Matrix Algebra with Applications
Fall 2019
MATH 304.01 (4 credits), MTu_ThF, 09:00A-09:50A, Wickersham 112

Prerequisite: A grade of C- or better in MATH 161 (*Calculus I*) is the prerequisite for this course.

Instructor: Dr. Buchanan

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Office Hours: 10:00A-10:50A (M_F), 10:00A-10:45A (Tu_Th), 02:00-02:50P (W), or by appointment

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Textbook: *Linear Algebra with Applications*, (open edition), W. Keith Nicholson, Lyryx Learning, Calgary, Alberta, Canada, (2019 Revision A).

You may download a PDF of the textbook for free and/or purchase a printed copy.

Description: An introduction to matrix algebra with emphasis on applications: systems of linear equations, matrix algebra, determinants, Euclidean and general vector spaces, inner product spaces, eigenvalues and eigenvectors, matrix transformations, numerical methods for matrices, selected applications such as Markov Chains, strategy games, cryptography, bar codes, Hadamard matrices, error correcting codes, graph theory, computer graphics, and internet search engines.

Objectives: Students will gain an understanding of the fundamental concepts and acquire the essential technical skills of matrix algebra including:

- Solving systems of linear equations using Gaussian elimination and/or Gauss-Jordan elimination,
- Performing matrix algebra including reduction to reduced row-echelon form, transpose, and finding inverse matrices,
- Matrix transformations and properties,
- Evaluating determinants and applying the properties of determinants as appropriate,
- Euclidean spaces, norm, dot product, distances, angles and other relevant properties,
- Geometry of Euclidean spaces, orthogonality and projections,
- Cross product,
- Concepts of linear dependence /independence, determining if a given set is a linearly independent set,
- The concept of a basis of a vector space, coordinates of vectors relative to a given basis, and determining the basis for, and the dimension of, a vector space,
- Rank and nullity, describing the fundamental matrix spaces,
- Finding eigenvalues, eigenvectors, and determining eigenspaces for a matrix,
- Determining diagonalizability and diagonalizing a matrix when possible,
- Inner product and inner product spaces,
- Geometrical quantities in inner product spaces, such as angles and lengths,
- Performing the Gram-Schmidt process and QR-decomposition.

Students will learn some significant applications of matrix algebra including:

- Network analysis and electrical circuits,
- Best approximations: least squares,
- Markov chains,
- Introduction to graph theory,

- Strategy games,
- Computer graphics,
- Cryptography,
- Internet search engines,
- Other application topics may be included.

Students will gain an understanding of elementary numerical matrix algebra including:

- LU decomposition and solution of linear systems,
- The power method and Rayleigh quotients,
- The singular value decomposition of matrices.

Topic Coverage: The following topics will be explored in this course.

- Systems of Linear Equations and Matrices
- Determinants
- Euclidean Vector Spaces
- General Vector Spaces
- Eigenvalues and Eigenvectors
- Inner Product Spaces
- Numerical Linear Algebra

Other topics may be covered as time or interest permit.

Attendance: Students are expected to attend all class meetings. There is an inverse correlation between a student's number of absences and final grade. This is due to the fact that daily contact with the material is essential to understanding the course contents. Getting the material second hand from someone else's notes is simply not the same as hearing it for yourself. If you must be absent from class you are expected to complete class requirements (tests and/or homework assignments) prior to the absence. Students who miss a test should provide a valid excuse, otherwise you will not be allowed to make up the test. Tests should be made up within one week of their scheduled date. No final exam exemptions. Further information and details about this attendance policy can be found in the University Approved Guidelines.

Homework: Students are expected to do their homework and participate in class. Homework will be facilitated through the online learning system supported by lyryx.com. Follow the instructions at the link https://login.lyryx.com/unprotected-servlets/FDOC.html?c=LILA1_2581 to register for the online homework system. The fee for the online homework system is \$39.95. Since homework will be assigned nearly every day the class meets, students should register with the online homework system as soon as possible.

Students should expect to spend a *minimum* of twelve hours per week reviewing notes taken during class and working assigned homework exercises. Preparation for the tests and final exam will require additional hours of study. Students will find it beneficial to review all lecture notes and other relevant material collected from the beginning of the semester until the present time at least once per week.

Tests: There will be three 50-minute in-class tests and a comprehensive final examination. The tests are tentatively scheduled for

1. Thursday, September 19, 2019
2. Friday, October 18, 2019

3. Thursday, November 14, 2019

The final exam is scheduled for Wednesday, December 11, 2019, 08:00A–10:00A. I will not "curve" test or exam grades.

Grades: Course grade will be calculated as follows.

Tests	50%
Exam	20%
Homework	30%

Tests and the final examination will be graded individually on a 100-point scale. If a student believes that an error was made in the grading of an assignment or test, the student should explain *in writing* why they believe an error exists and submit the graded material and the explanation of the possible error to me within 3 class periods of the graded test or homework being returned to the student. In no cases will adjustments to grades of less than 3 points be made. I keep a record of students' test and exam scores. Students should also keep a record of graded assignments, tests, and other materials. As an example of the calculation of the numerical course grade, suppose a student's four test grades were 87, 78, 65, and 70 (out of a maximum of 100 points on each test), the student's final examination grade was 71 (again, out of a maximum of 100). Suppose seven homework assignment were collected and the student's grades were 32/40, 38/50, 50/60, 20/40, 27/50, 40/40, and 23/40. This hypothetical student's numerical course grade would be calculated according to the formula

$$
\begin{aligned}
&\frac{87 + 78 + 65 + 70}{4} \cdot 0.50 + 71 \cdot 0.30 \\
&\quad + \frac{32/40 + 38/50 + 50/60 + 20/40 + 27/50 + 40/40 + 23/40}{7} \cdot 20 \\
&= \quad 37.5 + 21.3 + 14.4 \\
&= \quad 73.2
\end{aligned}
$$

The course letter grades will be calculated as follows. I will not "curve" course grades.

90-92	A−	93-100	A		
80-82	B−	83-86	B	87-89	B+
70-72	C−	73-76	C	77-79	C+
60-62	D−	63-66	D	67-69	D+
		0-59	F		

Course Repeat Policy An undergraduate student may not take an undergraduate course of record more than three times. A course of record is defined as a course in which a student receives a grade of A, B, C, D, (including + and −) F, U, Z or W. The academic department offering a course may drop a student from a course if the student attempts to take a course more than three times.[1]

The last day to withdraw from a course (and receive the W grade) is November 1, 2019.

Inclement Weather Policy: If we should miss a class day due to a school closing because of weather, any activities planned for that missed day will take place the next time the class meets. For example, if a test is scheduled for a day that class is canceled on account of snow, the test will be given the next time the class meets.

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[1]Memorandum to mathematics faculty from Dr. Charles G. Denlinger, Assistant Chair, Department of Mathematics, August 30, 2004.

Cell Phones: Silence (or better yet, turn off) all cellular telephones upon entering the classroom. Leaving class to initiate or receive a telephone call will not be tolerated and students doing so will not be re-admitted to the classroom until the following class meeting. Texting or tweeting during class interferes with the learning process. Students distracted by their cell phones are not engaged in class and will find, over the course of the semester, that learning and course grade will suffer.

Title IX Reporting Responsibilities: Millersville University and its faculty are committed to assuring a safe and productive educational environment for all students. In order to meet this commitment and to comply with Title IX of the Education Amendments of 1972, 20 U.S.C. §1681, *et seq.*, and act in accordance with guidance from the Office for Civil Rights, the University requires faculty members to report to the University's Title IX Coordinator incidents of sexual violence shared by students. The only exceptions to the faculty member's reporting obligation are when incidents of sexual violence are communicated by a student during a classroom discussion, in a writing assignment for a class, or as part of a University-approved research project. Faculty members are obligated to report to the person designated in the University Protection of Minors policy incidents of sexual violence or any other abuse of a student who was, or is, a child (a person under 18 years of age) when the abuse allegedly occurred.

Information regarding the reporting of sexual violence, and the resources that are available to victims of sexual violence, is available at https://www.millersville.edu/titleix/index.php.

Final Word: Math is not a spectator sport. What you learn from this course and your final grade depend mainly on the amount of work you put forth. Daily contact with the material through homework assignments and review of notes taken during lectures is extremely important.

No one can guarantee you success in this course. Your responsibilities and the instructor's expectation are outlined above. There will be no second chances or "do-overs".