

Penn State University - University Park
MATH 220, Matrices
Spring 2019

CATALOG DESCRIPTION: MATH 220(GQ) MATRICES (2 semester hours) Systems of linear equations; matrix algebra; eigenvalues and eigenvectors; linear systems of differential equations.

PREREQUISITE: MATH 110, MATH 140 or MATH 140H

TEXT:

Either (paper copy)

- David Lay, Linear Algebra and its Applications, Fifth Edition, Pearson;

or (this includes an electronic edition of the textbook)

- MyMathLab Online Course for Linear Algebra and Its Applications, 5/E, ISBN-13: 9780321989871. You may purchase this directly through [Pearson](#).

COURSE FORMAT: There are two 50-minute lectures each week. The sections covered in lectures are listed at the end of this syllabus.

MATH 220 LEARNING OBJECTIVES :

Upon successful completion of Math 220, the student should be able to:

1. Know what is meant by a system of linear equations (or linear system) and its solution set.
2. Know how to write down the coefficient matrix and augmented matrix of a linear system.
3. Use elementary row operations to reduce matrices to echelon forms.
4. Make use of echelon forms in finding the solution sets of linear systems.
5. Know how to manipulate with vectors in Euclidean space.
6. Understand the meaning of linear independence/dependence and span.
7. Interpret linear systems as vector equations.
8. Define matrix vector product and be able to interpret linear systems as matrix equations.
9. Write the general solution of linear systems in parametric vector form.
10. Understand the relation between the solution set of a consistent inhomogeneous linear system and its associated homogeneous equation.

11. Determine whether sets of vectors are linearly independent or dependent.
12. Know what is meant by a linear transformation between Euclidean spaces.
13. Determine the standard matrix of a linear transformation.
14. Give the geometric description of some matrices.
15. Understand the notion of one-to-one mapping and onto mapping.
16. Know how to scale a matrix, take the transpose of a matrix, and how to add and multiply matrices.
17. Know what is meant by an invertible matrix.
18. Know how to compute the inverse of a matrix, if it exists.
19. Understand the various characterizations of an invertible matrix.
20. Determine if a given subset of a Euclidean space is a subspace.
21. Know what is the column space and nullspace of a matrix and how to determine these spaces.
22. Find a basis of a subspace of a Euclidean space.
23. Define the concept of dimension and how to use the rank plus nullity theorem.
24. Know the recursive definition of determinants.
25. Make use of the properties of determinants in their calculations.
26. Find eigenvalues and eigenvectors of square matrices.
27. Diagonalize square matrices, whenever possible.

28. Compute the matrix of a linear transformation relative to given bases.
29. Compute the inner product of vectors, lengths of vectors, and determine if vectors are orthogonal.
30. Know what is meant by an orthogonal set, orthogonal basis and orthogonal matrix.
31. Find the orthogonal projection of a vector onto a subspace.
32. Find an orthogonal basis using the Gram-Schmidt process.
33. Orthogonally diagonalize symmetric matrices.

CALCULATORS: A graphics calculator is useful as a study and learning tool when used appropriately, but it is not essential. Matrices is a collection of ideas that is not mastered through calculator skills. **No calculators** are allowed on quizzes, midterms, or on the final examination.

TUTORS and PENN STATE LEARNING: Free mathematics tutoring is available at Penn State Learning located in 220 Boucke Building. Tutoring will begin during the second week of the semester. For more information, go to [PSU Learning](#). For more help, a private tutor list is available at [Courses](#) then scroll to Additional Information for the link.

EXAMINATIONS: One 75-minute evening examination will be given during the semester and a 110 minute comprehensive final examination will be given during the final examination period. NO books, notes, or calculators may be used on the examinations. You must bring your University ID card to all exams. The midterm examination will be given from **6:00 to 7:15 PM** on the following date:

Midterm Examination	Tuesday, February 26
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Rooms for examinations will be announced by your instructor at a later date and may also be found on the [Courses](#) website when they are available. It is not permissible to take the exam in a different instructor's assigned room.

CONFLICT – MAKEUP EXAM POLICY: In addition to the regularly scheduled midterm examinations, the math department schedules two additional options: a conflict exam for the midterm from 4:35 - 5:50 pm on the same night as the regularly scheduled exam and a makeup exam scheduled on an evening different from that of the regularly scheduled exam. Students who attend the conflict exam will not be permitted to leave before 5:55. Sign-up sheets for both the conflict exam and the makeup exam will be distributed by your instructor during class. If you need to schedule the conflict exam, you must sign up **at least one full week** ahead of the scheduled exam date. A valid conflict/makeup reason is required to sign up for either of these exams; when signing up, you must include a computer printout of your academic schedule, including your name, so your instructor can validate your request. It is the student's responsibility to sign up and to note the time and location of the makeup or conflict exam; that information is on the signup sheet. **It is the student's responsibility to sign up on the appropriate sheet.**

NOTE: If you miss an exam without an official excuse (such as illness or official university business), you *may* be allowed to take a makeup exam, but with an automatic 20% deduction from the grade. To avoid this deduction, you must notify your instructor with your official excuse, before the date and time of the makeup exam. This notification may be performed in person, via e-mail, or by telephone.

Who may take the Conflict Exam? If a student has a valid, documented conflict with the regular examination time, such as a class or another official university activity, (s)he may sign up for the conflict exam. If (s)he has not signed up for the conflict exam a week in advance, he or she will not be permitted to take the exam.

Instructions on Conflict Exam night. The student is responsible for knowing the room and time of the conflict examination. **Each student must bring his or her University ID to the conflict examination.** The ID will be checked by the proctor. **Although the conflict examination will end at 5:50 PM, no student will be permitted to turn on his/her cell phone nor leave the examination room before 5:55 PM.** Any student who leaves before 5:55 PM will receive a grade of zero on the examination and will not be allowed to retake it.

Who may take the Makeup Exam? Students who have a valid, documented reason, such as a class conflict or illness, during both the conflict and regular examination times are permitted to schedule a makeup examination with no penalty. The student must be prepared to verify the reason for taking the makeup. **Personal business, such as travel, employment, weddings, graduations, or attendance at public events such as concerts, sporting events, and Greek Rush events, is not a valid excuse. Forgetting the date, time or room of an examination is not a valid excuse.** Students who do not have a valid reason for missing the examination are permitted to schedule the makeup, but 20% points will be deducted from their score. Students who have taken either the regularly scheduled examination or conflict examination are not permitted to take the makeup examination. The makeup examination will be given from **6:00 to 7:15 PM** on the following date:

Makeup Midterm Examination	Wednesday, March 13
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How and when to sign up for the Makeup Exam. A student who is ill on exam night must contact his or her instructor within 24 hours of the exam. Students must sign up for the Makeup Exam **in class on a yellow form**, as soon as possible following the regular exam date. The student is responsible for knowing the room and time of the makeup examination. This information is on the yellow form. Instructors must turn in the yellow form **3 class days** prior to the examination date. If a student has not signed up with his or her instructor, the student will not be allowed to take the makeup exam.

Instructions on Makeup Exam night. The student is responsible for knowing the room and time of the makeup examination. **Each student must bring his or her PSU ID to the makeup examination.** The ID will be checked by the proctor.

What if a student misses both the regularly scheduled exam and the makeup exam? If a student misses both the regularly scheduled examination and the scheduled makeup due to a valid, verifiable reason, it may be possible to take a makeup examination by appointment. All such makeup examinations must be scheduled through the classroom instructor with the approval of the course coordinator and must be completed no later than one week after the scheduled makeup examination.

FINAL EXAMINATION: The final examination will be given during the week, April 29-May 3, 2019. **The final examination may be scheduled on any day during the final examination period. Do not plan to leave University Park until after Friday, May 3, 2019.** Students may access their final exam schedules Monday, February 11, through their Lionpath account. Notification of conflicts is given on the student's final exam schedule. There are two types of conflict examinations: direct and overload. Direct conflicts are two examinations scheduled at the same time. Overload examinations are defined as three or more examinations scheduled in consecutive time periods or within one calendar day. Students may elect to take the three or more examinations on the same day if they wish or request a conflict final examination. **A student must take action to request a conflict exam through Lionpath between February 11 and March 3, 2019. Conflict final examinations cannot be scheduled through the Mathematics Department, and there will be no sign up sheet in class for the final conflict examination.** Students who miss or cannot take the final examination due to a valid and documented reason, such as illness, may be allowed to take a makeup final examination at the beginning of the next semester. **Personal business, such as travel, employment, weddings, graduations, or attendance at public events such as concerts and sporting events is not a valid excuse. Forgetting the date, time, or room of an examination is not a valid excuse.** If the student does not have a valid reason, as explained above, a 20% point penalty will be imposed. All such makeup examinations must be arranged through the instructor with the approval of the course coordinator, and students in such a situation should contact their instructors within 24 hours of the scheduled final examination. Students who have taken the original final examination are not permitted to take a makeup examination.

COURSE GRADES: Grades will be assigned on the basis of 400 points, distributed as follows:

Midterm Examination	100
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Homework and/or Quizzes	150
Final Examination	150
Total	400

Final course grades will be assigned as follows:

Grade	Raw Score	Percent Score
A	370-400 POINTS	93%-100%
A-	359-369 POINTS	90%-92%
B+	346-358 POINTS	87%-89%
B	330-345 POINTS	83%-86%
B-	319-329 POINTS	80%-82%
C+	306-318 POINTS	77%-79%
C	279-305 POINTS	70%-76%
D	239-278 POINTS	60%-69%
F	000-238 POINTS	0%-59%

The unavoidable consequence is that some students will be "just a point" away from the next higher or lower grade. For reasons of fairness, the policy in this course is to **NOT** adjust individual grades in such circumstances.

NOTE: Your grade will be based **EXCLUSIVELY** on the midterm examination, homework and/or quizzes, and the final examination. **There is no "extra-credit" work.**

DEFERRED GRADES: Students who are **currently passing a course** but are unable to complete the course because of illness or emergency may be granted a deferred grade which will allow the student to complete the course within the first several weeks of the following semester. Note that deferred grades are limited to those students who can verify and document a valid reason for not being able to take the final examination. For more information see [DF grade](#).

LATE-DROP: Students may add/drop a course without academic penalty within the first six calendar days of the semester. A student may late drop a course within the first twelve weeks of the semester but accrues late drop credits equal to the number of credits in the dropped course. A baccalaureate student is limited to 16 late drop credits. The late drop deadline for Spring 2019 is **April 5, 2019**.

ADDITIONAL HELP at Penn State's Counseling & Psychological Services: Students with a need or interest in obtaining counseling services may wish to contact the Penn State Counseling & Psychological Services Office. More information about the Counseling & Psychological Services Office can be found here: <http://studentaffairs.psu.edu/counseling/>

ACADEMIC INTEGRITY: Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity is a basic guiding principle for all academic activity at The Pennsylvania State University, and all members of the University community are expected to act in accordance with this principle. Consistent with this expectation, the University's Code of Conduct states that all students should act with personal integrity, respect other students' dignity, rights and property, and help create and maintain an environment in which all can succeed through the fruits of their efforts.

Academic integrity includes a commitment not to engage in or tolerate acts of falsification, misrepresentation or deception. Such acts of dishonesty violate the fundamental ethical principles of the University community and compromise the worth of work completed by others.

In order to ensure all students have a fair and equal opportunity to succeed in this course, the Mathematics Department is committed to enforcing the University's academic integrity policy. Below is a description of academic misconduct and the department's responsibilities when misconduct is suspected.

Academic Misconduct

In this course, academic misconduct includes, but is not limited to:

- Copying the work of another student on an exam, quiz, or assignment;
- Passing off the work of another individual as your own;
- Using non-approved devices or aids on exams, quizzes, or assignments;
- Having unauthorized possession of exams or quizzes;
- Engaging in deception in order to extend or reschedule an exam, quiz, or assignment;
- Facilitating acts of academic misconduct by others.

When Academic Misconduct is Suspected

If a student is suspected of academic misconduct, the instructor's duties are to:

- Confidentially inform the student of the allegation;
- Enter the charge and recommended sanctions on an Eberly College of Science Academic Integrity form;
- Ask the student to meet in order to review the form and discuss the charges and sanctions. The student can choose to accept or contest the allegation at this point.

Note that a student's refusal to meet with the instructor or respond to the charges within a reasonable period of time is construed as acceptance of the allegation and proposed sanctions.

Once the Academic Integrity form has been accepted or contested by the student, it is sent to the College's Academic Integrity Committee for adjudication. A student cannot drop or withdraw from the course during the adjudication process.

Sanctions

If a student accepts an academic misconduct allegation, or if (s)he is found guilty during adjudication, probable sanctions include:

- A warning and
- Reduction of the assignment grade to zero or
- Reduction of the quiz or exam grade to zero.

Additional sanctions might include:

- Reduction in the final course grade;
- An F in the course.

In addition, the student will be unable to drop or withdraw from the course.

Please see the [Eberly College of Science Academic Integrity homepage](#) for additional information and procedures.

Also see the [Code of Ethics for Engineers](#) published by the National Society of Professional Engineers.

STUDENTS WITH DISABILITIES: Penn State welcomes students with disabilities into the University's educational programs. If you have a disability-related need for reasonable academic adjustments in this course, contact Student Disability Resources at 814-863-1807 (V/TTY). For further information, please visit Student Disability Resources web site: . <http://equity.psu.edu/student-disability-resources/> .

In order to receive consideration for accommodations, you must contact SDR and provide documentation (see the documentation guidelines at <http://equity.psu.edu/student-disability-resources/>). If the documentation supports your request for reasonable accommodations, SDR will provide you with an accommodation letter identifying appropriate academic adjustments. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. You must follow this process for every semester that you request accommodations.

CODE OF MUTUAL RESPECT AND COOPERATION: The Eberly College of Science Code of Mutual Respect and Cooperation pertains to all members of the college community; faculty, staff, and students. The [Code of Mutual Respect and Cooperation](#) was developed to embody the values that we hope our faculty, staff, and students possess, consistent with the aspirational goals expressed in the Penn State Principles. The University is strongly committed to freedom of expression, and consequently, the Code does not constitute University or College policy, and is not intended to interfere in any way with an individual's academic or personal freedoms. We hope, however, that individuals will voluntarily endorse the 12 principles set forth in the Code, thereby helping us make the Eberly College of Science a place where every individual feels respected and valued, as well as challenged and rewarded.

EDUCATIONAL EQUITY: The Office of the Vice Provost for Educational Equity serves as a catalyst and advocate for Penn State's diversity and inclusion initiatives. Educational Equity's vision is a Penn State community that is an inclusive and welcoming environment for all. If you wish to learn more or if you wish to [report bias](#), please visit the Educational Equity [website](#).

QUESTIONS, PROBLEMS, OR COMMENTS: If you have questions or concerns about the course, please consult your instructor first. If further guidance is needed, you may contact the course coordinator whose contact information is given below.

Course Coordinator

Dr. Misha Guysinsky, Teaching Professor

112A McAllister Building

University Park, PA 16802

E-mail: mxg30@psu.edu

Include your Name, Student ID, Course, and Section Number in any correspondence.

SUGGESTED LECTURE SCHEDULE

WEEK	DAY	DATE	SECTION(S)	TOPIC	COMMENTS
1	Monday	Jan 7	1.1	Systems of Linear Equations	CLASS BEGINS
	Wednesday	Jan 9	1.1, 1.2	Systems of Linear Equations, Row Reduction and Echelon Forms	
2	Monday	Jan 14	1.2	Row Reduction and Echelon Forms	
	Wednesday	Jan 16	1.3	Vector Equations	
3	Monday	Jan 21		No Classes	Martin Luther King Day -
	Wednesday	Jan 23	1.3, 1.4	Vector Equations, The Matrix Equation $Ax=b$	

4	Monday	Jan 28	1.5	Solution Sets of Linear Systems	
	Wednesday	Jan 30	1.7	Linear Independence	
5	Monday	Feb 4	1.8	Introduction to Linear Transformations	
	Wednesday	Feb 6	1.9	The Matrix of a Linear Transformation	
6	Monday	Feb 11	2.1	Operations on Matrices	
	Wednesday	Feb 13	2.2	The Inverse of a Matrix	
7	Monday	Feb 18	2.3	Characterizations of Invertible Matrices	
	Wednesday	Feb 20	2.8	Subspaces of \mathbb{R}^n	
8	Monday	Feb 25		Review	
	Tuesday	Feb 26			MIDTERM EXAM
	Wednesday	Feb 27	2.9	Dimension and Rank	
9	Monday	March 4		No Classes	SPRING BREAK
	Wednesday	March 6		No Classes	SPRING BREAK
10	Monday	March 11	3.1	Introduction to Determinants	
	Wednesday	March 13			MAKEUP EXAM
	Wednesday	March 13	3.2,3.3	Properties of Determinants, Cramer's Rule, Inverse matrix	

11	Monday	March 18	5.1	Eigenvalues and Eigenvectors	
	Wednesday	March 20	5.1	Eigenvalues and Eigenvectors	
12	Monday	March 25	5.2	The Characteristic Equation	
	Wednesday	March 27	5.3	Diagonalization	
13	Monday	April 1	5.3	Diagonalization	
	Wednesday	April 3	6.1	Inner Product, Length and Orthogonality	
14	Monday	April 8	6.2	Orthogonal Sets, Orthogonal Matrices	
	Wednesday	April 10	6.3	Orthogonal Projections	
15	Monday	April 15	6.4	The Gram-Schmidt Process	
	Wednesday	17	7.1	Diagonalization of Symmetric Matrices	
16	Monday	April 22		Review	
	Wednesday	April 24		Review	LAST CLASS