Linear Algebra - Math 304

Spring 2021 - Course Coordinator: Prof. Alex Feingold

Sec	Instructor	Office	Email(*)	Meets	Room
1	Matthew Haulmark	online	Haulmark	MWF:8:00-9:30	online
2	Michael Dobbins	online	Dobbins	MWF:8:00-9:30	online
3	David Biddle	online	Biddle	MWF:9:40-11:10	online
4					
5	Christopher Eppolito	online	Eppolito	MWF:11:20-12:50	online
6	Alex Feingold	online	Feingold	MWF:1:10-2:40	online
7	Thomas Kilcoyne	online	Kilcoyne	MWF:2:50-4:20	online
8	Thomas Kilcoyne	online	Kilcoyne	MWF:4:40-6:10	online

(*): To send an email to your instructor, click on the link in the Email column of the table.

If a section has its own detailed syllabus webpage, a link to that page will be provided under the Instructor column of the table above.

Each instructor should provide their students with a Zoom link to the recurring class meetings which begin on Friday, Feb 12, and end on Monday, May 17, 2021.

Below is a partial syllabus with information for all sections that you should know. Your instructor may have a more detailed syllabus about how your section will be run.

Textbook

``Linear Algebra'' by Jim Hefferon, Fourth Edition, available as a free download here:

Linear Algebra by Jim Hefferon.

On can buy a cheap printed version and access more free resources at the textbook's official website.

Here are also some additional books that students and instructors may find helpful.

A First Course in Linear Algebra by Robert A. Beezer

Elementary Linear Algebra by K.R. Matthews

Linear Algebra by D. Cherney, T. Denton, R. Thomas, and A. Waldron

Approximate Exam Schedule (Each section instructor will decide when it is appropriate to give Exams 1, 2, 3.)

Exam 1: The week of March 8-12.

Exam 2: The week of April 12-16.

Exam 3: The week of May 10-14.

Final Exam: Tuesday, May 25, 8:00 - 10:00 AM Online.

Grades

Remote format of the course requires steps to combat academic dishonesty and to protect the honest students from unfair competition. Details about how quizzes and exams will be administered so as to achieve that goal will be announced by your instructor. Your instructor may decide to use: (1) Limited time to answer each question, (2) Visual observation of you during the exam through Zoom, (3) Oral exams in place of, or in addition to, written exams. Some advice about preparing for oral exams is available through the following link:

How to study for oral exams

The course total will be determined as follows:

Quizzes: 20%

Exam 1: 20%

Exam 2: 20%

Exam 3: 20%

WebWork Homework (common for all sections): 5%

Final Exam: 15%

At the end of the course, your grade in the course will be determined by your instructor based on your course total and the following approximate scale. (Borderline cases will be decided by other factors such as attendance or participation.)

A 90%, A- 85%, B+ 80%, B 75%, B- 70%, C+ 65%, C 55%, C- 50%, D 45%

Homework

Online homework will be done using WebWork. The server address is

https://webwork.math.binghamton.edu/webwork2/304Spring2021/

For students, your WebWork account username is the pre@ portion of your binghamton.edu e-mail account. Your initial password is the same as the username. For example, if your Binghamton e-mail

account is xyzw77@binghamton.edu then your username is: xyzw77 and your initial temporary password is: xyzw77

Make sure to change your password as soon as possible to a secure password, and save that choice where it will not be lost.

Important: Besides the WebWork homework sets, you should do problems from the book, as selected by your instructor, see an approximate schedule below. This part of the homework will not be graded, but it will be important to your success in the course.

Expected workload

You are expected to spend about 12.5 hours per week on average for this class, including participation in Zoom lectures, watching instructional videos, solving homework problems (graded and ungraded), reviewing the material, and preparing for the tests. Expect the work load to be higher than average in the weeks before the exams.

Expected behavior in class

During online classes all students are expected to participate in a way that maximizes their learning and minimizes disruptions for their classmates. Your instructor has the final word on the use of video and audio in the general Zoom sessions, break-out rooms, and online office hours. If you have any concerns, limitations, or circumstances, please communicate with your instructor to find the most appropriate solution.

Academic Code of Honor

For all graded assignments and exams, you are not allowed to use any help not explicitly authorized by your instructor. This includes, but is not limited to, problem-solving websites, notes, help from other people, etc. All instances of academic dishonesty will be investigated, penalized, and referred to the appropriate University officials for maximal possible punishment. In other words, **don't even think of trying to cheat.**

Getting Help

If you fall behind in class, or need extra help to learn the material, talk to your instructor as soon as you can. They should be able to help you and also point you to other resources. We also encourage you to talk to your classmates, and, in particular, to form informal study groups to prepare for the exams.

Disability Information

If you have a disability for which you are or may be requesting an accommodation, please contact both your instructor and the Services for Students with Disabilities office (119 University Union, 607-777-2686) as early in the term as possible. Note: extended time for the examinations may not automatically apply to the interview-style exams, but we will work with you to provide reasonable accommodations that are appropriate for your situation.

Suggested problems from our textbooks

The table below contains suggested problems from sections of our textbooks (Heffron or Matthews) in the format "Chapter:Section.Subsection.ProblemNumber". Your instructor may suggest other problems or exercises. **These problems are for practice only and are not to be turned in.** There will be graded homework assignments given through WebWork which should be done in the order indicated by your instructor. Instructional videos linked below are **supplementary material**, not intended to replace the regular lectures. The order in which material is presented in class meetings will be determined by your instructor, and may not precisely follow the order in our textbooks.

Topics	Text	Problems
Introduction, preview, examples; linear combination	Ch. 1, I.1	1:I.1.17,19,21
Gaussian elimination (reduction)	Ch. 1, I.1	1:I.1.22,24,27,32
(Augmented) matrix of a system, solution set	Ch. 1, I.2	1:I.2.15,16,17,18,21,25
Basic logic: statements, connectives, quantifiers	Appendix	
Set theory, general functions	Appendix	
Homogeneous and non-homogeneous systems (no formal induction in Lemma 3.6)	Ch. 1, I.3	1:I.3.15,17,18,20,21,24
Points, vectors, lines, planes	Ch. 1, II.1	1:II.1.1,2,3,4,7
Distance, dot product, angles, Cauchy-Schwarz and Triangle Inequalities	Ch. 1, II.2	1:II.2.11,12,14,16,17,21,22
Gauss-Jordan reduction, reduced row echelon form	Ch. 1, III.1	1:III.1.8,9,10,12,13,14,15
Linear combination lemma, uniqueness of RREF (no proofs of 2.5, 2.6)	Ch. 1, III.2	1:III.2.11,14,20,21,24
Review	Ch. 1; Appendix	Student's_Guide; Sample_Problems; Solutions
Matrix operations, including the transpose. Linear system as a matrix equation	Matthews 2.1	3:III.1.13,14,15,16
Linear maps (transformations) given by matrices	Matthews 2.2	3:III.1.19; 3:III.2.12,17,30
Vector spaces: definition, examples	Ch. 2, I.1	2:I.1.17,18,19,21,22,29,30

Linear maps between vector spaces	Ch. 3, II.1	3:II.1.18,19,20,22,24,25,26,28
Subspaces. Span	Ch. 2, I.2	2:I.2.20,21,23,25,26,29,44,45
Linear independence	Ch. 2, II.1	2:II.1.21,22,25,28
Properties of linear independence	Ch. 2, II.1	2:II.1.29,30,32,33
Basis of a vector space	Ch. 2, III.1	2:III.1.20,21,22,23,24,25,26,30,31,34
Dimension of a vector space	Ch. 2, III.2	2:III.2.15,16,17,18,19,20,21,24,25,28
Column space, row space, rank	Ch. 2, III.3	2:III.3.17,18,19,20,21,23,29,32,39
Range space and Kernel (Null space)	Ch. 3, II.2	3:II.2.21,23,24,26,31,35
Review		Student's_Guide; Sample_Problems; Solutions
Invertible matrices: definition, equivalent conditions; inverse matrix	Ch.3, IV.4	3:IV.4.13,14,15,16,17,18,19,26,29 InvertibleMatrices_1 InvertibleMatrices_2 InvertibleMatrices_3 InvertibleMatrices_4 InvertibleMatrices_5
Elementary matrices. Row reduction using elementary matrices	Ch. 3, IV.3; CDTW Ch. 2, 2.3	3:IV.3.24,25,32 ElementaryMatrices_1 ElementaryMatrices_2 ElementaryMatrices_3
Determinant of a matrix, properties	Ch. 4, I.1, I.2	4:I.1.1,3,4,6,9; 4:I.2.8,9,12,13,15,18 Determinants_1 Determinants_2 Determinants_3 Determinants_4 Determinants_5 Determinants_6
More on Determinants	Ch. 4, II.1, III.1	4:III.1.11,14,16,17,20,21,22 Determinants_7(Cramer) Determinants_8(Adjoint)
Matrix of a linear transformation, matrix of the composition, inverse	Ch. 3, III.1, IV.2	3:III.1.13,17,18,19,21,23 Matrix_of_Transformation_1
Change of basis, similar matrices	Ch. 3, V.1, V.2; Ch. 5, II.1	3:V.1.7,9,10,12; 5:II.1.5,8,11,13,14 Matrix_of_Transformation_2 Matrix_of_Transformation_3 Matrix_of_Transformation_4 Similar_Matrices
Complex numbers	Matthews 5.1–5.6	Matthews 5.8.1,2,5,6,7,9 Complex_Numbers_1 Complex_Numbers_2 Complex_Numbers_3 Complex_Numbers_4 Complex_Numbers_5
Eigenvectors, eigenvalues, eigenspaces for matrices and linear operators. Characteristic polynomial	Matthews 6.1, 6.2; Ch. 5, II.3	5:II.3.23,24,25,26,27,28,29,30,31 Eigenvectors_1 Eigenvectors_2 Eigenvectors_3 Eigenvectors_4 Eigenvectors_5
Diagonalization of matrices	Ch. 5, II.2, II.3	5:II.3.22,33,36,46 Diagonalization_1 Diagonalization_2 Diagonalization_3 Diagonalization_4 Diagonalization_5 Diagonalization_6
Orthogonal and orthonormal bases of R^n and its subspaces; orthogonal matrices	Ch. 3, VI.1, VI.2	3:VI.1.6,7,17,19; 3:VI.2.10 Orthogonal_1 Orthogonal_2 Orthogonal_3 Orthogonal_4
Orthogonal complement of a subspace, orthogonal projection	Ch. 3, VI.3	3:VI.3.11,12,13,14,26,27 Complements_1 Complements_2 Complements_3 Complements_4 Complements_5
Gram-Schmidt process; orthogonal diagonalization of matrices	Ch. 3, VI.2	3:VI.2.13,15,17,18,19,22 GramSchmidt_1 GramSchmidt_2 OrthogonalDiagonalization_1 OrthogonalDiagonalization_2

Review for Final Exam		Student's_Guide; Sample_Book_Problems; Sample_Problems; Solutions

Sample Exams and Other Study Materials

IMPORTANT: Please note that the sample exams below are **traditional** written exams. Our interview-style exams will focus more on understanding and less on calculations.

Examination 1

Sample_1,Answers_1; Sample_2,Answers_2; Sample_3,Answers_3

Examination 2

Being **cumulative**, Examination 2 will cover all the material of Examination 1 as well as additional topics:

Sample_1,Answers_1; Sample_2,Answers_2; Some_Practice_Problems, Answers

Examination 3 and Final Examination

Being **cumulative**, Examination 3 and Final Examination will cover all the material of Examinations 1 and 2 as well as additional topics:

Sample_1, Answers_1; Sample_2, Answers_2; Sample_3, Answers_3

The following sample exams are traditional cumulative final exams. They are adapted, with permission, from the collection of Dr. Inna Sysoeva

Sample_1, Answers_1; Sample_2, Answers_2; Sample_3, Answers_3; Sample_4, Answers_4; Sample_5, Answers_5

Syllabi from previous semesters

The syllabus for Math 304 in Fall 2020 is available through this link:

Fall 2020 page

The syllabus for Math 304 in Fall 2019 is available through this link:

Spring 2020 page

The syllabus for Math 304 in Fall 2019 is available through this link:

Fall 2019 page

The syllabus for Math 304 in Spring 2019 is available through this link:

Math 304 Syllabus for Spring 2019

The syllabus for Math 304 in Fall 2018 is available through this link:

Fall 2018 page