

# Math 312: Linear Algebra

Summer 2019, Session II

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<b>Course Website</b>	Will shortly be available at <a href="https://www.math.upenn.edu/~bmor/">https://www.math.upenn.edu/~bmor/</a>
<b>Lectures</b>	MTWR 10AM – 12:10PM in DRL 3W2
<b>Office Hours</b>	Half hour after class Monday, Tuesday and Wednesday + 1–3 PM on Thursdays in DRL 3E6A
<b>Extra Help</b>	Math help is available MTWR 9AM – 1PM with Yizheng Li. On Monday, Wednesday, Thursday (except in the week of June 17th) this is in 2N36. On other days it is in 4N49.

**Course Overview:** Linear algebra started with solving multivariable linear equations. It has since been reinterpreted in terms of *linear transformations*, and this course will explain this viewpoint, and look at elementary properties and applications of these.

**Prerequisites:** We assume Math 240 (or equivalent). We will *briefly* review some of the basics of solving linear equations, matrix operations, vectors, scalars, equations defining lines and planes, however the course will assume that this is not a first introduction to this material. We will also use basic calculus knowledge.

**Material:** We'll cover the following linear algebra techniques:

- Solving linear systems
- Gauss-Jordan elimination
- Vector Spaces and Subspaces
- Dimension
- The Rank-Nullity Theorem
- Linear Transformations
- Determinants
- Eigenvectors and Eigenvalues
- Diagonalization
- Orthonormal Bases
- Gram-Schmidt Process
- Singular Value Decomposition
- Inner Product Spaces
- SVD Decomposition.

and some subset of the following applications of the above depending on class interest

- Least-Squares Approximation
- Fourier Series
- Markov Chains
- Google's PageRank Algorithm
- Principal Component Analysis
- Linear Programming
- Support Vector Machines

**Text:** There is no set text. However it is highly recommended that you regularly consult at least one of the following resources frequently to reinforce topics in lectures. The books will soon be placed on course reserve at the library shortly.

References for specific sections will be recommended.

- *Introduction to Linear Algebra*, Gilbert Strang, Wellesley Cambridge Press
- *Applied Linear Algebra*, Gilbert Strang
- *Linear Algebra Done Right*, Axler. Note: This book has the best description of the theory that I am aware of. However it does not include any calculations explicitly.
- *Fundamentals of Linear Algebra and Optimization*, Jean Gallier and Jocelyn Quaintance, available online at <http://www.cis.upenn.edu/~cis515/linalg.pdf>.
- *MIT Open Courseware* Includes videos, assignments, etc. for a course taught by Gilbert Strang on Linear Algebra. Available at [ocw.mit.edu](http://ocw.mit.edu) in courses 18.06 and 18.06 SC.
- *Linear Algebra*, Jim Hefferon, <http://joshua.smcvt.edu/linearalgebra/>
- *Linear Algebra Wikibook* [en.wikibooks.org/wiki/Linear\\_Algebra](http://en.wikibooks.org/wiki/Linear_Algebra)

**Illnesses etc.** If for whatever reason (e.g. Illnesses/family emergency etc.) you will need to miss some significant segment of class time/are unable to complete homework/attend exams etc, then please let me know ASAP so that something can be arranged.

### Grade Components:

- 30% Homework
- 10% Project
- 30% Two Midterms (15% each).
- 30% Final Exam

**Homework:** There will be four weekly (large) Homework assignments. These will partially be computational questions, and partially ones requiring deeper understanding of the material. Late homework is only accepted under extenuating circumstances.

**Project** There will be a short project. This will be along the lines of understanding and writing a short summary [or working out an involved example of] a linear algebra technique or application not covered in class. More details, including suggested projects are available on the project information sheet.

**Mid Terms:** There will be two one hour midterms. These will take place at the start of class on the dates indicated below. If you are unable to make these dates please let me know as soon as possible.

**Final Exam:** The final exam takes place on the last day of class. It is two hours long. If you are unable to make this time please let me know as soon as possible.

**Collaboration and Academic Integrity:** Collaboration in studying and working on problems, including homework problems, is strongly encouraged. However both so that everyone understands the material, and for reasons of academic integrity, I ask for the following:

- Write up work individually. That is after discussing a problem, and working out how to solve a problem with others, you must write the solution on your own, based on your own understanding of the problem solution developed with others. *Copying solutions is not permitted. Asking homework questions online is not permitted.*
- Please list all people you worked with on your homework solutions.

**Getting Help:** This course will move fast, through some conceptually complicated material. It is important not to fall behind.

As such when you're confused, or have questions about anything, please use some of the following resources:

- **Me** All questions are encouraged in class. Also please come to office hours, especially if you have further questions, or if you are having difficulties with any of the material. If you can't make it to my scheduled office hours email me to make an appointment. No Questions are too basic!
- **Math Help** with Yezheng Li is available Monday through Thursday 9AM to 1PM. On Monday, Wednesday, Thursday (except in the week of June 17th) this is in 2N36. On other days it is in 4N49. No appointment is necessary.
- **The Tutoring Center** [www.vpul.upenn.edu/tutoring/](http://www.vpul.upenn.edu/tutoring/)
- **Math Department Approved Private Tutors**  
[www.math.upenn.edu/ugrad/tutors.html](http://www.math.upenn.edu/ugrad/tutors.html)
- **Weingarten Learning Resource Center** [www.vpul.upenn.edu/lcr/lr](http://www.vpul.upenn.edu/lcr/lr)

**Disabilities:** If you require special accommodation you should contact the Office of Student Disabilities Services (SDS) at the Weingarten Learning Resources Center as soon as possible. For more information, see [www.vpul.upenn.edu/lrc/sds](http://www.vpul.upenn.edu/lrc/sds). Please also send me an email to say that you are doing this.

**Important Dates:**

MONDAY	TUESDAY	WEDNESDAY	THURSDAY
<b>July 8th</b>	<b>9th</b>	<b>10th</b> You can submit up to 5 problems from Homework 1 for feedback by Thursday.	<b>11th</b> July 12th is last day to drop with no financial obligation. Project topic needs to have been decided.
<b>15th</b> Homework 1 due	<b>16th</b>	<b>17th</b> Midterm	<b>18th</b> July 20th is last day to drop with 50% financial obligation, and to change grade status
<b>22nd</b> Homework 2 due	<b>23rd</b>	<b>24th</b>	<b>25th</b> Project should have been discussed with me by this time.
<b>29th</b> Midterm, Homework 3 due	<b>30th</b> Project Draft Due	<b>31st</b>	<b>Aug 1st</b> August 2nd is last day to withdraw
<b>5th</b> Homework 4 due	<b>6th</b>	<b>7th</b> Review	<b>8th</b> Final, Project Due