Ma 300 ❖ Linear Algebra

Spring 2024

Instructor: Dr. Laurel Carpenter
Office: AL 46
Office Hours: schedule via https://calendly.com/llcarpen
Email: llcarpen@bju.edu
Preferred Contact: MS Teams: personal message via personal chat,
course content questions via this course's Q&A channel
Lecture: MWF 2:00-2:50, AL 301

Textbook: Larson, *Elementary Linear Algebra,* 8th edition,
Calculator Requirements: A TI-89 or TI-Nspire is required (TI-Nspire CAS is recommended)

Catalog Description: Vector, vector functions, linear functions, solutions of systems of linear equations, matrices, determinants, and eigenvalues.

Course Context: Linear Algebra is required for programs in Mathematics, Physics, Computer Science, Actuarial Science, and Mathematics Education and is recommended for Engineering.

This course supports the following Core Goals (IG) of this institution, goals (MS) of the Division of Mathematical Sciences, and program learning outcomes (MM) for the mathematics major in which, upon degree completion, the student will…

IG 2: Communicate effectively by various means in a variety of contexts.
IG 3: Understand the human experience within the framework of … natural sciences, and mathematics.
IG 4: Analyze, evaluate, and synthesize information and ideas.
IG 5: Solve problems through critical and creative thinking, working independently or collaboratively.
MS 1: Understand the essential theory of mathematics… and appropriately apply the theory in solving problems.
MS 2: Use critical-thinking/analytical skills to understand mathematical… problems and design solutions with the aid of appropriate tools.
MS 3: Apply an understanding of how mathematics… can be used as a tool to examine the natural universe.
MM 1: Progress logically from premises to valid conclusions in a variety of mathematical contexts.
MM 2: Apply mathematics to model real-life situations.
MM 3: Select and use technology for understanding, as well as a labor-saving or problem-solving tool.
MM 4: Construct a biblically consistent philosophy of mathematics.

Course Learning Outcomes: This course is designed to…

1. Develop competency at applying linear systems and matrix solution techniques in a variety of contexts including engineering, computing, and the natural sciences.
2. Provide a foundation in vector and matrix theory that supports related areas such as analysis and differential equations, operations research, modern geometry, stochastics, cryptography, and graph theory.
3. Introduce the field of abstract algebra including important concepts in vector spaces and linear transformations.
4. Sharpen critical-, analytical-, and creative-thinking while applying abstract ideas to scenarios in the natural world.
5. Develop concise use of language and logical thought in proving algebraic properties and theorems.
6. Foster instructor-independent learning of new mathematical concepts, approaches, and applications.
7. Encourage the communication of mathematical concepts clearly to various audiences both orally as well as in writing.

Objectives:

	The student will be able to…	Course Goals Supported	Course Content	Assessment
1.	Reduce a matrix to an REF or the RREF either by hand or using technology	CG 1, CG 3, CG 5	Chapter 1	HW, Test
2.	Use matrices (by conversion to RREF) to solve linear systems	CG 3, CG 4	Chapter 1	HW, Test
3.	Apply linear systems to problems such as curve fitting, network analysis, and chemical reactions	CG 2, CG 4, CG 5	Chapter 1	HW, Project
4.	Perform matrix operations including matrix addition, matrix multiplication, scalar-matrix multiplication, and transposition	CG 1, CG 3, CG 5	Chapter 2	HW, Quiz, Test
5.	Identify the algebraic properties of matrices	CG 1, CG 3, CG 5, CG 7	Chapter 2	HW, Quiz, Test,
6.	Factor matrices (when applicable) into elementary matrices and/or into LU form	CG 1, CG 2, CG 3, CG 4, CG 5	Chapters 2 and 3	HW, Test
7.	Apply matrices to problems in stochastics, cryptography, and Leontief input-output models	CG 2, CG 4, CG 5	Chapter 2	HW, Project
8.	Construct cofactors and calculate determinants of matrices both by hand and using technology	CG 1, CG 3, CG 5	Chapter 3	HW, Quiz, Test
9.	Construct inverse matrices both by hand (using elementary matrices, using adjoints) and using technology		Chapters 2 and 3	HW, Quiz, Test
10.	Identify when a square matrix is invertible (using the Equivalent Conditions for a Nonsingular Matrix)	CG 1, CG 2, CG 3, CG 4, CG 5, CG 6, CG 7	Chapter 3	HW, Test
11.	Apply determinants to problems of area and volume in real n-space as well as to applications using Cramer's Rule		Chapter 3	HW, Project
12.	Determine if a given structure is a vector space, a subspace of a vector space, and/or an inner-product space	CG 1, CG 3, CG 5	Chapters 4 and 5	HW, Quiz, Test
13.	Determine if a given set of vectors is linearly independent, a spanning set, and/or a basis	CG1, CG 3, CG 5, CG 7	Chapter 4	HW, Quiz, Test
14.	Define bases (and calculate dimensions) for the row-space (rank), column-space, and null-space (nullity) of a matrix and articulate the principle of duality	CG1, CG 3, CG 5, CG 7	Chapter 4	HW, Quiz, Test
15.	Determine coordinate and transition matrices in real n-space	CG 1, CG 2 CG 3, CG 4, CG 5, CG 7	Chapter 4	HW, Test
16.	Calculate (in an inner-product space) the norm of a vector, the distance between vectors, and the angle between vectors	CG 1, CG 2 CG 3, CG 4 CG 5, CG 6, CG 7	Chapter 5	HW, Test
17.	Construct orthogonal projections and orthonormal basis for a given basis in an inner product space using the Gram- Schmidt process	CG 1, CG 2 CG 3, CG 4, CG 5, CG 6, CG 7	Chapter 5	HW, Test
18.	Construct a Fourier approximation to a polynomial	CG 1, CG 2 CG 3, CG 4, CG 5, CG 6, CG 7	Chapter 5	HW, Test
19.	Identify when a relation is a linear transformation and if the linear transformation is 1-1 and/or onto.	CG 1, CG 2 CG 3, CG 4, CG 5, CG 6, CG 7	Chapter 6	HW, Quiz, Test
20.	Determine bases for the kernal, domain, and range of a linear transformation	CG 1, CG 2 CG 3, CG 4, CG 5, CG 6, CG 7	Chapter 6	HW, Test
21.	Represent a linear transformation as a matrix.	CG 1, CG 2 CG 3, CG 4, CG 5, CG 6, CG 7	Chapter 6	HW, Test
22.	Determine if two matrices represent the same linear transformation	CG 1, CG 2 CG 3, CG 4, CG 5, CG 6, CG 7	Chapter 6	HW, Test
23.	Determine (and interpret) eigenvectors and associated eigenvalues of linear transformations.	CG 2, CG4	Chapter 7	HW, Test

Grading and Assessment

Grading Scale:

Final grades will be assigned according to a standard 10 percentage-point scale calculated out of the total points available during the semester. Percentages will be rounded to the nearest whole percentage when determining final grades.

90% - 100%	A
80% - 89%	B
70% - 79%	C
60% - 69%	D

Grades are determined by total points made up of the following categories:

Quizzes:

- Quizzes may be announced or unannounced. Always be ready.
- Quizzes are worth 5 to 10 points each and will accumulate to between 75 and 100 points.
- Quizzes will be closed book. Some quizzes will be without calculator.
- Missed quizzes due to absence of any kind will not be made up; however, there will be two extra quizzes.

Homework, Study Logs, and Reflections:

- Homework will be assessed via Reflections.
- You are responsible for checking your homework problems from the answers in the back of the book.
- Reflections will be due via Canvas 4 calendar days after the end of each chapter and will be worth 5 points each.

Application Presentations:

- Students will have the opportunity to present two or three applications in class (depending on class size). Applications may be from topics appearing at the end of each chapter or from outside sources.
- Application presentations will be worth between 20 and 30 points each.
- Presentations may be delayed for extenuating circumstances only with instructor's approval and only if time in the course allows. Delayed presentations will incur a 20% penalty.

Tests and Final Exam:

- There will be four tests and a Final Exam.
- The tests will be worth approximately 75 points each and the Final Exam will be worth approximately 125 points.
- All tests will be closed book and will allow the use of a stand-alone calculator.
- Missed tests may be made up only with instructor's permission and will incur a 10% per day penalty. The Final Exam, may be made up only with registrar's permission. In extenuating circumstances, late penalty may be waived.
- With instructor's permission, tests may be taken before the test day.

Other Policies

Classroom Deportment

The classroom is a professional environment. Students are expected to be respectful to their instructor and peers in behavior, attitude, attire, and use of technology. The instructor has the right to require students who are participating in distracting behavior to leave the class.

Absences:

Students who miss more than 3 lectures may be dropped from the course. Missing more than 20 minutes of any part of a lecture or lab may count as a full absence. Students should notify the instructor by email as soon as possible after an absence (preferably within 24 hours). If the absence is planned, the student should notify the instructor before missing class. Students who are absent are personally responsible to obtain notes from fellow classmates.
BJU attendance policy is in effect (see https://home.bju.edu/bju-policies/ for details).

Academic Integrity and Artificial Intelligence Policies:

BJU's academic integrity and artificial intelligence policies are in effect. (see https://home.bju.edu/bju-policies/ for details).

University Policies: We will follow University guidelines.

Copyright Policy:

Ma 300 Linear Algebra ❖ Course Schedule and Assignments ❖ Spring 2024

This assignment sheet is a tentative schedule. We may get ahead or behind; adjust as necessary.

Date	Discussion	Assessment	Suggested Exercises
Unit 1 Linear Systems, Matrices, and Determinants			
---- 1/10 1/12	Sections 1.1-1.3		1.1 #1, 3, 5, 13, 15, 19, 37, 45, 52, 53, 59, 61, 64, 65, 67, 69, 70, 86 1.2 #3, 7, 11, 13, 15, 17, 19-21, 22-24, 33, 35, 37, 39, 41, 43, 50, 52, 59, 60, 68 1.3 #21, 23, 25
1/15 1/17 1/19	**MLK Day** Sections 2.1-2.4	no class Monday **Chapter 1 Reflection**	2.1 #7, 11, 13, 23, 25, 29-36 all, 41, 43, 55, 71, 85, 86 2.2 #7, 13, 15, 27, 29, 37, 38, 55, 56, 59 2.3 #5, 13, 15, 25, 27, 41, 45, 47, 53, 55, 57, 71, 72, 65 (proof) 2.4 #1-11 odd, 19, 21, 23, 25, 31, 33, 40, 41, 42
1/22 1/24 1/26 1/29 1/31 2/2		 **Chapter 2 Reflection** **Test 1** **Project 1** **Chapter 3 Reflection**	3.1 #1, 9, 11, 15, 19, 27, 29, 31, 41, 43, 44, 45 3.2 #1-15 odd, 21, 23, 29, 37, 38, 40, 42 3.3 #3, 9, 17, 21, 23, 25, 33, 47, 57, 59 (proof), 60 (proof), 65, 71, 72
Unit 2 Vector Spaces and Inner-Product Spaces			
2/5 2/7 2/9 2/12 2/14 2/16 2/19 2/21 2/23 2/26 2/28 3/1	Sections 4.1-4.7 Bible Conference	 **no classes** **2/14-16** **Chapter 4 Reflection** **Test 2**	4.1 #1, 5, 9, 13, 15, 17, 21, 23, 27, 31, 33, 37, 41, 43, 47, 57, 58, 65-68 all (proof) 4.2 #1-12 all, 13-25 odd, 41, 49, 50 4.3 #3, 4, 7, 9, 11, 17, 23, 27, 29, 37, 39, 41, 43, 44, 53 (proof), 57 (proof) 4.4 #1, 3, 5, 9, 13, 17, 19, 23, 25, 31, 33, 35, 37, 41, 53, 55, 63, 64 4.5 #2, 4, 5, 7, 9, 11, 13, 15, 29, 33, 35, 37, 39, 43, 44, 45, 49, 53, 56, 57, 59, 79, 80 4.6 #7, 9, 15, 17, 19, 21, 23, 25, 33, 39, 43, 51, 53, 57, 59, 65a, 70, 73-77 all 4.7 #7, 9, 11, 13, 17, 19, 23, 25, 31, 37, 41, 49, 55, 56
3/4 3/6 3/8 3/11 3/13 3/15 3/18 3/20 3/22 3/25 3/27 3/29	Sections 5.1-5.5 Spring Break --------	 **No classes** **3/18-22** **--------** **Test 3** **Project 2** **Chapter 5 Reflection**	5.1 #3, 7, 9, 11, 13, 15, 19, 25, 35, 43, 57, 73, 74 5.2 #17, 23, 31, 37, 39, 41, 49, 59, 65, 85, 86 5.3 #1, 11, 15, 19, 23, 29, 53 (proof), 55 (proof), 56 (proof) 5.4 #7, 9, 21, 25, 27, 33, 47, 48 5.5 #77, 86, 87
Unit 3 Linear Transformations, Eigenvalues, and Eigenvectors			
4/1 4/3 4/5	Sections 6.1-6.4		6.1 #3, 15, 19, 21, 22, 25, 29, 31, 33, 39 6.2 #1, 3, 5, 9, 11, 15, 17, 19-27 odd, 33-36 all, 41-44 all, 49, 65, 66

Date	Discussion	Assessment	Suggested Exercises
4/8 4/10 4/12	AACS	**no class 4/10** **Chapter 6 Reflection**	6.3 #1, 5, 7, 9, 11, 15, 19, 23, 25, 27, 33, 35, 41, 43, 52, 53, 54 6.4 #3, 7, 13, 15, 17, 41, 42
4/15 4/17 4/19 4/22 4/24 4/26	Sections 7.1-7.3	**Test 4** **Project 3**	7.1 #1, 3, 5, 9, 11, 21, 23, 33, 51, 53, 55, 59 7.2 #3, 7, 9, 11, 15, 19, 29 7.3 #9, 13, 23, 27, 35, 41
5/1		**Final Exam/Paper** Wed 5/1 3:30-4:40	Final exam according to BJU final exam schedule