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	2568H
Course Title	Honors Linear Algebra
Transcript Abbreviation	Hon Lin Alg
Course Description	This course, an introduction to linear algebra, is aimed at math majors who want a rigorous background in finite-dimensional linear algebra and exposure to applications of modern relevance, including some practice in implementing ideas from this course on a computer.
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	A grade of C- or above in 2153, 2162.xx, 2182H, or 4182H; or credit for 254.xx, 263.xx, 263.01H, or 264H.
Exclusions	Not open to students with credit for 4568 (568), 5520H (520H), or 572.
Electronically Enforced	Yes

Cross-Listings

Cross-Listings

Subject/CIP Code

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

Requirement/Elective Designation

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

Course Details

Course goals or learning objectives/outcomes

- Understand abstract vector spaces
- Understand and apply matrix algebra
- Understand and apply linear transformation
- Understand and apply eigenvalues and eigenvectors
- Understand and apply inner products

Content Topic List

- Vector spaces
- Linear systems and matrix algebra
- Linear transformations
- Eigenvalues and eigenvectors
- Inner products and least squares approximations
- Applications of linear algebra

Sought Concurrence

No

Attachments

- syllabus-2568H.pdf: Syllabus

  (Syllabus. Owner: Husen,William J)

- sp18_2568_syllabus.pdf: Syllabus-non-honors

  (Syllabus. Owner: Husen,William J)

- comparison-between-2568-and-2568H (1).pdf: Comparison sheet

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

- Math 2568H Qualitative Difference.docx: Statement of Qualitative Difference

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

- Curriculum_map_master_20180213.pdf: Curriculum map (combined)

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

Comments

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Husen,William J	02/13/2018 10:26 AM	Submitted for Approval
Approved	Husen,William J	02/13/2018 10:26 AM	Unit Approval
Approved	Haddad,Deborah Moore	02/13/2018 10:41 AM	College Approval
Pending Approval	Nolen,Dawn Vankeerbergen,Bernadette Chantal Oldroyd,Shelby Quinn Hanlin,Deborah Kay Jenkins,Mary Ellen Bigler	02/13/2018 10:41 AM	ASCCAO Approval
Pending Approval	Chamberlain,Lindsey Joyce	02/13/2018 01:59 PM	Ad-Hoc Approval

HONORS LINEAR ALGEBRA SAMPLE SYLLABUS
MATH 2568H

Text. G. Strang, *Linear Algebra and Its Applications* (Fourth Edition)

Description. This course, an introduction to linear algebra, is aimed at math majors who want: a rigorous background in finite-dimensional linear algebra and exposure to applications of modern relevance, including some practice in implementing ideas from this course on a computer. Coursework consists of homework assignments that are assigned nearly every week, 2 midterms, a final exam, and a final project. Homeworks and the final project will incorporate the use of computing platforms in implementing ideas from this course.

Curriculum. A list of topics is given below.

(1) vector geometry
(2) linear systems, Gauss-Jordan elimination
(3) matrix operations (incl. inverses)
(4) determinants and non-singularity
(5) vector spaces (abstract and subspaces of Euclidean space), linear independence, basis and dimension
(6) linear transformations
(7) eigenvalues and diagonalization
(8) symmetry, positive-definiteness, similarity
(9) orthogonality, Grahm-Schmidt orthogonalization
(10) singular value decomposition
(11) applications optionally drawn from the following list:
    (a) numerical integration, numerical differentiation
    (b) least-squares regression and QR factorization
    (c) finding equilibrium states in Markov chains (e.g. Google PageRank algorithm)
    (d) network analysis (spanning trees, Kirchoff's Laws for electrical circuits)
    (e) data analysis (e.g. PCA algorithm or support vector machines)
    (f) linear programming and LU factorization
    (g) Fast Fourier Transform
    (h) difference equations

The curriculum will concurrently incorporate the use of computing platforms, such as `Matlab`, `R`, or `Python`.

Final projects. The final project, a group project, will incorporate an implementation of one of the discussed applications for a real-world problem or simulation thereof, involving the use of a computer. This project will culminate in a presentation, for example in the form of a poster to be presented in a poster session or the production of a video presentation to be viewed by the teacher. All projects will require prior approval. Final projects will be graded on the basis of clarity in communication, correctness of the mathematics and its communication, topicality, and the use of computer to implement ideas from the course in an essential manner.

Grades. Grades will be based on total points earned on homework, midterms, final exam and final project. Homework, in total, will count for 100 points. Each midterm exam will count for 100 points, the final exam will count for 200 points and the final project will count for 100 points.

Disability Statement. Students with disabilities (including mental health, chronic or temporary medical conditions) that have been certified by the Office of Student Life Disability Services will be appropriately accommodated and should inform the instructor as soon as possible of their needs. The Office of Student Life Disability Services is located in 098 Baker Hall, 113 W. 12th Avenue; telephone 614- 292-3307, slds@osu.edu; (`http://slds.osu.edu`).

Academic Misconduct Statement. 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 3335-5-487). For additional information, see the Code of Student Conduct (`http://studentlife.osu.edu/csc/`).

Spring 2018 MATH 2568 Linear Algebra

Class Time: 12:40-1:35pm MWF (call number 32366) **Instructor: Yu TSUMURA**

➢ **Instructor's Information**

Office: Mathematics Tower (MW) 400

Email: tsumura.2@osu.edu

Office Hour: Monday & Tuesday 10:00-11:30AM

Grader: Chen, Junjie [chen.5810@osu.edu] MW200

Please contact your grader for any question regarding grades of your assignments.

Website: https://yutsumura.com/math-2568-linear-algebra-spring-2018/

➢ **Course Description**

Matrix algebra, vector spaces and linear maps, bases and dimension, eigenvalues and eigenvectors, applications.

➢ **Materials**

Required in Class:

Linear Algebra Workbook by Yu Tsumura (I will give handouts in class)

A binder is useful as I give many handouts.

Reference:

This is Linear Algebra by Crichton Ogle (available on my website)

➢ **Grading**

(1)	Midterm Exam 1	100 pts
(2)	Midterm Exam 2	100 pts
(3)	Final Exam	200 pts
(4)	Homework	130 pts
(5)	Attendance	30 pts
	Total	**560 pts**

Points	560-504	503-487	486-465	464-448	447-431	430-409	408-392	391-375	374-353	352-336	335-
%	100-90	89-87	86-83	82-80	79-77	76-73	72-70	69-67	66-63	62-60	59-
Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	E

Your grade will be determined only by total points you obtain.

NO CURVES by the Math Department policy.

➢ **Requirements**

1. Midterm Exams

Two in-class midterm exams will be given. No calculators, no electric devices, no notes, no books are allowed.

1st Midterm Exam: Feb. 9th (F)

2nd Midterm Exam: Mar. 28th (W)

2. Final Exam

Final exam will be given during the exam week. (**May. 1st (T) 12:00-1:45pm**)

It is cumulative.

3. Homework

13 homework assignments will be given throughout the semester (10 pts each). Some problems may not be graded. Each homework is due in class. Late homework will not be accepted.

You may handwrite your solutions or you may use a word processor but you may be asked to submit the source file as well. Your handwriting must be neat so that the grader can read it with no effort. Think your homework is a report for your future employer. Do not submit your first draft computation. You need to revise it so that your idea is well-presented to the grader.

When you solve homework problems, you are encouraged to work in groups, but you should be honest with yourself: being able to nod along when the solution is told to you is not the same as being able to solve the problem yourself.

You may discuss homework scores (with the grader) or exam scores (with the instructor) only within a week after the date the instructor return them in class. After a week, all scores will be finalized.

4. Attendance

The first **three absences** will not be penalized. From the fourth absence on, **each will lower your attendance grade by 5 points from the maximum 30 pts.** If your attendance point is zero, then your final grade is automatically E. If you have a legitimate reason (influenza, extended illness, job interview, school trip, family emergency) you may be excused. In such case, you must notify your instructor in advance with **the official document** issued by an authority. In any case, you have to initiate the communication with the instructor to avoid grade reduction. Every tardiness of 20 minutes or more will count as an absence. If you leave before the class ends without the instructor's permission, you will not receive the attendance point.

➢ **How to Succeed/Expectation**

Before each lecture, you are required to read the Linear Algebra Workbook and do some practice problems. These practice problems will not be collected but they help you understand the materials. and activities in class. The instructor will assume that you have read the workbook and did practice problems. Refer to "Preparation" in the workbook for required practice problems.

➢ **Cheating Policy**

Cheating on your in-class quizzes and exams will result in **an automatic "F"** for the entire course. Those who let someone see his/her paper will receive a score of zero on that quiz/exam.

➢ **Make-up Policies**

No make-up tests will be given except under unusual circumstances which are beyond your control. The need for a make-up must be expressed to the instructor **IMMEDIATELY** with supporting documents. Make-up exams must be taken within one week of the original date.

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➢ **Important Dates**

Feb. 2nd (F) Last Day to drop without a "W"
Mar. 23rd (F) Last day to drop without petitioning
For more information regarding important dates of the registration, go to
https://registrar.osu.edu/registration/Important_dates/SP18_important_dates.pdf

Schedule (tentative)

				Homework Due	Topics (the order is subject to change)
1		1/8	M		
2	Week 1	1/10	W		
3		1/12	F		
		~~1/15~~	~~M~~	**MLK Day (No Class)**	
4	Week 2	1/17	W	HW1	Intro to Matrices and Systems of Linear Algebra
5		1/19	F		Echelon Form and Gaussian-Jordan Elimination
6		1/22	M		Consistent Systems of linear Equations
7	Week 3	1/24	W	HW2	Matrix Operations
8		1/26	F		Algebraic Properties of Matrix operations
9		1/29	M		Linear Independence and Nonsingular Matrices
10	Week 4	1/31	W	HW3	Matrix Inverses and Their Properties
11		2/2	F		
12		2/5	M		
13	Week 5	2/7	W	HW4	
14		2/9	F		**Midterm Exam 1**
15		2/12	M		
16	Week 6	2/14	W	HW5	
17		2/16	F		
18		2/19	M		
19	Week 7	2/21	W	HW6	Vector Space Properties of R^n
20		2/23	F		Examples of Subspaces
21		2/26	M		Bases for Subspaces
22	Week 8	2/28	W	HW7	Dimension
23		3/2	F		Vector Spaces
24		3/5	M		Subspaces
25	Week 9	3/7	W	HW8	Linear Independence, Bases, and Coordinates
26		3/9	F		Orthogonal Bases for Subspaces
		3/12-3/16	M-F	**Spring Break (No Class)**	Linear Transformation from R^n to R^m
27		3/19	M		
28	Week 10	3/21	W	HW9	
29		3/23	F		
30		3/26	M		
31	Week 11	3/28	W	~~HW10~~	**Midterm Exam 2**
32		3/30	F	HW10	
33		4/2	M		
34	Week 12	4/4	W	HW11	
35		4/6	F		The Eigenvalue Problem for 2x2 Matrices
36		4/9	M		Determinants and the Eigenvalue Problem
37	Week 13	4/11	W	HW12	Eigenvalues and Characteristic Polynomial
38		4/13	F		Eigenvectors and Eigenspaces
39		4/16	M		Complex Eigenvalues and Eigenvectors
40	Week 14	4/18	W	HW13	Similarity Transformations and Diagonalization
41		4/20	F		
42	Week 15	4/23	M		

Final Exam: May. 1st (T) 12:00-1:45pm

COMPARISON BETWEEN 2568 AND PROPOSED 2568H

OLD TEXT: [1] Johnson, Riess, Arnold, *Introduction to Linear Algebra* (Fifth Edition)
NEW TEXT: [2] G. Strang, *Linear Algebra and Its Applications* (Fourth Edition)

Description. The honors section is aimed at math majors who want: a more rigorous background in finite-dimensional linear algebra than 2568; and exposure to applications of modern relevance, including some practice in implementing ideas from this course on a computer. In addition to the standard coursework for 2568, 2568H will concurrently incorporate Matlab, R, or Python exercises into the homeworks and require a final project. A comparison of curricula is spread out over the next few pages for readability. The instructor may find it more convenient to combine Modules I and II into a single unit tested in Midterm 1, test the contents of Module II in Midterm 2, and have a month for exploring some of the more sophisticated applications and attendant theory (e.g. Simplex Method and LU Factorization or Singular Value Decomposition and PCA) listed in bold.

Module I: Linear Systems

Non-Honors. The first module for non-honors 2568 sections cover the following:

(1) solving linear systems: 1.1-1.3 in [1]
(2) matrix operations (including inverses): 1.5-1.6,1.9 in [1]
(3) linear independence, non-singularity 1.7 in [1]

Changes. The honors version will cover the above at a faster clip and *additionally* cover the following material.

(1) determinants: 6.1-6.3 in [1]
(2) (optional) Cramer's Rule: 6.4 in [1]
(3) (optional) inverses in terms of determinants: 6.5 in [1]

Optional supplements. The instructor will additionally cover *applications* possibly drawn from the list:

(1) applications to numerical differentiation, integration, polynomial interpolation: 1.4 in [1]
(2) network analysis: (Kirchoff's Law, Markov Chains, Spanning Trees): 2.4 in [2]

Module II: Vector Spaces.

Non-Honors. The second module for non-honors 2568 sections cover the following:

(1) vector geometry (dot products and cross products): 2.1-2.3 in [1]
(2) vector spaces (Euclidean and abstract): 3.2-3.3,5.2,5.3 in [1]
(3) bases and dimension (Euclidean and abstract): 3.4,3.5,5.4 in [1]
(4) orthogonal bases: 3.6 in [1]
(5) linear transformations (between Euclidean spaces): 3.7 in [1]

Minimal Changes. The honors version will cover the above at a faster clip and *additionally* cover the following material.

(1) dimension of abstract vector spaces: 5.5 in [1]
(2) linear transformations of abstract vector spaces: 5.7,5.8 in [1]
(3) matrix representations of abstract linear transformations: 5.9 in [1]

Optional supplements. The instructor will additionally cover *applications* (and some requisite theory) possibly drawn from the list

(1) least-squares regression (linear, quadratic, etc.): 3.8 in [1] and **QR factorization** as a tool: 7.6 in [1]
(2) Fast Fourier Transform: 3.5 in [2]
(3) **Linear Programming** and **LU Factorization** as a tool: 8.1-8.4 in [2]

Module III: Eigenvalues.

Non-Honors. The third module for non-honors 2568 sections cover the following:

(1) determinants: 4.2 in [1]
(2) eigenvalues, eigenvectors, eigenspaces for matrices: 4.1,4.2,4.4-4.6 in [1]
(3) similarity transformations and diagonalization: 4.7 in [1]

Minimal Changes. The honors version will *instead* cover the following material.

(1) eigenvalues, eigenvectors, eigenspaces for abstract linear transformations: 4.1,4.2,4.4-4.6 in [1] and beyond
(2) similarity transformations and diagonalization: 4.7, 5.10 in [1]
(3) **positive definiteness and singular value decomposition**: 6.2,6.3 in [2]

Optional supplements. The instructor will additionally cover *applications* (and theory) possibly drawn from the list:

(1) difference equations: 5.3 in [2]
(2) equilibria in Markov chains, PageRank
(3) separating hyperplanes in data classification, support vector machines
(4) **applications of singular value decomposition** (e.g. PCA, image processing)

Final projects. The final project, a group project, will incorporate an implementation of one of the discussed applications for a real-world problem or simulation thereof, involving the use of a computer. This project will culminate in a presentation, for example in the form of a poster to be presented in a poster session or the production of a video presentation to be viewed by the teacher. All projects will require prior approval. Final projects will be graded on the basis of clarity in communication, correctness of the mathematics and its communication, topicality, and the use of computer to implement ideas from the course in an essential manner.

Math 2568H - Statement of Qualitative Difference

1. Math 2568H is a first course in linear algebra which will cover all of the topics of a typical linear algebra course (Math 2568) along with significant additions. A successful student will be required to master the materials in this course through homework; in-class activities, and a final project. In particular, the final project will compel a student to internalize all of the concepts from this course and then apply them in a coherent fashion to a real-world project. This project will include not only written work, but also computations using appropriate computing platforms. This project will represent an excellent synthesis of topics covered in this course.

2. Math 2568H goes beyond the material taught in Math 2568, both in breadth and depth. In addition to all of the topics taught in Math 2568, Math 2568H includes additional material relating to abstract vectors spaces: Bases, dimension, linear transformations, eigenvectors and eigenspaces. This represents a significant increase in the level of mathematics covered. Moreover, Math 2568 is generally taught as a procedural class – the concentration is on students understanding the basic methods of linear algebra and how to apply these methods to standard problems. In contrast, Math 2568H will include not only these standard methods but also explores the theory behind them. Students will be expected to prove several of the more important results from linear algebra.

3. Exposure to research and methodology: Linear algebra is a subject that forms the underpinning of many areas of mathematics. In the proposed Math 2568H, exploring the notion of linearity and its implications, both geometrical and analytical, will be used to relate powerful abstract mathematical concepts to applications. This will be done both within mathematics and beyond. While "research in linear algebra" itself belongs to earlier centuries, there is current research interest in topics related to the treatment of extremely large linear systems. The Math 2568H course will treat topics like *LU* factorization, which are not part of a standard undergraduate curriculum, along with applications to networks and other "modern" uses of linear algebra. By relating abstract linear algebra to areas of current interest. Math 2568H will both go beyond the standard undergraduate course and present an introduction to applications of mathematics.

4. The typical Math 2568 course consists of a set of standardized homework questions along with corresponding assessments based off these questions. Math 2568H will include all of these standard types of questions; however, students will be additionally required to provide proofs for standard results. Moreover, an important part of Math 2568H will be a final project which will bring together the material from this course as applied to a real-world problem or simulation. Math 2568H students will be expected to use the methods learned from class, along with computing platforms such as MATLAB in putting together their project. Students will then present their project either in person or produce a video version of the same.

5. Applications of Linear Algebra are ubiquitous in Applied and Interdisciplinary Mathematics. 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 project topics (their role in the course was described in the preceding paragraph) will provide opportunities for students to interact with faculty, both inside and outside of class.

6.Intellectual exchange: It is currently the intention that the projects be, at least in part, team efforts.

7.Creative thinking: Linear Algebra provides a framework for abstracting fundamental notions of linearity (linear spaces and linear operations) and for recognizing linear structures in actuality – both in mathematics and in models of the physical world. One difference between the regular and the honors course is that the basic course focuses on mastering techniques (notation and carrying out standard constructions) while the honors section will advance to analyzing the concepts that underlie them. A focus on concepts rather than manipulation of symbols will characterize the honors section.

8. Interdisciplinary work: As befits its place in an interdisciplinary curriculum, the course will include modules based on the appearance (and application) of linear algebra in areas outside traditional theoretical mathematics. The specific areas chosen will depend on the interests and expertise of the instructor, but will include operations research, modern physics, data analytics, mathematical biology, computational mathematics, and engineering.

9. Pedagogical process that demands a high level of intellectual output: Linear Algebra is a subject with a reputation for completely befuddling students on first contact. The simple approach to dealing with this, adopted in standard courses, is to restrict the expectations from students to having them master a certain level of proficiency in dealing with the symbols of the subject. If at the end of a semester, students can manipulate matrices, use Gaussian elimination to solve systems of linear equations, and determine whether a set of vectors is linearly independent or forms a basis, instructors are prepared to award a passing grade. The honors course will make more rigorous (and more rewarding) demands of students. A pedagogical process that succeeds at this will need to be interactive in a high degree (something that is not possible in the large sections of the regular course) and will include the use of computer tools (such as Matlab) that embody the principles of linear algebra, as well as a textbook and reference materials that expound the subject at a higher level, and homework problems and exercises that test concepts as well as manipulation of symbols.

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	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 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	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	Advanced	Begining	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	Advanced	Beginning	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	Advanced	Beginning	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**	**Begining**								
	Math 3345	Advanced	Beginning	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.												