

**Changes may be made to this document, and linked pages or files, before the semester starts.**

## Syllabus and course information

### MAS 4105 — Linear Algebra 1 Section 6137 (14931) home page, Fall 2022 MTWF 7th period (1:55–2:45), Little 233

[Link to class home page](#)

- Instructor: [Dr. David Groisser](#)  
Teaching Assistant: [Andres Zuniga](#)
- Prerequisites: Calculus 3 (MAC 2313 or MAC 3474) and Sets and Logic (MHF 3202), each with a grade of at least C.
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**Modality:** All four weekly class meetings (Monday, Tuesday, Wednesday, Friday) will be face-to-face.

The MWF meetings will be ordinary lectures by Dr. Groisser. On Tuesdays the class will meet with Teaching Assistant Andres Zuniga for Q&A and other discussion. I won't spend MWF time going over homework; that's part of what the Tuesday class meetings are for. The pace of the course needs to be brisk to get through all the material.

**Syllabus (course content):** An introduction to vector spaces, linear transformations, and inner products. The general approach is theoretical (emphasizing theorems and proofs) rather than computational. We will cover chapters 1–6 of the textbook, with some omissions and (possibly) additions. General topics will include:

- real vector spaces; subspaces
- linear combinations; linear independence; basis; dimension
- linear transformations; rank; kernel; nullity
- relating linear transformations to matrices and matrix algebra
- using matrices to solve linear systems of equations
- eigenvalues and eigenvectors; diagonalization
- inner-product spaces

**Textbook:** Friedberg, Insel, and Spence, *Linear Algebra*, 5th edition (2019).

**Tentative, approximate weekly schedule of lectures.** Click [here](#). You are expected to read the relevant material in the appropriate chapter-section of the textbook no later than the day after we cover that material in class.

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### Communicating with Dr. Groisser outside class

- **Office Hours:**
  - **In-person office hours:** **Tentatively**, Wednesday 8th period (3:00-3:50) and Friday 9th period (4:05-4:55). My office is Little Hall 308. *I require you to wear a mask at all times in my office*, since Little 308 is a small, poorly ventilated room in which I spend most of my workday.
  - **Virtual office hours:** **Tentatively**, Tuesday 8th period (3:00-3:50). These will be set up as Zoom meetings.

Office-hour days and times are currently tentative because, as of this writing, the meeting-times of various committees and seminars have not been set. I will update this page and [my schedule page](#) if and when my regular office hours change.

For either type of office hour, please arrive early in the period or let me know to expect you later; otherwise I may not stay in my office or at my computer for the whole period.

Students who can't make scheduled office hours may see me by appointment on most weekdays (but *never on a Thursday*). See also the statement about office hours in the [attendance policy](#).

**If you have the flu or similar contagious disease, or think you might, please do not come to my office.**

(This request for common courtesy has been in all my syllabi since Fall 2009; see [http://dgarchive.com/classes/3473\\_f09/syllabus.html#officehrs](http://dgarchive.com/classes/3473_f09/syllabus.html#officehrs), for example. There has never been a single complaint about it, and it is not a special request made just for students with COVID-19 symptoms, so I see no valid reason to remove it now. It is also consistent with UF's current policy for attending classes.)

- **Emailing me.**

I receive a ton of email, so please be aware that:

- **EMAIL IS NOT A SUBSTITUTE FOR SEEING ME IN OFFICE HOURS.** I will not answer math questions by email; an interactive conversation is needed.
- **I don't answer email that lacks an *informative* subject line and the sender's full name.**
- In general I answer students' emails **only on days that I normally have office hours, and only at certain times.** On office-hour days, I'll generally respond to emails that arrive before the halfway mark of my office hour. *Exception:* I generally don't wait till the next office hour to respond to emails inquiring about (possible) typos in a homework assignment, or informing me of some problem with one of my course webpages.
- I may not respond to email that asks questions that are answered in items you should have read (for example: this syllabus, the class home page, homework page(s), solutions handouts, emails I've sent to the class, and announcements I've posted in Canvas), or that should be (or should have been) asked in office hours.
 

Your TA's email policy may be less strict than mine, but *do not abuse his generosity*. You should not expect him to be available 24/7, or to answer math questions by email, or to respond promptly to emails sent outside of whatever hours he sets.
- I don't provide individualized grade information by email.
- I won't open attachments (or follow links) that look suspicious to me. I generally delete, without fully reading, any email that contains these.
- My email address is located [here](#).
- **Communications from me or your TA.** You are required to read fully, and reasonably promptly, any communications I send you or that your TA sends you. This includes, but may not be limited to, emails (either to the class listserv or to you personally) and announcements on Canvas.

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**Graded components of course.** Your final grade will be determined by:

- Two midterms (hour exams), each counting for 20% of final grade.
- A cumulative final exam, counting for 30% of final grade.
- Homework, totaling 30% of final grade.

*I reserve the right to adjust the above percentages in individual cases (only to a student's benefit) if I feel that circumstances warrant. **I will not answer any questions about hypothetical situations in which I might do this.***

### Exams

- Each midterm will be held on a Wednesday, so that the Tuesday discussion session can be used as a review. **I estimate that the date for the first exam will be either Sept. 28 or Oct. 5, and that the date for the second exam will be either Nov. 2 or Nov. 9.** (Before finalizing the dates, I'll want to be confident that we'll have gotten through certain material before the exams. In a course of this type, it's hard to predict many weeks in advance what the exact dates are that we'll cover specific material.) I will give you at least a week's notice before each midterm.
- **The final exam will be a two-hour exam given Wed. Dec. 14, starting at 10:00 a.m., in our usual classroom. By registering for this section of this course, you are agreeing to be available for an in-person two-hour exam on this date at this time.** You are expected to

arrange your post-semester travel plans accordingly, and are strongly advised to make those plans NOW. I will have little sympathy for students who state they are "unable" to take the final exam at its scheduled time, or that to do so would pose a hardship. If you voluntarily put yourself in this position, expect a zero for your final-exam score.

- On any exam: unless I say otherwise, you are responsible for knowing any material I cover in class, any subject covered in homework, and all the material in the textbook chapters we are studying.

**Homework:** You should start on each homework problem within a day of its appearance on the [homework page](#). **It is impossible to overstate the importance of doing *all* the homework.** The homework page includes important [rules](#) regarding homework-submission.

When I start posting problems for an assignment, you'll often see wording like "Assignment X (not yet complete)"; I remove the "(not yet complete)" once all the problems are posted. I wait until we've covered certain material to post certain problems, so that you don't waste time trying to do problems you don't yet have the tools for.

**Grading:** See [My grading system for this course](#), below, for additional information.

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**Student Honor Code.** UF students are bound by The Honor Pledge, which states:

We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: *"On my honor, I have neither given nor received unauthorized aid in doing this assignment."*

The Honor Code, which can be found [here](#), specifies a number of behaviors that are in violation of this code. As stated at the given link, *Cheating includes but is not limited to:*

- *Using any materials or resources prepared by another Student without the other Student's express Consent **or** without proper attribution to the other Student.*
- *Using **any** materials or resources, **through any medium**, which the Faculty has not given **express** permission to use and that may confer an academic benefit to the Student.*
- ...
- *Collaborating with another person, **through any medium**, on **any** academic activity, when Faculty has expressly prohibited collaboration.*

In addition, students are obligated to report to appropriate personnel any condition that facilitates academic misconduct.

**The "You cheat, you fail" rule:** In my class, the penalty for cheating is, almost always, a failing grade (E) for the course (if the student doesn't drop). I will not tolerate students who take advantage either of their classmates or of me, causing me to waste time on police-work. If you cheat, do not expect a second chance from me.

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**My grading system for this course**

1. After each homework or exam, I decide grade cutoffs for that item according to the philosophy "A =

excellent, B = good, C = satisfactory, D = unsatisfactory but passing". In setting these cutoffs, *I do not have a predetermined grade curve or predetermined percentages for letter grades.*

- At the end of the semester, I compute a numerical "raw score" for each student, on a 1000 point scale, using the weighting scheme [stated earlier](#): 20% (200 points) for each midterm, 30% (300 points) for the final exam, 30% (300 points) for the homework.

On the exams themselves, you'll see point-totals different from the ones above. These are rescaled appropriately in the raw-score computation. For example, if point-values for the problems on the first midterm add up to 138, your exam score will be multiplied by 200/138 in the above computation.

Similarly, the homework assignments will not all be the same length and will not all count equally; they will count proportionally to the number of points in each assignment. For example, if the point-values of the homework assignments add up to 249, then your homework-point total will be multiplied by 300/249 in the raw-score computation.

- By applying the same weighting scheme to the cutoffs for exams and homework, I construct raw-score grade cutoffs for each of the grades A, B, C, D. The cutoffs I use for A- and B+ are the trisection points of the interval from the B cutoff to the A cutoff; the cutoffs for the B-, C+, C-, and D+ grades are computed analogously.

The grades that UF currently allows instructors to assign are A, A-, B+, B, B-, C+, C, C-, D+, D, D-, and E. ([For grade-point equivalencies of these grades, see this catalog page.](#)) All of these are grades are possible in this class, except the D-.

In my philosophy (and that of my own college professors) of what a minus-grade means, a B-, for example, is *not* the lower end of the B range; it is *somewhat below* the bottom of the B range, and means that your work falls a little short of "good". (Said another way: another professor whose regards your work as "a little short of 'good' ", but who regards B- as meaning "the low end of the 'good' range", would *not* assign you a B- ; he/she would assign you a C+.) This philosophy is consistent with the degree-requirements for most majors at UF: courses count towards your major only if you get a "flat" C or higher, because a C- means that your performance was *less than* satisfactory—not that it was *barely* satisfactory—and therefore that you did not satisfactorily complete the course. This philosophy is also consistent with UF's [S-U grade option](#).

For similar reasons, I have never given the D- grade. "D" means "unsatisfactory but passing". My D cutoff is the rock bottom of what I consider to be the "passing" range, so anything below that is a failing grade, which at UF is the E grade. (*Note*: Because a C is usually needed for a course to count towards requirements for majors, minors, etc., an unfortunate number of faculty, advisors, and students have come to refer to every grade less than C as "failing". *This is not the correct meaning of "failing grade", nor has it ever been*; again see [this catalog page](#).)

Since I don't determine the exam-grade cutoffs ahead of time, I can't tell you in advance exactly how many points you'll need to get a particular grade for the course.

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**Attendance policy.** As UF has advised, **students with a contagious illness (or reasonable suspicion of one) should not come to class.** But healthy students are expected to attend **every** lecture, barring such things as family emergencies, weddings, funerals, UF-sanctioned extracurricular activities, and religious holidays (see below). All (potentially) excusable absences that are known in advance—i.e. all those whose justifications are something other than illness or emergencies—will not be treated as excused unless you inform me of them in advance.

Students who *choose* (for reasons other than the ones above) not to attend class regularly are forfeiting the right to my help in office hours, including explanations of their mistakes on homework and exams. These students should also not expect replies to their emails, even for questions like "Is there an exam tomorrow?" or "Have you decided when the next exam will be?" Also be aware that the [University of Florida Attendance Policies](#) contain the following paragraph:

*The university recognizes the right of the individual professor to make attendance mandatory. After due warning, professors may prohibit further attendance and subsequently assign a failing grade for excessive absences.*

If you miss class the day I return an exam or homework, you'll have to pick up your exam or homework from my office. I expect you to do this within a week (unless you are ill or quarantining); I will not hold onto your exam indefinitely. The same is true of any handouts that you missed receiving in class.

**A grade penalty of up to 5% may be imposed for an unexcused absence on the Monday before Thanksgiving.**

I expect students to arrive *on time* and to pay attention for all 50 minutes of the period. Arriving late is disruptive (as is leaving early). If a non-optional time commitment (e.g. a class the previous period in a distant location) will force you to be late on a regular basis, let me know at the start of the semester.

If you are absent, for any reason, you should obtain *written* notes from a classmate. (**Students are not permitted to share their own recordings of lectures with each other**, should they make any such recordings. (See [In-class recording by students](#) below.)

### What if you miss an exam?

If you miss an exam for a valid reason, and supply me with satisfactory documentation *promptly*, I will work out with you some way that is as fair as is feasible for you to make up the missing grade-component. Except in very large classes (which I don't teach) with cookie-cutter exams (which I don't give), there is no such thing as a fair make-up exam. Thus, the way I have you make up the missing grade-component may or may not be via an exam. If you miss an exam for a reason that I do not consider valid (consistent with UF policy on which absences should be excused), or do not supply me with satisfactory documentation within two days, you should expect to receive a zero for that exam. If extenuating circumstances cause a reasonable delay in your providing me with satisfactory documentation, I may treat your exam-absence as valid and documented. (However, I will be the sole judge of what is "satisfactory", "extenuating", and "reasonable".)

If you are too ill to take an exam, please notify me by email before the exam starts (if possible).

- **Religious Holidays.** The following is part of the [University of Florida Policy on Religious Holidays](#). "Students, **upon prior notification of their instructors**, shall be excused from class or other scheduled academic activity to observe a religious holy day of their faith."

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### In-class recording by students

Students are allowed to record video or audio of class **lectures**. However, **the purposes for which these recordings may be used are strictly controlled**. The only allowable purposes are (1) for **personal** educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. **All other purposes are prohibited**. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A class lecture does not include private conversations between students, or between a student and the instructor, that happen to take place during a class session. Recording of these conversations is prohibited.

**Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student.** Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. **A student who publishes a recording without written consent may be subject to a civil cause of action** instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

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**Accommodations for students with disabilities.** If you wish to request accommodation for a disability you must first register with the [Disability Resource Center](#). It is always important that you share your accommodation letter with your instructor, and discuss your accommodations, as early as possible in the semester.

**Teaching-evaluations.** Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at [gatorevals.aa.ufl.edu/students/](http://gatorevals.aa.ufl.edu/students/). Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals or via [ufl.bluera.com/ufl/](http://ufl.bluera.com/ufl/). Summaries of course-evaluation results are available to students at [gatorevals.aa.ufl.edu/public-results/](http://gatorevals.aa.ufl.edu/public-results/).

#### **UF Health and Wellness Resources:**

- **U Matter, We Care initiative.** If you or someone you know is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu), 352-392-1575, or visit [umatter.ufl.edu/](http://umatter.ufl.edu/) to refer or report a concern, and a team member will reach out to the distressed student.
- **Contact information for the Counseling and Wellness Center.** Visit [counseling.ufl.edu/](http://counseling.ufl.edu/) or call 352-392-1575 for information on crisis services as well as non-crisis services.
- **Student Health Care Center.** Call 352-392-1161 for 24/7 information to help you find the care you need, or visit [shcc.ufl.edu/](http://shcc.ufl.edu/).
- **University Police Department.** Visit [police.ufl.edu/](http://police.ufl.edu/) or call 352-392-1111 (or 9-1-1 for emergencies).
- **UF Health Shands Emergency Room / Trauma Center.** For immediate medical care call 352-733-0111 or go to the emergency room at 1515 SW Archer Road, Gainesville, FL 32608; [ufhealth.org/emergency-room-trauma-center](http://ufhealth.org/emergency-room-trauma-center).

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#### **Goals of course:**

- For the student to become accustomed to communicating mathematical ideas precisely and clearly, in written form.
- For the student to know the meanings and definitions of the following terms;

- (real) vector space; subspace; sum and direct sum of two subspaces; complementary subspaces (or a complement of a subspace); linear combination; span; linear dependence and independence; basis; dimension; finite- and infinite-dimensional; convex set;
- linear transformation and related terminology: injective; surjective; bijective; isomorphism; isomorphic; identity linear transformation; inverse; invertible; kernel; null space; image; range; rank; nullity; eigenvalue; eigenvector; characteristic polynomial; algebraic and geometric multiplicities of an eigenvalue; eigenspace; determinant;
- matrix-related terminology: column space; row space; null space; rank; nullity; transpose; square matrix; inverse; invertible; diagonal matrix; upper- and lower-triangular matrix; symmetric matrix; anti- or skew-symmetric matrix; identity matrix; the same eigenvalue/vector-related terminology as for linear transformations; diagonalizable matrix; determinant (recursive definition); elementary row operations; row-reduction;
- terminology related to linear systems of equations: solution; solution set; homogeneous and non-homogeneous; general solution; solution space (in the homogeneous case); consistent; inconsistent; equivalent systems of equations;
- inner product; inner-product space; norm; unit vector; orthogonal vectors; orthonormal set; orthonormal basis; Gram-Schmidt process;
- time permitting: orthogonal complement of a subspace (finite-dimensional case); orthogonal projection; orthogonal transformation; orthogonal matrix.
- For the student to
  - know that the inverse of an invertible linear transformation is linear;
  - know basic matrix algebra;
  - know that, for invertible matrices, "transpose" commutes with "inverse";
  - know, in the finite-dimensional setting, the equivalence of several criteria for invertibility of a linear transformation or matrix, including the determinant criterion;
  - be able to compute, by hand, the inverses of invertible  $2 \times 2$  and  $3 \times 3$  matrices;
  - know that there is a general formula for the inverse of a general invertible matrix; time permitting, know the formula itself;
  - be able to determine (with proof) whether a given subset of a vector space is a subspace;
  - know the relationships between finite-dimensional linear transformations and matrices, including that composition of linear transformations corresponds to multiplication of matrices; clearly understand the difference between a linear transformation and a matrix; be able to translate between statements about linear transformations and the corresponding statements about matrices; be able to compute the matrix of a linear transformation with respect to given finite bases; know the change-of-basis formula for such a matrix (or be able to compute the new matrix, with or without having memorized a formula);
  - be able to recast a finite system of linear equations in finitely many variables as a matrix equation; know that, in the homogeneous case, the solution-space is a subspace, and be able to find a basis; be able, in the non-homogeneous case, to determine whether the system has a solution, and if so, to write down the solution in the form (particular solution) + (general solution of the associated homogeneous



equation)" where the second term is given in terms of a basis of the relevant null-space; know how to accomplish the preceding using row-reduction; (time permitting) know Cramer's Rule;

- know (not necessarily with proof) the properties of the determinant-function on square matrices: behavior with respect to elementary row and column operations; multiplicativity; invariance under transpose; invariance under change-of-basis;  $\det(A^{-1}) = 1/\det(A)$ ;
- be able to compute a determinant using elementary row and column operations;
- know the relation between the characteristic polynomial and eigenvalues;
- know that a system of linear equations with at least two solutions has infinitely many, and that that a system of linear equations with more variables than unknowns has either no solutions or infinitely many;
- know the statements of basic theorems of elementary linear algebra, including: the "rank plus nullity" theorem; that a basis can be obtained from a linearly independent (respectively, spanning) set by adding (resp., deleting) vectors; characterization of bases as minimal spanning sets and maximal linearly-independent sets; all bases of a given finite-dimensional vector space have the same number of elements; every finite-dimensional real vector space is isomorphic to  $\mathbb{R}^n$  for some  $n$ ; the kernel and image of a linear transformation are subspaces of the domain and codomain respectively;  $\text{rank}(A) = \text{rank}(A^t)$  (or "row rank = column rank") for a matrix  $A$ ; linear independence of eigenvectors corresponding to distinct eigenvalues;
- use mathematical terminology and notation correctly;
- be able to write complete, mathematically correct, grammatically nearly-perfect proofs involving linear-algebraic terms and concepts (including proofs of linear dependence/independence and proofs by induction in a linear-algebraic context);
- be able to prove those theorems of basic linear algebra whose proofs are not too long;
- be able, on a timed exam, to come up with proofs of true linear-algebraic statements previously not seen by the student, when such statements follow quickly and easily from definitions and theorems that the student is expected to know;
- be able to produce an orthonormal basis of a low-dimensional vector space or subspace via the Gram-Schmidt process;
- For the student to be able to produce an example of:
  - a vector space of any given finite dimension;
  - an example of a finite-dimensional real vector space that is not explicitly  $\mathbb{R}^n$ ;
  - an infinite-dimensional vector space;
  - a linear and a non-linear transformation between two given vector spaces;
  - a non-diagonalizable matrix;
  - a system of at least two linear equations in at least two unknowns with
 

{	no solutions;
	a unique solution;
}	infinitely many solutions.

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