MAT 223 Linear Algebra: Winter 2018

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This syllabus is very long, but it contains lots of important information, including most of the types of questions you're likely to have throughout the semester. Not reading it, and asking the instructor a question easily located here, is bad etiquette. The above table of contents is "clickable" for easy navigation.

1 Course Website -

All important information is regularly maintained on the course website

http://www.math.toronto.edu/nhoell/MAT223

Please bookmark the page for your convenience and check in regularly. You are expected to **check your email regularly** throughout the semester as you will receive exam and other course-related announcements sent to your inbox throughout the semester. Important **announcements** will be posted on the course website as well. If you ask an instructor questions whose answer is easily found in the main course page you may find your Instructor staring at you quizzically. If you email your Instructor asking a question whose answer is easily found on the course website, you should expect no response for what are, I hope, obvious reasons.

2 Content of this Course -

This course is an introduction to linear algebra. Many of you have no doubt already seen some ways of solving systems of linear equations in high school. In this course we greatly expand on what you may have seen and consider how to deal with such systems in a systematic and general way. Dealing with systems of linear equations in an abstract manner is profoundly useful for developing general methods for solving such systems. These methods have tremendous applications across a variety of disciplines including *physics, economics, chemistry, statistics, mathematics, operations research, artificial intelligence, computer science, imaging, neuroscience, machine learning,* and other areas of science. At times the material may feel quite abstract and removed from direct applications but we will try to stay as grounded as possible and highlight the importance and utility of all the general techniques we present. Mastery of this material is the first step on the long journey towards a proper scientific training, as it is in many ways the de facto *lingua franca* in the sciences.

Technical Details

Make sure you are aware of the following University details regarding this course.

- Prerequisites: High School Level Calculus
- Exclusion: MAT240H1
- Distribution Requirement Status: This is a Science course
- Breadth Requirement: The Physical and Mathematical Universes (5)

3 Lecture Sections -

There are six instructors for the course as listed below.

- LEC0101: MWF 9:00–10:00 in HS610
 Instructor: Professor Ketterer
 Email: ckettere@math.toronto.edu
- LEC0201: T 13:00-15:00 & R 13:00-14:00 in MP103 Instructor & Coordinator: Professor Nicholas Hoell Email: nicholashoell@gmail.com
- LEC0301: MWF 14:00–15:00 in SF1105 Instructor: Professor Siefken Email: siefkenj@math.toronto.edu

- LECO401: TWR 12:00–13:00 in BA1160 Instructor: Professor Sean Uppal Email: uppal@math.utoronto.ca
- LEC0501: MWF 11:00–12:00 in SS2118
 Instructor: TBD
 Email: TBD
- LEC0601: W 13:00-15:00 & R 14:00-15:00 in SS2118
 Instructor & Coordinator: Professor Nicholas Hoell
 Email: nicholashoell@gmail.com
- LEC5201: T 18:00–21:00 in MP134 Instructor: Professor Henry Kim Email: henrykim@math.utoronto.ca

Each of the above instructors has weekly office hours at times and locations which will be given on the course website.

Lecture Behaviour

None of the instructors take attendance, although we all **strongly encourage attendance** as it is the best way to stay on top of material throughout the term as well as to get viewpoints and idiosyncrasies particular to the instructors (who, after all, are writing the exams you'll be taking!) Here are some additional thoughtlets on attending lecture.

- 1. Don't feel shy about raising your hand and asking for clarification on points of confusion. Whatever your confusion, there are no doubt others in the room who share it. Moreover, **the instructors of MAT223 welcome and encourage your active participation**. It helps *us* learn about what students may be struggling with.
- 2. There is a big difference between being merely *physically present* and being *intellectually present*. Being physically present is no harder than finding a seat. Being intellectually present requires paying attention. In particular texting, being on your laptop, having earbuds in, chatting, or generally showing obvious signs of disengagement not only hinders your ability to learn but they are things your instructors will point out and ask you to stop doing.
- 3. If you miss a lecture due to illness or other understandable reasons, feel free to ask your instructor after the next lecture you attend about topics you may have missed. In addition you will find it helpful to make friends over the term with whom you can share notes. And, failing that, this course will be having a Piazza forum accompanying it. Therefore, simply sending an email to your instructor along the lines of "I was sick yesterday what did you cover?" however will, for what I hope are obvious reasons, go unanswered.

4 Tutorials -

There are tutorial sections for this course and you must be registered to one. They are offered on TWR at various times for your convenience. These are your opportunity to learn directly from your TA and ask questions you may have lingering from the main lecture hours. **Tutorials begin on the third week of classes**, namely on Tuesday, January 16th. There will be quizzes in tutorials (*every* tutorial) throughout the semester and therefore you **must bring paper and a pen/pencil** to tutorials in order to write the quizzes. As well, you may **only write quizzes in the tutorial section you are enrolled in** on Blackboard **as a Blackboard "group**". Blackboard doesn't sync with ACORN as it should so *just because ACORN shows you as registered in a given tutorial section doesn't mean you are in our roster* and if you don't self-enroll in a tutorial group on Blackboard (enroll in *the same* group as you are listed in on ACORN) **your quizzes will not be counted**. In addition, since self-enrolment in groups is enabled **your instructors will not do this for you** and will ignore email requests to do so. So you need to go in Blackboard, under Tools, and select the UT Groups Self-Signup Tool and select the tutorial in which you are registered in ACORN/ROSI.

5 Textbook

5.1 Required Texts

This book has two main texts. Our first required text will be *Linear Algebra and its Applications* by David Lay, Steven Lay, and Judi McDonald, 5th edition ISBN-13: 978-0-321-98238-4. We are only using selected portions from the text. It is a clean, well-written slim hardcover well suited for this course. If **you decide to use an older edition** of the book, that's fine but you **do so at your own risk** because the suggested problems may not match those which are in the fifth edition. It is **the students' responsibility alone** to make sure you are working through analogous problems if in fact you decide to use an older edition. If **you ask your instructor about using other editions**, they will look at you quizzically and point you to this syllabus.

Our second required text is the online interactive course notes package offered through TopHat (www.tophat. com). This extends and expands upon material in the main text which is covered too superficially for our course. The interactive problems are counted towards your homework score. You can visit the Top Hat Overview

https://success.tophat.com/s/article/Student-Top-Hat-Overview-and-Getting-Started-Guide

within the Top Hat Success Center which outlines how you will register for a Top Hat account, as well as providing a brief overview to get you up and running on the system. You can register by simply visiting our course website:

- Unique Course URL: https://app.tophat.com/e/159636
- Note: our Course Join Code is 159636

Top Hat **will require a paid subscription**, and a full breakdown of all subscription options available can be found here:

www.tophat.com/pricing

After you pick your subscription, your textbook will be applied at checkout for an additional fee. *Don't worry if you don't see any content in the course right away*, I will make it available to you as we progress through the semester. When you sign up make sure you register using your student number when it asks for that. In the past people mistook student number for their emails or UTorIds, causing confusion with marks later on. Should you require assistance with Top Hat at any time, due to the fact that they require specific user information to troubleshoot these issues, please contact their Support Team directly by way of email (support@tophat.com), the in app support button, or by calling 1-888-663-5491.

5.2 Optional Texts

You may also wish to consult the text *Linear Algebra*, by Friedberg, Insel & Spence, 4th ed. ISBN: 978-0-130-08451-4. This book is often used for the specialist linear algebra course MAT240/MAT247. It's a well written text, with great problems. It happens to be too advanced for this course but for those of you looking to delve deeper, this is a great text to read.

Another excellent book is *Introduction to Linear Algebra* by Strang, 4th ed. ISBN-13: 978-0-980-23277-6. It's an exceptional text, which suffers only from being too advanced (and too comprehensive) for what we'd like to get through this semester. If you find yourself enjoying this course it may be worthwhile to grab a copy of this text as it will serve you well.

6 Other Materials -

In addition to the textbook, we will occasionally post additional problems and references on the course website as the semester progresses. Please don't limit yourself solely to the main texts!

Some students in the past found the following videos to be helpful.

https://www.youtube.com/playlist?list=PLZHQObOWTQDPD3MizzM2xVFitgF8hE_ab

7 Piazza Forum –

We will be having class discussions on the Piazza discussion forum.

https://piazza.com/utoronto.ca/winter2018/mat223h1s/home

You should know that this is a place where you can go to (anonymously, if you wish) ask questions and get feedback from lots of other students who are in the class. You'll get the most benefit by trying to answer questions posed by other students and, for the most part, the TAs and Instructors who frequent the site do not actively answer questions but are there to ensure that answers floating around are, in fact, correct so that misinformation doesn't spread. Students benefited greatly from the Piazza forums in the past and I suggest enrolling as soon as possible.

8 Homework —

Homework is to be done online using the interactive TopHat text. As well you should do all suggested problems listed on the course website.

9 Quizzes –

Quizzes will be given in tutorials. These are short problems designed to keep you current on the topics and make sure you don't fall too far behind. Since the lowest two quiz scores are not counted as part of the score in the class **no medical notes are necessary/accepted** in the case of a missed quiz. **You are expected to bring your student identification (T-card)**, **paper and a pen/pencil to tutorials** as the quizzes will be written on paper you bring. You may **only write quizzes in the tutorial section you are registered in**.

10 Grading –

Grades will be based according to some quizzes throughout the term, two midterm exams and a final exam. Your final grade in the course will be determined by the following

• Homeworks: 5%

- Quizzes: 5%; the lowest two scores will be dropped
- Midterms: 25% for the highest, 15% for the lowest
- Final Exam: 50%

The quizzes are given in tutorials throughout the term and are there as a chance for you to get feedback on your progress and understanding thus far. You are expected to bring your student identification (T-card), paper and a pen/pencil to tutorials as the quizzes will be written on paper you bring. You may only write quizzes in the tutorial section you are registered in.

11 Tests

There are two midterms during the semester. They are held on

- 1. Midterm 1: Friday, February 2nd, 4:10-5:00PM
- 2. Midterm 2: Friday, March 9th, 4:10-5:00PM

Note on Exams: No electronic devices/aids will be allowed during the exams. It is the students' responsibility to ensure that the allotted exam time is available.

Arrangements may be made for a test on the **same day but an alternate time** for students who have a regularly scheduled University of Toronto class (or laboratory) scheduled at that time. This **requires presenting evidence of your enrollment** in such a course (e.g. your schedule from ACORN/ROSI) **prior** to the week of the midterm. If you are such a student you you'll be asked to provide proof of such a conflict as the exam approaches in an email announcement. Without proof of course conflicts, and without proper notification, you **will not be allowed to take the midterm at an alternative time**.

11.1 Multiple Tests

It should be mentioned that *having multiple tests on the same day* does **not** count as a course conflict. If you happen to have multiple tests on the day of one of ours but there is no overlap in the hours the test is held **this does not count** as a course conflict and you are expected to write our midterm.

11.2 Missed Tests

There are no makeup tests. A student presenting proof of a **valid** reason for missing a test (see the section on Missed Term Tests in the Rules and Regulations section of the Faculty of Arts and Science 2016-2017 Calendar as well as the following section of this syllabus) will have their grading scheme adjusted to the following

- Homeworks: 5%
- Quizzes: 5%; the lowest two score will be dropped
- Midterm: 30% for the midterm taken
- Final Exam: 60%

In the unlikely event that there are two VALID medical excuses, this procedure will not be followed. Students in this circumstance will have their mark depend 90% on the final exam and 5% each on quizzes & homeworks. Almost **every student who has purported to be in this situation has failed the course** due to a very low mark on the final exam. It is strongly advised that you write all 2 term tests. Missing both tests and only taking the final exam is a **near guarantee of failing the course**.

11.3 Medical Notes

In the case of a legitimate medical issue **medical notes will be accepted ONLY from MDs with a valid CPSO number**. You must present your section Instructor with a University of Toronto Verification of Student Illness or Injury form available at http://www.illnessverification.utoronto.ca/index.php. Some important remarks about these notes.

• These forms **must be submitted to your course instructor within 3 business days of the missed test** for the absence to not be penalized. Failure to submit proper, valid and timely documentation will result in a grade of 0 on your missed test.

- The form must have all required fields filled properly and *legibly*.
- The form must be original.
- The form is only considered valid if **completed by a qualifed medical doctor not an acupunc-turist, chiropractor, naturopath or other health care professional.**
- Upon submission of the documentation review of the medical note will be done before it is accepted as valid. The review **may include following up with your doctor, your college registrar, or other departmental advisors.**

Presenting a false medical excuse is a severe offence and will be dealt with through the Office of the Dean of the Faculty of Arts and Science.

11.4 Athletic Absences

If you are a member of a University of Toronto sports team which has an event scheduled on the date of one of our tests and you wish to not miss your event then you **must get a letter on University letterhead** from your coach in order for this to count as an excused absence. The same grading policy towards excused medical absences applies in this instance. The only difference is that **you must have the letter sent to us prior to the week of the midterm you plan on missing**.

12 Contact -

12.1 Email Etiquette

It is University policy that **instructors need only reply to emails sent from University email accounts**. Acceptable emails are of the form student@utoronto.ca, topstudent@math.toronto.edu, etc. We will not likely ever reply to a non-University email address (those from addresses like, say, studentwhoseemaildidntge-treturned@hotmail.com or studentwhodidntreadthesyllabus@gmail.com). Any email should have the words "MAT223" somewhere in the subject line. As for email etiquette, sending technical mathematics questions to

your instructor is fine if they are **very short** and worded *very* precisely. Save longer questions for the beginning Q&A part of the following lecture, or ask during office hours, or during your tutorials, or at the Math Aid Centre. We also wish for you to use the online Piazza forum for discussing questions with each other (which we monitor to avoid misinformation spreading).

You should **not address us** as "Hey", "Yo", or other highly informal salutation in an email. If you do you probably won't get a reply. Keep in mind we get a high volume of emails each semester and it may take time before you hear back from us (if at all). Your chances of having your email read and being replied to increase *dramatically* if you can follow the instructions above.

12.2 Whom do I contact?

- 1. For any math-related questions ask any instructor (see above), ask on the Piazza forum, or ask your TA in tutorials, or ask in the MathAid Centre (see below)
- 2. For enrolment changes contact your college registrar
- 3. For tutorial enrolment, you can "self-enroll" (i.e. **without our help**) in the Blackboard Group associated with the tutorial section you've registered in on ACORN. You can do this by going into the "Tools" section and selecting the UT Groups self sign-up tool.

- 4. If you have a regularly scheduled University of Toronto course which conflicts with a test date, you'll be asked to contact the coordinator via email once the exam is nearing, no need to pre-empt this with emails prior to being requested.
- 5. For questions about which math course is right for you, contact the Undergraduate Administrator Donna Birch at dbirch@math.utoronto.ca, or in BA6291 or via 416-978-5082.
- 6. If you require accommodations for a disability, or have any accessibility concerns about the course, the classroom, or course materials, please contact Accessibility Services: http://www.accessibility.utoronto.ca/index.htm
- 7. If you have a personal situation and are concerned about how it may affect your academic performance, please contact your college registrar.

There are TAs for MAT223 regularly assigned to the MathAid center which will be open for help during the academic year at hours maintained on the course website. The MathAid Centre is on the main floor of the Physical Geography Building located on 45 St. George St.

Blackboard is used by instructors of MAT223 for sending out email to the class or when entering marks on tests and homeworks. For any important course information and announcements you should look to the course web site listed at the front of this syllabus.

13 Academic Integrity (Important) -

Cheating (including plagiarism) is very serious and, consequently, will be taken **very** seriously. Cheating can result in failure **or worse**. Don't do it! I caution you, the instructors of MAT223 are *extremely* diligent in pushing for the **maximum possible penalties** for those found cheating. Any collusion or fabrication during or after test/quiz situations will be vigorously pursued. This includes talking (or making other extraneous noises of any kind) during a test. We don't tolerate any kind of chatter during tests.

One other thing. There are students for whom the statement "The test is now over, please put your pens and pencils down while we collect the tests" seems to not entirely register. We consider egregious dismissals of our requests to stop writing to be a form of academic integrity violations which we enforce with the same stringency as talking during a test. **It's not worth the risk!** Every semester there are students who don't heed this warning, and every semester this situation is dealt with through administrative channels that have serious consequences for the student.

14 Important Dates -

The following are a list of dates you may wish to know and whom to contact in special cases.

- 1. January 17: Last day to add the course.
- 2. February 2: Midterm #1
- 3. February 19–23: Reading Week
- 4. March 9: Midterm #2
- 5. March 14: Last day to drop without academic consequence. Also, last day to add or remove a CR/NCR option.
- 6. April 4: Last day of class. Also last day to request a late withdrawal from the college registrar's office.

15 External Resources -

15.1 Accessibility Accommodations

The University of Toronto is committed to accessibility. As such, if you require accommodations for a disability, or have any other accessibility concerns about the course, the classroom or course materials, please contact Accessibility Services, http://www.studentlife.utoronto.ca/ as soon as possible.

15.2 Writing and English Language Instruction

For information on campus writing centres and writing courses, please visit http://www.writing.utoronto.ca/. FREE English language instruction with the ELL Program will start in Winter 2016. The Communication Cafe offers drop-in discussions, presentations, and debates, along with learning about Canadian culture - no registration necessary. Sessions are facilitated by writing centre instructors. For more information about the English Learning Language (ELL) program, please visit http://www.artsci.utoronto.ca/current/advising/ell.

15.3 Other Resources

As well, you may wish to visit any of the following.

- Student Life Programs and Services: http://www.studentlife.utoronto.ca
- Academic Success Centre: http://www.studentlife.utoronto.ca/asc
- Health and Wellness Centre: http://www.studentlife.utoronto.ca/hwc

16 The Menu –

We will keep, *very roughly*, to the following schedule. The **schedule is not rigid** and may vary depending on which section you are enrolled in. You should consult the course webpage for more accurate information as the course moves on. The suggested problems will take you considerable time, but staying on top of them is the only way to master the material. We strongly advise you to do all of them, and to read the corresponding sections of the textbook. This, together with attendance of lectures and tutorials, may easily take more than 15 hours per week.

- - Topics: Overview. Introduction. Systems of linear equations. Row Reduction.
 - Suggested Problems: Section 1.1: 1–28, 33–34 Section 1.2: 1–31
- Week 2
 - **Topics:** Reduction continued. Vectors and Linear Combinations. Geometry of Vectors: orthogonality, Cauchy-Schwarz inequality, vector projections.
 - Suggested Problems: Section 1.3: 1-6. 9-26, 32-34
- Week 3
 - Tutorials Begin & Quiz 1
 - Topics: Matrix-vector product. Homogeneous systems.
 - Suggested Problems: Section 1.4: 1-36. Section 1.5: 1-40

• Week 4		
- Quiz 2		
- Topics: Independence. Transformations.		
- Suggested Problems: Section 1.7: 1-18, 20-40. Section 1.8: 1-36		
• Week 5		
- Quiz 3		
- Midterm 1 on Friday, February 2		
- Topics: More transformations.		
- Suggested Problems: Section 1.9: 1–24.		
• Week 6		
- Quiz 4		
- Topics: Matrix arithmetic. Intro to inverses.		
- Suggested Problems: Section 2.1: 1–34.		
• Week 7		
- Quiz 5		
- Topics: Inverses. Elementary matrices.		
- Suggested Problems: Section 2.2: 1–35. Section 2.3: 1–38.		
• Week 8		
- Quiz 6		
- Tonics: III factorization Subspaces and bases		
- Suggested Problems: Section 2.5: 1–4. 24. Section 2.8: 1–36		
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- Quiz 7		
- Midterm 2 on Friday, March 9		
- Iopics: Dimension and rank. Gram-Schmidt procedure.		
- Suggested Problems: Section 2.9: 1–28		
• Week 10		
- Quiz 8		
- Topics: Rank theorems. Fundamental theorem of linear algebra.		
- Suggested Problems: Section 4.6: 1–30		
• Week 11		
– Quiz 9		
- Topics: Determinants. Cofactor expansion. Cramer's rule.		
- Suggested Problems: Section 3.1: 1–14, 33–42. Section 3.2: 1–4, 15–16, 21–40.		
• Week 12		
- Quiz 10		
- Topics: Eigenvectors and diagonalization.		
- Suggested Problems: Section 5.1: 1-8, 17-19, 21-27, Section 5.2:1-15, 19, 20, Section 5.3: 7-12.		

In the above, section numbers refer to the fifth edition of Lay's text.