MAT 343: Applied Linear Algebra – Spring 2024

Course and Faculty Information

Course Catalogue Description: Solving linear systems, matrices, determinants, vector spaces, bases, linear transformations, eigenvectors, norms, inner products, decompositions, applications. Problem solving using MATLAB.

Prerequisites: The official prerequisite is MAT 266 with a grade of C or better. However, it is strongly recommended students take MAT 267 (Calculus III) prior to taking this class.

Instructor: Professor Alex Mahalov

Contact Info: mahalov@asu.edu

Office Hours: 2.45pm-3.45pm, TuTh

Office: Wexler 831

Course Overview

Linear Algebra is the study of vector spaces and linear transformations on vector spaces. Linear Algebra is central to both pure and applied mathematics. Techniques from Linear Algebra are also used in analytic geometry, engineering, physics, natural science, computer science, and the social sciences. Topics include the use and application of matrices in the solution of systems of linear equations, determinants, real n-dimensional vector spaces, abstract vector spaces and their axioms, linear independence, span and bases for vector spaces, linear transformations, eigenvalues and eigenvectors, matrix factorizations, and orthogonality. Computer explorations using MATLAB is an integral component of this course.

Course Learning Outcomes

At the completion of this course, students will be able to:

1. Solve linear systems using Row Echelon form and Reduced Row Echelon Form.
2. Perform matrix operations and apply the algebraic properties of these operations.
3. State the definition of singular matrix and how it relates to the solution of square systems.
4. Evaluate determinants and state and apply their properties.
5. Determine whether a set with given operations is a vector space and whether a subset of a vector space is a subspace.
6. Determine whether a set of vectors is linearly independent.
7. Determine bases for subspaces and transition matrices from one basis to another.
8. Find matrix representations of linear transformations and use them in applied problems.
9. Evaluate norms and inner products.
10. Apply the Fundamental Subspaces Theorem to find bases for orthogonal complements.
11. Find the least squares solutions of an overdetermined problem and the best fit to a set of data points.
12. Find orthogonal projections onto subspaces.
13. Find orthonormal basis using the Gram-Schmidt algorithm.
14. Determine eigenvalues and bases of eigenspaces of a matrix and determine whether a matrix is diagonalizable.
15. Determine and use matrix factorizations such as LU, QR and SVD.
16. Use MATLAB to explore applications of linear algebra

Textbook

Linear Algebra with Applications, 10e by Steven J. Leon, Lisette G. De Pillise, Pearson-Prentice Hall.

Calculators

A graphing calculator is recommended. Graphing calculators which perform symbolic manipulation (e.g. TI89, TI92, Casio FX2 or 9970G) are not allowed for proctored tests. The allowed calculators are TI83, TI83Plus, TI84, TI84Plus, TI85, TI86, TI36xPro, CASIO FX9750GII, CASIO FX-CG10, TI- Inspire CX (note that TI-Inspire CX-CAS is **not** allowed). **No calculators are allowed during the first test.**

Student Success

To be successful:

- attend class
- read announcements
- read and respond to course email messages as needed
- complete assignments by the due date specified
- communicate regularly with your instructor and peers
- create a study and/or assignment schedule to stay on track
- plan to allocate at least 10 hours per week of coursework (Arizona Board of Regents require 135 total hours of coursework for a 3-credit course).
- **tutoring services** can be found through the Tutor Search tab **https://tutoring.asu.edu/.** You can also find support at the **Math Tutoring center** and the **Engineering Tutor Center**

Methods of Evaluation

Assignment	**Percentage**
Exam 1: Covers 1.1-1.5, 2.1, 2.2, 3.1-3.3 **Exam 2** . Covers 3.4-3.6, 4.1, 4.2, 5.1-5.2 There are no retakes or "corrections", and no lowest grade will be dropped, nor will you receive extra credit assignments to erase the consequences of a bad test.	45%
FINAL (Comprehensive)	30%
WeBWorK/Quizzes Quizzes may be given in class unannounced. No make ups. Online Homework will be submitted online via the internet using the homework system WeBWorK. WeBWorK contains questions pertaining to each topic, the due dates for which are listed on the website. **No extension of due dates will be given**. In order to log on to WeBWorK, go to **https://webwork.asu.edu/** and login with your ASUrite ID and password. If you have trouble logging in into WeBWorK, email your instructor.	12.5%
MATLAB LABS There will be a total of six MATLAB computer labs plus a LAB 0, which is extra credit. Labs 1-6 must be submitted through the Assignment feature in Canvas in pdf format. The labs count for 12.5% of the grade. **No late assignments will be accepted.** Teaching Assistants will be available to provide help if needed. You are **not** required to purchase MATLAB. All students can download MATLAB through MyApps or can use MATLAB remotely through MyApps. Check the Links & Tool module for more information about MATLAB.	12.5%

Cell phones and Electronic Devices

Any student who accesses a phone or any internet-capable device during an exam for any reason, automatically receives a score of zero on the exam. All such devices must be turned off and put away and made inaccessible during the exam. Accessing any such device for any reason will result in a score of 0 for the exam. This includes smart watches. Your instructor reserves the right to ask you to remove your watch during an exam. Notes or "cheat sheets" are not allowed during proctored exams.

Academic Integrity

Academic honesty is expected of all students in all examinations, papers, and laboratory work, academic transactions, and records. Please be aware that the School of Mathematics and Statistical Sciences (SoMSS) takes academic dishonesty in any form as a very serious matter. We are obliged to investigate all such cases and if the evidence warrants it, we send the case up to the Dean's Office for review. The possible sanctions include, but are not limited to, appropriate grade penalties, course failure (indicated on the transcript as a grade of E), course failure due to academic dishonesty (indicated on the transcript as a grade of XE), loss of registration privileges, disqualification, and dismissal. For more information, see **http://provost.asu.edu/academicintegrity)**

Submitting Assignments

WeBWorK scores will be automatically recorded in the WeBWorK site. MATLAB labs 1 -5 are automatically scored in canvas. Lab 6 must be submitted to the designated area of Canvas.

Assignment due dates follow Arizona Standard time.

Grading

Your grade will be determined based on the following grading schema:

Grade	Percentage	Grade	Percentage
A+	100% - 97%	B-	80% - 82.9%
A	96.9% - 93%	C+	76% - 79.9%
A-	92.9% - 90%	C	70% - 75.9%
B+	87% - 89.9%	D	60% - 69%
B	83% - 86.9%	E	Below 60%

Grading Procedure

Grades reflect your performance on assignments and adherence to deadlines. Grades are based only on academic work and are calculated using the same criteria for all students. It is highly unethical to bring to your instructor's attention the possible impact of your mathematics grade on your future plans, including graduation, scholarships, jobs, etc. The instructor may exercise an option to withdraw you from the course if they think you are compromising the ability to assess your work independently of any other consideration. The Y grade is **not** an option for this class.

Late or Missed Assignments

Notify the instructor **BEFORE** an assignment is due if an urgent situation arises and you are unable to submit the assignment on time. Follow the appropriate University policies to request an accommodation for religious practices (https://www.asu.edu/aad/manuals/acd/acd304-04.html) or to accommodate a missed assignment due to University-sanctioned activities (http://www.asu.edu/aad/manuals/acd/acd304-02.html) .

Tentative Schedule

Week	Dates	TOPICS	COMMENTS
1	1/8-1/12	**1.1** Systems of Linear Equations **1.2** Row Echelon Form	
2	1/15-1/19	**1.3** Matrix Arithmetic **1.4** Matrix Algebra	1/15 MLK Holiday (no class) **Due Fr.1/19: MATLAB LAB 0** 1/21: Drop Deadline
3	1/22-1/26	**1.5** Elementary Matrices **2.1** The Determinant of a matrix	**Due Fr. 1/26: MATLAB LAB 1:** Matrix and Vector Computations
4	1/29-2/2	**2.2** Properties of Determinants **3.1** Vector Spaces	
5	2/5-2/9	**3.2** Subspace **3.3** Linear Independence	**Due Fr. 2/8: MATLAB LAB 2**: Solving Systems and simple programming
6	2/12-2/16	Review **TEST 1**	**TEST 1: covers 1.1-1.5, 2.1-2.2, 3.1-3.3**
7	2/19-2/23	**3.4** Basis and Dimension **3.5** Change of Basis	**Due Fr. 2/23: MATLAB LAB 3**: The LU Decomposition
8	2/26-3/1	**3.6** Row Space and Column Space **4.1** Linear Transformations: Definitions and Examples	
9	3/4-3/8		**SPRING BREAK**
10	3/11-3/15	**4.2** Matrix Representations of Linear Transformation **5.1**The scalar product in R^n	**Due Fr. 3/15: MATLAB LAB 4:** Computer Graphics and Animation
11	3/18-3/22	**5.2** Orthogonal Subspaces **5.3** Least Squares Problems	
12	3/25-3/29	Review **TEST 2**	**TEST 2: covers 3.4-3.6, 4.1-4.2, 5.1-5.3** 3/31: Course withdrawal Deadline
13	4/1-4/5	**5.4** Inner Product Spaces **5.5** Orthonormal Sets	**Due Fr. 4/5: MATLAB LAB 5:** Least Squares
14	4/8-4/12	**5.6** The Gram-Schmidt Orthogonalization process **6.1** Eigenvalues and Eigenvectors	
15	4/15-4/19	**6.3** Diagonalization **6.5** The Singular Value Decomposition	**Due Fr. 4/19: MATLAB LAB 6:** The SVD Decomposition and Image Compression
16	4/22-4/26	**6.5** The Singular Value Decomposition Review **Review**	Classes end 4/26
17	4/29-5/3	**FINAL EXAM**	See Schedule of Finals

Communicating With the Instructor

Class attendance is required. Always happy to discuss mathematics with students. Please see me during office hours or by appointment. My office is in Wexler 831.

Email

ASU email is an official means of communication (http://www.asu.edu/aad/manuals/ssm/ssm107-03.html) among students, faculty, and staff. Students are expected to read and act upon email in a timely fashion. Students bear the responsibility of missed messages and should check their ASU-assigned email regularly. Please **do not** use the Canvas inbox for messages.

All instructor correspondence will be sent to your ASU email account.

Copyrighted Materials

Students must refrain from uploading to any course shell, discussion board, or website used by the course instructor or other course forum, material that is not the student's original work, unless the students first comply with all applicable copyright laws; faculty members reserve the right to delete materials on the grounds of suspected copyright infringement. **The content of this course, including lectures and other instructional materials, are copyrighted materials. Students may not share outside the class, including uploading, selling, or distributing course content or notes taken during the conduct of the course.** Any recording of class sessions is authorized only for the use of students enrolled in this course during their enrollment in this course. Records and excerpts of recordings may not be distributed to others. Any (parts of) exams, assignment, reports, or solutions to these, from current or previous semester, posted to any website not affiliated with ASU will result in academic integrity disciplinary actions against the students posting them and the students using them.

Additional Course Policies

- Students are responsible for assigned material whether or not it is covered in class. Students are responsible for material covered in class whether or not it is in the text. Working regularly on assigned problems and *attending class* are essential in order to do well. Expect to spend at least 6-10 hours weekly on homework/labs. You are expected to read the text, preferably before the material is covered in class.
- Make-up exams are at the discretion of the instructor and only in case of documented emergency. In any case, no make-up exams will be given unless the student has notified the instructor through email before the test is given.
- Cellular phones can be used in class only for classroom related activities (zoom polls, online quizzes). Quizzes are given in class unannounced.
- No late HW will be accepted, and no make-up quizzes will be given.
- All E-mail communication must be done from your ASU account. Due to FERPA (Family Educational Rights and Privacy Act), E-mails received from other accounts will not be answered.

Disability Resources

Establishing Eligibility for Disability Accommodations: Students who feel they will need disability accommodations in this class but have not registered with the Student Accessibility and Inclusive Learning Services (SAILS, formerly called DRC) should contact SAILS immediately. SAILS staff can also be reached at: 480-965-1234 (V), 480-965-9000 (TTY). Their hours are 8:00 AM to 5:00 PM, Monday through Friday. For additional information, visit: **https://eoss.asu.edu/drc**

Policy Against Threatening Behavior

All incidents and allegations of violent or threatening conduct by an ASU student (whether on-or off campus) must be reported to the ASU Police Department (ASU PD) and the Office of the Dean of Students. If either office determines that the behavior poses or has posed a serious threat to personal safety or to the welfare of the campus, the student will not be permitted to return to campus or reside in any ASU residence hall until an appropriate threat assessment has been completed and, if necessary, conditions for return are imposed. ASU PD, the Office of the Dean of Students, and other appropriate offices will coordinate the assessment in light of the relevant circumstances. For more information, please visit https://eoss.asu.edu/dos/Policies and https://eoss.asu.edu/dos/safety/ThreateningBehavior

Reporting Title IX Violations

Title IX is a federal law that provides that no person be excluded on the basis of sex from participation in, be denied benefits of, or be subjected to discrimination under any education program or activity. Both Title IX and university policy make clear that sexual violence and harassment based on sex is prohibited. An individual who believes they have been subjected to sexual violence or harassed on the basis of sex can seek support, including counseling and academic support,

from the university. If you or someone you know has been harassed on the basis of sex or sexually assaulted, you can find information and resources at https://sexualviolenceprevention.asu.edu/faqs. **As a mandated reporter, instructors are obliged to report any information they become aware of** regarding alleged acts of sexual discrimination, including sexual violence and dating violence. ASU Counseling Services, https://eoss.asu.edu/counseling is available if you wish to discuss any concerns confidentially and privately.

Policy on Sexual Discrimination

Arizona State University is committed to providing an environment free of discrimination, harassment, or retaliation for the entire university community, including all students, faculty members, staff employees, and guests. ASU expressly prohibits discrimination , harassment, and retaliation by employees, students, contractors, or agents of the university based on any protected status: race, color, religion, sex, national origin, age, disability, veteran status, sexual orientation, gender identity, and genetic information.

As a mandated reporter, I am obligated to report any information I become aware of regarding alleged acts of sexual discrimination, including sexual violence and dating violence. ASU Counseling Services, https://eoss.asu.edu/counseling , is available if you wish to discuss any concerns confidentially and privately.

Other SoMSS and University Policies and Procedures

The Y grade is **not** an option for this class.

Final Exam Make Up Policies: The final exam schedule will be strictly followed. Except to resolve those situations described below, no changes may be made in this schedule without prior approval of the Dean of the college in which the course is offered. Under this schedule, if a conflict occurs, or a student has more than three exams on one day, the instructors may be consulted about an individual schedule adjustment. If necessary, the matter may be pursed further with the appropriate dean(s). This procedure applies to conflicts among any combination of Downtown Phoenix campus, Tempe campus, Polytechnic campus, West campus, and/or off campus class. Make-up exams will NOT be given for reasons of a non-refundable airline tickets, vacation plans, work schedules, weddings, family reunions, and other such activities. Students should consult the final exam schedule before making end-of- semester travel plans. Exceptions to the schedule and requests for make-up examinations can be granted only by the Department Chair, Associate Department Chair or the Director of First Year Mathematics, and for one of the following reasons:

1. Religious conflict (e.g., the student celebrates the Sabbath on Saturday)
2. The student has more than three exams scheduled on the same day as the math final
3. There is a time conflict between the math final and another final exam

Incomplete: A grade of incomplete will be awarded only in the event that a documented emergency or illness prevents the student who is doing acceptable work from completing a small percentage of the course requirements. The guidelines in the current **Student Service Manual** regarding a grade of incomplete will be strictly followed. The form for an incomplete request is at **https://students.asu.edu/forms/incomplete-grade-request**. Once the student completes their part, they should bring it to the instructor for approval.

Ethics: Grades are based only on academic work and are calculated using the same criteria for all students. It is highly unethical to bring to your instructor's attention the possible impact of your mathematics grade on your future plans, including graduation, scholarships, jobs, etc. The instructor may exercise an option to withdraw you from the course if they think you are compromising the ability to assess your work independently of any other consideration.

Syllabus Disclaimer

The syllabus is a statement of intent and serves as an implicit agreement between the instructor and the student. Every effort will be made to avoid changing the course schedule, but the possibility exists that unforeseen events will make syllabus changes necessary. **Remember to check your ASU email and the course site often. Any in-class, canvas or e-mail announcements is considered official addendum to this syllabus.**