by contrapositive, quantifiers
Sep. 11 (3 days)	Real numbers, rational numbers, irrationality proofs ($\sqrt{2}$)
Sep. 18 (3 days)	More irrationality proofs, decimal expansions, repeating and non-repeating decimals*
Sep. 25 (3 days)	Inequalities among real numbers*, review, midterm 1
Oct. 2 (3 days)	Functions, injectivity, surjectivity
Oct. 9 (2 days)	Pigeonhole principle, Infinite sets
Oct. 16 (3 days)	Cantor's theorem on the continuum, Induction and complete induction
Oct. 23 (3 days)	Properties of the integers, primes, infinitude of primes, Existence of factorization, Greatest common divisor
Oct. 30 (3 days)	Euclidean algorithm*, Fundamental theorem of Arithmetic, Congruence and equivalence classes
Nov. 6 (2 days)	Fermat's little theorem*, Euler's ϕ function*
Nov. 13 (3 days)	Euler's generalization of Fermat's little theorem*, review, midterm 2
Nov. 20 (1 day)	RSA encryption*
Nov. 27 (3 days)	Permutations, Binomial and multinomial coefficients, binomial theorem
Dec. 4 (2 days)	More counting, review

Mathematics 3345

Meeting Time:

Website:

Instructor:

Office:

Phone Number:

Email:

Office Hours:

Text:	**The Fundamentals of Higher Mathematics** by Neil Falkner
Content:	We will certainly cover sections 1 through 11 of the text and will try to cover a couple additional sections.
	The focus of this class will be learning how to read and write mathematical proofs. The mathematical content, while important, is secondary to the reading and writing goals. Consequently, the standards for writing in this class will be higher than in previous math classes. There will be a number of in-class activities to develop students' writing skills. Students are expected to memorize definitions and statements of theorems.
Technology:	Use of laptops and tablet devices is permitted. If you think that your use of your devices may be distracting, please sit towards the back of the class. If you must text or surf on your phone, please keep it where no one can see it.
Homework:	Homework will be collected at the beginning of class most days. No late homework will be accepted. The five lowest homework scores will be dropped.
	Homework can be handwritten (if legible), word processed, or in some variety of TeX. If wordpressed or in TeX, please use at least 12 point font. Emailed homework will not be accepted except under special circumstances.
	Turned-in homework should have your full name and be stapled.

Exams:

There will be two in-class midterm exams and a comprehensive final.

Midterm 1	date	in class
Midterm 2	date	in class
Final Exam	date	time

Exams are closed book and closed notes. Problems on the exams will generally be similar to the homework problems. The instructor will be maintaining a list of the type of problems that can be asked on the exam.

Makeup midterms will be given only under very special circumstances. If a midterm is missed and the instructor is given prior notice and official documentation of an emergency or illness, the other exams will be re-weighted.

Writing:

The purpose of writing in mathematics is not merely to demonstrate that *you know something* but rather to *explain the material to someone who does not yet know it.* Consequently, you should provide sufficient details and aim to write with clarity. We will discuss this in class.

Grading:

Homework and Participation	20%
Midterm exams	40%
Final exam	40%

Individual test scores will not be re-centered. Raw scores will be used to compute overall course scores. Course grades will be determined by applying cut-offs to the course scores. The instructor will not take personal factors into account when assigning course grades.

Grade Revisions:

You may request that homework or exams be regraded. This request must be *in writing* and turned in at the beginning of the class immediately after the work is returned to you. No late grade revision requests will be accepted.

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Math 3345 Schedule

Date	Topic
Date	**Topic**
Aug. 23 (2 days)	Intro, motivation, Sentences, logical connectives, DeMorgan laws, truth tables, distributive laws
Aug. 28 (3 days)	Conditional sentences, implication, Conditional proof, basic proofs about even and odd integers, Quantifiers
Sep. 4 (2 days)	More quantified statements, order of quantifiers, unique existence
Sep. 11 (3 days)	Axioms of integers, divisibility, primes, infinitude of primes
Sep. 18 (3 days)	Rational numbers, irrational numbers, irrationality of $\sqrt{2}$, Congruence
Sep. 25 (3 days)	Induction, review, midterm 1
Oct. 2 (3 days)	Binomial coefficients, division algorithm, complete induction
Oct. 9 (2 days)	Examples of complete induction, Existence of factorization into primes
Oct. 16 (3 days)	Uniqueness of factorization, Sets, specification of sets
Oct. 23 (3 days)	Set operations, Pairwise disjointness, Indexed unions and intersections, Cartesian product
Oct. 30 (3 days)	Functions, Composition, Surjections
Nov. 6 (2 days)	Injections, Bijections
Nov. 13 (3 days)	Inverse functions, review, midterm
Nov. 20 (1 day)	More on compositions and injectivity
Nov. 27 (3 days)	Cardinality and counting, infinite sets, examples of bijections
Dec. 4 (2 days)	Cantor's theorem on the continuum, review

MATH 3345H INTENDED AUDIENCE

Math 3345H is an Introduction to Higher Mathematics aimed at strong, enthusiastic students. Its primary goal is to be a systematic introduction to problem solving and proof-writing through *interesting, non-trivial mathematics*. This goal should help the class serve as a bridge between a problem-oriented Calculus class and more conceptual classes in the math major. Consequently, the class is expected to be taken by first and second year students who intend to major in mathematics or use some theoretical mathematics in their major. This class will be valuable for students interested in conceptual computer science, the more theoretical side of economics, or theoretical physics among other areas of study. Because many graduate programs in other disciplines like to see advanced coursework in mathematics, this class should be helpful to students aside from the usual mathematics majors.

Moreover, this class will fill a specific gap in the math major. The math department offers two honors tracks in the traditional math major, one (Track 1) beginning with Honors Calculus (Math 1181H), the other (Track 2) beginning with Honors Analysis (Math 4181H). Students in these tracks will take the later honors math classes together. Unfortunately, the transition tends to be very difficult for students in Track 1 and they often struggle with Honors Linear Algebra (Math 5520H), taken in the Autumn semester of their sophomore year. It is hoped that an honors version of Math 3345 (taken in the spring semester of their freshman year) will give students a stronger background in rigorous mathematics before they take Math 5520H.

While many students taking this class are interested in majoring in a technical field and have seen Calculus, this class does not rely on much background material. For the most part, the class will make do with high school algebra. Instead, the focus is on becoming more fluent in and comfortable with abstraction.

MATH 3345H STATEMENT OF QUALITATIVE DIFFERENCE

1. How specific goals will be achieved

Math 3345H is a Foundations of Higher Mathematics class aimed at strong, enthusiastic students. Its primary goal is to be a systematic introduction to problem solving and proof-writing through *interesting, non-trivial mathematics*. This goal should help the class serve as a bridge between a problem-oriented Calculus class and the more conceptual classes in the math major. Its secondary goal is to generate excitement about mathematics by exposing students to some of math's greatest intellectual successes, many of which do not easily fit into standardized undergraduate classes.

The goals will be achieved by exposing students to appealing mathematics in manageable, well-defined lessons and testing their understanding through homework, in-class activities, and a writing project. The homework will develop not only basic, routine understanding, but deeper understanding through more difficult problems forcing students to synthesize several concepts. There will be non-trivial bonus problems that will encourage students to expand the boundaries of their knowledge, challenging the most talented students. In-class activities will involve students working together to solve multi-part problems. The writing project will force students to learn some new material on their own and think about how to explain it to their peers.

Because the class will have a faster pace than the non-honors version, students will see more mathematics. It is hoped that the additional exposure will deepen students' enthusiasm.

2. Exposure to material

Math 3345H's faster pace will allow students to see more mathematics. The course will cover all the material of Math 3345 while leaving several weeks free for an in-depth exploration of more advanced material of the instructor's choice. The attached sample syllabus includes a unit on basic number theory that goes far beyond Math 3345. An instructor could choose to replace that unit with one on discrete math/combinatorics, set theory, geometry, abstract algebra, theoretical computer science, game theory, etc.

Because the homework will test deeper, more conceptual understanding, students will spend more time out of class mastering the material.

3. Methodology

A Foundations of Higher Mathematics class will necessarily expose students to both the language of mathematics and to interesting mathematical ideas. Because Math 3345H will involve a deeper focus on the mathematical ideas, students will learn how mathematics is built up from simple axioms to achieve non-obvious results. Moreover, students will see how new ideas become natural when phrased in

the proper language. While students will not do research in this class nor be exposed to very much current research, they will gain an appreciation of the challenges inherent in mathematical discovery.

The writing project will give students an opportunity to develop expository skills which are, indeed, a necessary component of doing mathematical research.

4. Amount and Quality of Work

The typical Math 3345 homework involves routine problems to test basic understanding and proofs of theorems that are only slight modifications of ones covered in class. In Math 3345H, students will solve harder problems that combine several ideas in their homework. This moves beyond routine problems towards a more conceptual understanding. Students will have the opportunity to solve quite difficult bonus problems.

The expository paper is unlike anything in Math 3345 in terms of length and time-frame for work.

5. Amount and kind of student/faculty contact

This course will be taught by different faculty members, according to their interests and schedules in different semesters, and different instructors will interact with students, and will present an array of topics, in accord with their interests. The writing project will provide opportunities for students to interact with faculty, both inside and outside of class.

6. Environment fostering intellectual exchange

The in-class activities will encourage students to collaborate in class and hopefully out of class.

There is also the possibility of honors peer mentors as in Math 4181H. These are advanced math majors who facilitate problem sessions.

7. Creative thinking

The non-trivial problems in the homework will encourage creative problem solving. A difficult problem may combine several concepts in an unexpected way. The writing project will force students to think deeply about the best way to explain a new topic.

8. Interdisciplinary work

An instructor can choose to include a unit on applications of mathematics to other domains such as theoretical computer science (e.g., complexity classes) or economics (e.g., game theory). Students may explain how math is used in other disciplines in their writing project.

9. Pedagogical process that demands a high level of intellectual output

The higher demands on students' understanding and expository skills will involve new pedagogical processes. Certainly students will have to learn how to master new mathematics on their own for the writing project. It is expected that students will be asking deeper questions in class and will be collaborating on the more challenging work during in-class activities.

Curriculum Map - Mathematics BA/BS - Theoretical Track

	Course	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
Prerequisits						
	Math 1151	Begining	Begining	Begining		
	Math 1152	Begining	Begining	Begining		
	Math 1295				Intermediate	Begining
Core						
	Math 2153	Intermediate	Intermediate	Begining		
	Math 2568 or	Begining	Begining	Begining		Begining
	Math 2568H	**Intermediate**	**Begining**	**Intermediate**	**Begining**	**Begining**
	Math 3345 or	Advanced	Advanced	Intermediate	Intermediate	Intermediate
	Math 3345H	**Advanced**	**Advanced**	**Intermediate**	**Intermediate**	**Intermediate**
	Math 4530 or Stat 4201	Intermediate	Begining	Intermediate	Intermediate	Intermediate
	Stat 4202	Intermediate		Intermediate		Intermediate
Required in track						
	Math 2255	Begining	Intermediate	Intermediate	Begining	
	Math 4547	Advanced	Advanced	Intermediate	Advanced	Begining
	Math 4548	Advanced	Advanced	Intermediate	Advanced	Begining
	Math 4580	Advanced	Advanced	Intermediate	Advanced	Begining
	Math 4581	Advanced	Advanced	Intermediate	Advanced	Begining
Electives						
	Math 3589			Intermediate	Intermediate	Advanced
	Math 3607			Intermediate	Intermediate	Advanced
	Math 3618			Intermediate	Advanced	Advanced
	Math 4350			Intermediate	Advanced	Advanced
	Math 4504	Advanced	Intermediate	Intermediate	Advanced	Advanced
	Math 4507	Advanced	Intermediate	Intermediate	Advanced	Advanced
	Math 4551	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
	Math 4552	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
	Math 4556			Intermediate	Advanced	Advanced
	Math 4557	Intermediate		Intermediate	Intermediate	Intermediate
	Math 4570	Intermediate	Intermediate	Advanced	Intermediate	Intermediate
	Math 4573	Advanced	Intermediate	Intermediate	Intermediate	Intermediate
	Math 4575	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
	Math 4578	Intermediate	Intermediate	Intermediate	Intermediate	Advanced
	Math 5632			Intermediate	Advanced	Advanced
Expected major program learning outcomes						
	Goal 1	Learn conceptual frameworks needed to study higher mathematics, including an introduction to mathematical reasoning and an understanding of how to read and write proofs.				
	Goal 2	Aquire basic mastery of core areas of mathematics including calculus, analysis and algebra.				
	Goal 3	Develop powerful mathematical problem solving skills.				
	Goal 4	Learn to communicate mathematical understanding effectively.				
	Goal 5	Become proficient in chosen tracks within the major.				

Curriculum Map - Mathematics BS - Honors Track (I)

	Course	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
Prerequisits						
	Math 1181H	Intermediate	Intermediate	Begining		
Core						
	Math 2182H	Intermediate	Intermediate	Begining		
	Math 3345 or	Advanced	Advanced	Intermediate	Intermediate	Intermediate
	Math 3345H	Advanced	Advanced	Intermediate	Intermediate	Intermediate
	Stat 4202	Intermediate		Intermediate		Intermediate
Required in track						
	Math 4181H	**Advanced**	**Advanced**	**Advanced**	**Advanced**	**Advanced**
	Math 4182H	Advanced	Advanced	Advanced	Advanced	Advanced
	Math 5520H	**Advanced**	**Advanced**	**Advanced**	**Advanced**	**Intermediate**
	Math 5529H	Advanced	Advanced	Advanced	Advanced	Intermediate
	Math 5530H	Advanced	Advanced	Advanced	Advanced	Intermediate
	Math 5590H	Advanced	Advanced	Advanced	Advanced	Advanced
	Math 5591H	Advanced	Advanced	Advanced	Advanced	Advanced
Electives						
	Math 5522H	Advanced	Advanced	Advanced	Advanced	Intermediate
	Math 5540H	Advanced	Advanced	Advanced	Advanced	Advanced
	Math 5576H	Advanced	Advanced	Advanced	Advanced	Advanced
Expected major program learning outcomes						
	Goal 1	Learn conceptual frameworks needed to study higher mathematics, including an introduction to mathematical reasoning and an understanding of how to read and write proofs.				
	Goal 2	Aquire basic mastery of core areas of mathematics including calculus, analysis and algebra.				
	Goal 3	Develop powerful mathematical problem solving skills.				
	Goal 4	Learn to communicate mathematical understanding effectively.				
	Goal 5	Become proficient in chosen tracks within the major.				

Curriculum Map - Mathematics BS - Honors Track (II)						
	Course	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
Core						
	Math 4181H	Advanced	Advanced	Advanced	Advanced	Advanced
	Math 4182H	Advanced	Advanced	Advanced	Advanced	Advanced
	Stat 4202	Intermediate		Intermediate		Intermediate
Required in track						
	Math 5520H	Advanced	Advanced	Advanced	Advanced	Intermediate
	Math 5529H	Advanced	Advanced	Advanced	Advanced	Intermediate
	Math 5530H	Advanced	Advanced	Advanced	Advanced	Intermediate
	Math 5590H	Advanced	Advanced	Advanced	Advanced	Advanced
	Math 5591H	Advanced	Advanced	Advanced	Advanced	Advanced
Electives						
	Math 5522H	Advanced	Advanced	Advanced	Advanced	Intermediate
	Math 5540H	Advanced	Advanced	Advanced	Advanced	Advanced
	Math 5576H	Advanced	Advanced	Advanced	Advanced	Advanced
Expected major program learning outcomes						
	Goal 1	Learn conceptual frameworks needed to study higher mathematics, including an introduction to mathematical reasoning and an understanding of how to read and write proofs.				
	Goal 2	Aquire basic mastery of core areas of mathematics including calculus, analysis and algebra.				
	Goal 3	Develop powerful mathematical problem solving skills.				
	Goal 4	Learn to communicate mathematical understanding effectively.				
	Goal 5	Become proficient in chosen tracks within the major.				

	Course	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
Curriculum Map - Mathematics BA/BS - Financial Track						
	Course	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
Prerequisits						
	AcctMIS 2000			Begining		Intermediate
	CSE 1222 or 1223			Begining		Intermediate
	CSE 2111			Begining		Intermediate
	Econ 2001			Begining		Intermediate
	Econ 2002			Begining		Intermediate
	Math 1151	Begining	Begining	Begining		
	Math 1152	Begining	Begining	Begining		
	Math 1295				Intermediate	Begining
Core						
	Math 2153	Intermediate	Intermediate	Begining		
	Math 2568 or	Begining	Begining	Begining		Begining
	Math 2568H	**Intermediate**	**Begining**	**Intermediate**	**Begining**	**Begining**
	Math 3345 or	Advanced	Advanced	Intermediate	Intermediate	Intermediate
	Math 3345H	**Advanced**	**Advanced**	**Intermediate**	**Intermediate**	**Intermediate**
	Math 4530 or Stat 4201	Intermediate	Begining	Intermediate	Intermediate	Intermediate
	Stat 4202	Intermediate		Intermediate		Intermediate
Required in track						
	BusFin 3120 or 3220			Intermediate	Intermediate	Advanced
	Math 2255	Begining	Intermediate	Intermediate	Begining	
	Math 3589			Intermediate	Intermediate	Advanced
	Math 3607			Intermediate	Intermediate	Advanced
	Math 3618			Intermediate	Advanced	Advanced
	Math 5632			Intermediate	Advanced	Advanced
Required in track - Choose one						
	Math 4512	Intermediate		Intermediate	Intermediate	Intermediate
	Math 4547	Advanced	Advanced	Intermediate	Advanced	Begining
	Math 4557	Intermediate		Intermediate	Intermediate	Intermediate
Expected major program learning outcomes						
	Goal 1	Learn conceptual frameworks needed to study higher mathematics, including an introduction to mathematical reasoning and an understanding of how to read and write proofs.				
	Goal 2	Aquire basic mastery of core areas of mathematics including calculus, analysis and algebra.				
	Goal 3	Develop powerful mathematical problem solving skills.				
	Goal 4	Learn to communicate mathematical understanding effectively.				
	Goal 5	Become proficient in chosen tracks within the major.				

	Curriculum Map - Mathematics BA/BS - Education Track					
	Course	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
Prerequisits						
	Math 1151	Begining	Begining	Begining		
	Math 1152	Begining	Begining	Begining		
	Math 1295				Intermediate	Begining
	CSE 1222, 1223 or 2221			Begining	Begining	
Core						
	Math 2153	Intermediate	Intermediate	Begining		
	Math 2568 or	Begining	Begining	Begining		Begining
	Math 2568H	**Intermediate**	**Begining**	**Intermediate**	**Begining**	**Begining**
	Math 3345 or	Advanced	Advanced	Intermediate	Intermediate	Intermediate
	Math 3345H	**Advanced**	**Advanced**	**Intermediate**	**Intermediate**	**Intermediate**
	Math 4530 or Stat 4201	Intermediate	Begining	Intermediate	Intermediate	Intermediate
	Stat 4202	Intermediate		Intermediate		Intermediate
Required in track						
	Math 4504	Advanced	Intermediate	Intermediate	Advanced	Advanced
	Math 4507	Advanced	Intermediate	Intermediate	Advanced	Advanced
	Math 4547	Advanced	Advanced	Intermediate	Advanced	Begining
	Math 4548	Advanced	Advanced	Intermediate	Advanced	Begining
	Math 4578	Intermediate	Intermediate	Intermediate	Intermediate	Advanced
	Math 4580	Advanced	Advanced	Intermediate	Advanced	Begining
	Math 4581	Advanced	Advanced	Intermediate	Advanced	Begining
Expected major program learning outcomes						
	Goal 1	Learn conceptual frameworks needed to study higher mathematics, including an introduction to mathematical reasoning and an understanding of how to read and write proofs.				
	Goal 2	Aquire basic mastery of core areas of mathematics including calculus, analysis and algebra.				
	Goal 3	Develop powerful mathematical problem solving skills.				
	Goal 4	Learn to communicate mathematical understanding effectively.				
	Goal 5	Become proficient in chosen tracks within the major.				

Curriculum Map - Mathematics BA/BS - Applied Track (Chemistry)

	Course	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
Prerequisits						
	Biology 1113 or 1114			Beginning		Intermediate
	Chem 1210			Beginning		Intermediate
	Chem 1220			Beginning		Intermediate
	CSE 1222 or 1223			Beginning		Intermediate
	Math 1151	Beginning	Beginning	Beginning		
	Math 1152	Beginning	Beginning	Beginning		
	Math 1295				Intermediate	Beginning
	Physics 1250			Beginning		Intermediate
	Physics 1251			Beginning		Intermediate
Core						
	Math 2153	Intermediate	Intermediate	Beginning		
	Math 2568 or	Beginning	Beginning	Beginning		Beginning
	Math 2568H	**Intermediate**	**Begining**	**Intermediate**	**Begining**	**Begining**
	Math 3345 or	Advanced	Advanced	Intermediate	Intermediate	Intermediate
	Math 3345H	**Advanced**	**Advanced**	**Intermediate**	**Intermediate**	**Intermediate**
	Math 4530 or Stat 4201	Intermediate	Beginning	Intermediate	Intermediate	Intermediate
	Stat 4202	Intermediate		Intermediate		Intermediate
Required in track						
	Math 2255	Beginning	Intermediate	Intermediate	Beginning	
	Math 4557	Intermediate		Intermediate	Intermediate	Intermediate
Required applied math courses (choose two)						
	Math 3607			Intermediate	Intermediate	Advanced
	Math 4552	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
	Math 4556			Intermediate	Advanced	Advanced
Required applied science courses (choose two)						
	Chem 2210				Advanced	
	Chem 4300				Advanced	
	Chem 4310				Advanced	
Electives						
	Math 3607 (if not before)			Intermediate	Intermediate	Advanced
	Math 4547	Advanced	Advanced	Intermediate	Advanced	Begining
	Math 4548	Advanced	Advanced	Intermediate	Advanced	Begining
	Math 4551	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
	Math 4552 (if not before)	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
	Math 4556 (if not before)			Intermediate	Advanced	Advanced
	Math 5101	Beginning	Advanced	Intermediate		Intermediate
	Math 5102	Beginning	Advanced	Intermediate		Intermediate
	Math 5451	Beginning	Beginning	Intermediate	Beginning	Advanced
	Math 5756			Beginning	Intermediate	Intermediate
	Math 5757			Beginning	Intermediate	Intermediate
Expected major program learning outcomes						
	Goal 1	Learn conceptual frameworks needed to study higher mathematics, including an introduction to mathematical reasoning and an understanding of how to read and write proofs.				
	Goal 2	Aquire basic mastery of core areas of mathematics including calculus, analysis and algebra.				
	Goal 3	Develop powerful mathematical problem solving skills.				
	Goal 4	Learn to communicate mathematical understanding effectively.				
	Goal 5	Become proficient in chosen tracks within the major.				

Curriculum Map - Mathematics BA/BS - Applied Track (Physics)

	Course	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
Prerequisits						
	Biology 1113 or 1114			Beginning		Intermediate
	Chem 1210			Beginning		Intermediate
	CSE 1222 or 1223			Beginning		Intermediate
	Math 1151	Beginning	Beginning	Beginning		
	Math 1152	Beginning	Beginning	Beginning		
	Math 1295				Intermediate	Beginning
	Physics 1250			Beginning		Intermediate
	Physics 1251			Beginning		Intermediate
Core						
	Math 2153	Intermediate	Intermediate	Beginning		
	Math 2568 or	Beginning	Beginning	Beginning		Beginning
	Math 2568H	**Intermediate**	**Begining**	**Intermediate**	**Begining**	**Begining**
	Math 3345 or	Advanced	Advanced	Intermediate	Intermediate	Intermediate
	Math 3345H	**Advanced**	**Advanced**	**Intermediate**	**Intermediate**	**Intermediate**
	Math 4530 or Stat 4201	Intermediate	Beginning	Intermediate	Intermediate	Intermediate
	Stat 4202	Intermediate		Intermediate		Intermediate
Required in track						
	Math 2255	Beginning	Intermediate	Intermediate	Beginning	
	Math 4557	Intermediate		Intermediate	Intermediate	Intermediate
Required applied math courses (choose two)						
	Math 3607			Intermediate	Intermediate	Advanced
	Math 4552	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
	Math 4556			Intermediate	Advanced	Advanced
Required applied science courses						
	Physics 2300					Advanced
	Physics 2301					Advanced
Electives						
	Math 3607 (if not before)			Intermediate	Intermediate	Advanced
	Math 4547	Advanced	Advanced	Intermediate	Advanced	Begining
	Math 4548	Advanced	Advanced	Intermediate	Advanced	Begining
	Math 4551	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
	Math 4552 (if not before)	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
	Math 4556 (if not before)			Intermediate	Advanced	Advanced
	Math 5101	Beginning	Advanced	Intermediate		Intermediate
	Math 5102	Beginning	Advanced	Intermediate		Intermediate
	Math 5451	Beginning	Beginning	Intermediate	Beginning	Advanced
	Math 5756			Beginning	Intermediate	Intermediate
	Math 5757			Beginning	Intermediate	Intermediate
Expected major program learning outcomes						
	Goal 1	Learn conceptual frameworks needed to study higher mathematics, including an introduction to mathematical reasoning and an understanding of how to read and write proofs.				
	Goal 2	Aquire basic mastery of core areas of mathematics including calculus, analysis and algebra.				
	Goal 3	Develop powerful mathematical problem solving skills.				
	Goal 4	Learn to communicate mathematical understanding effectively.				
	Goal 5	Become proficient in chosen tracks within the major.				

Curriculum Map - Mathematics BA/BS - Math Biology						
	Course	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
Prerequisits						
	Biology 1113			Beginning		Intermediate
	Biology 1114			Beginning		Intermediate
	Chem 1210			Beginning		Intermediate
	Math 1151	Beginning	Beginning	Beginning		
	Math 1152	Beginning	Beginning	Beginning		
	Math 1295				Intermediate	Beginning
Core						
	Math 2153	Intermediate	Intermediate	Beginning		
	Math 2568 or	Beginning	Beginning	Beginning		Beginning
	Math 2568H	**Intermediate**	**Begining**	**Intermediate**	**Begining**	**Beginning**
	Math 3345 or	Advanced	Advanced	Intermediate	Intermediate	Intermediate
	Math 3345H	**Advanced**	**Advanced**	**Intermediate**	**Intermediate**	**Intermediate**
	Math 4530 or Stat 4201	Intermediate	Beginning	Intermediate	Intermediate	Intermediate
	Stat 4202	Intermediate		Intermediate		Intermediate
Required in track						
	Math 2255	Beginning	Intermediate	Intermediate	Beginning	
	Math 3350				Intermediate	Beginning
Required in track - Choose one						
	Math 5660 or MolGen 5660					Intermediate
	Biology 3401					Intermediate
Required applied math courses (choose two)						
	Math 3607			Intermediate	Intermediate	Advanced
	Math 4556			Intermediate	Advanced	Advanced
	Math 4557	Intermediate		Intermediate	Intermediate	Intermediate
Required applied science courses						
	Physics 2300					Advanced
	Physics 2301					Advanced
Electives						
	Biochem 4511					Advanced
	Chem 2510					Advanced
	EEOB 3310					Advanced
	EEOB 3420					Advanced
	EEOB 4520					Advanced
	Math 3607 (if not before)			Intermediate	Intermediate	Advanced
	Math 4530				Intermediate	Advanced
	Math 4547	Advanced	Advanced	Intermediate	Advanced	Begining
	Math 4551	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
	Math 4552	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
	Math 4556 (if not before)			Intermediate	Advanced	Advanced
	Math 4557 (if not before)	Intermediate		Intermediate	Intermediate	Intermediate
	Math 4580	Advanced	Advanced	Intermediate	Advanced	Begining
	Math 5101	Beginning	Advanced	Intermediate		Intermediate
	Math 5102	Beginning	Advanced	Intermediate		Intermediate
	Math 5540H	Advanced	Advanced	Advanced	Intermediate	Begining
	MolGen 4500					Advanced
	MolGen 5601					Advanced
Expected major program learning outcomes						
	Goal 1	Learn conceptual frameworks needed to study higher mathematics, including an introduction to mathematical reasoning and an understanding of how to read and write proofs.				
	Goal 2	Aquire basic mastery of core areas of mathematics including calculus, analysis and algebra.				
	Goal 3	Develop powerful mathematical problem solving skills.				
	Goal 4	Learn to communicate mathematical understanding effectively.				
	Goal 5	Become proficient in chosen tracks within the major.				