

Department of Mathematics, University of Toronto  
**MAT221H1F - Applied Linear Algebra**  
Fall 2014

### Brief Course Description

Welcome to MAT221H1F Applied Linear Algebra . This sheet answers the most common questions about the course. Please take a few minutes to read this course information handout carefully and keep a copy for your records.

This is the first undergraduate course in linear algebra taken by students from a variety of disciplines. The course covers: systems of linear equations, matrix algebra, vector geometry, Euclidean space  $\mathbb{R}^n$ , orthogonality, rank, introduction to linear transformations, determinants, eigenvalues and eigenvectors, diagonalization, and their applications. (see pages 5 & 6 for the full list of topics covered and schedule).

There are several differences between the current MAT223 and MAT221. The setting of the current MAT223 is the general notion of a vector space, and the theory of linear mappings between vector spaces. For many students this approach is a tad abstract, and certain fields of study may not require this level of abstraction. One of the goals of MAT221 is to replace some of the theoretical components and abstract reasonings with applications and computational components. MAT221 will introduce all the relevant concepts of a vector space (linear independence, span, basis etc), but will present them solely for the standard n-dimensional space  $\mathbb{R}^n$  . MAT221 will be application oriented and illustrated (wherever possible) through real- world applications of linear algebra. The course MAT223 is a prerequisite for its sequel, MAT224 (Linear Algebra II), and students needing the latter should still enrol in the former.

Throughout the course, you will have an opportunity to develop your problem solving, reasoning, and logic skills. Students will be required to be able to solve standard computational problems in each section covered, and understand all theoretical concepts involved. Students may also be required to do simple, short proofs of particular statements.

You will see some interesting and exciting material in this course. If you run into some trouble along the way, please do not hesitate to contact your instructor or TA for help.

### Lectures/Administrative Information

Section	Time	Lecture Room	Instructor	Office
L5101	T4-6, R3	WI 1017	S. Uppal	ES 3145

**Course Coordinator:** S. Uppal.

**Email:** [uppal@math.utoronto.ca](mailto:uppal@math.utoronto.ca). Please read the "Email Policy" on page 3 of this document before sending an email.

**Office hours:** Wednesdays 1:10-2:00pm, Thursdays 4:10-6:00pm or by appointment. If you would like to book an appointment outside my regularly scheduled office hours, please send me an email indicating the times you are available to meet. Also, please give at least 24 hours notice for appointments so that there is suitable time to make arrangements.

The course Blackboard website is accessible through the main UofT portal at <https://portal.utoronto.ca>. All announcements and handouts will be posted on the course website. Please visit the website regularly.

### Marking Scheme

Your final grade will be calculated by the following formula:

Midterm Exam - 30%, Problem Sets - 20%, Final Exam - 50%.

### Textbook

Jeffrey Holt: *Linear algebra with Applications*, 1st edition. There is also a *Students Solution Manual* available should you wish to purchase it.

### Tutorials

Every student should be registered in one tutorial section. **You must register in one of the tutorial time slots through ROSI before the end of the first week of classes.** By the end of the second week of classes tutorial groups and locations will be posted on the course website.

Tutorials begin the 3rd week of class. During your tutorials the TA will discuss some problems from the problems sets. Feel free to ask questions about the problems you have most difficulty with. Tutorials are an integral part of the course and should be regarded as just as important as lectures. See below for the weekly tutorial schedule.

### Problem Sets

There will be seven problem sets given throughout the term with only the best five counting towards your final grade. Problem sets require a good effort and a suitable amount of time should be spent on them. While problem sets are worth a relatively small percentage of your final grade, an honest effort on problem sets typically results in good marks on exams and a good overall grade.

Problem Set Schedule:

Problem Set 1 will be given Friday September 19 and due Monday September 29;

Problem Set 2 will be given Friday September 26 and due Monday October 6;

Problem Set 3 will be given Friday October 3 and due Monday October 13;

Problem Set 4 will be given Friday October 24 and due Monday November 3;

Problem Set 5 will be given Friday October 31 and due Monday November 10.

Problem Set 6 will be given Friday November 7 and due Monday November 17.

Problem Set 7 will be given Friday November 14 and due Monday November 24 .

Each problem set will consist of "essential" problems which are to be handed in, and "suggested" problems which are not to be handed in but are similar to problem set questions and will be discussed in tutorials. .

### Midterm Exams

There will be one 110 minute midterm exam to be written on Tuesday October 21 from 4:10-6:00pm during

regularly scheduled class time. Exact details about exam coverage etc will be discussed in class and posted on the website roughly two weeks before the test date.

If you miss the midterm for a legitimate reason which you can document, your grading scheme will be adjusted by increasing the final exam component of your mark. The documentation must be submitted to the course coordinator no later than 7 days after the date of the exam/quiz otherwise your grade for the exam/quiz will be recorded as zero. From the Faculty of Arts & Science:

"You will need official documentation that confirms you were unable to do what you were supposed to do on the dates you were supposed to do it, i.e., documentation must indicate incapacity, and give the dates or period affected. Generally speaking, the stronger your documentation, the stronger your case...Those doctors notes with Patient was ill or Off work scribbled on little prescription pads wont be accepted. Also, the Medical Certificate must indicate that the doctor diagnosed and treated you when you were ill; **it cannot just report that you told the doctor after-the-fact that you were ill previously.**"

Generally, an illness must be serious enough that it prevents you from writing an exam. For example, a headache is not sufficient to warrant absence. The only accepted note is a fully completed University of Toronto Verification of Student Illness or Injury form. You can find a copy of the form here:

<http://www.illnessverification.utoronto.ca/>

It must be original and completed by a qualified medical doctor (e.g., not an acupuncturist, chiropractor, or other health care professional). The doctors OHIP registration number must be provided on the note. Under no circumstances can the final exam count for more than 80% of your final mark.

### Questions and Answers Website

This term we will be using Piazza for class discussion. The system is highly catered to getting you help fast and efficiently from classmates, the TA, and myself. Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza. Piazza has a LaTeX equation editor for simple math formatting. You can also take photos of your written work so you may ask questions without keying in elaborate expressions.

Piazza will be used only as a question and answer forum about the course material. No administrative information such as exam information, handouts, grades etc will be posted on Piazza - this information will be posted on the main course webpage on Blackboard. Joining Piazza is optional - if you wish join, you will first need to register using your @utoronto.ca email account at

[piazza.com/utoronto.ca/fall2014/mat221h1f](http://piazza.com/utoronto.ca/fall2014/mat221h1f)

### Email Policy

All email correspondence must be done through your @mail.utoronto.ca email account. I will not respond to emails sent from hotmail, gmail, yahoo and the like. Also, please be sure to put MAT221H1F in the subject line or your email may get filtered to my junk mail.

Email correspondence is to be used for **non-teaching purposes** only. This may include setting up an appointment with your instructor or clarification of the course structure. I may not respond to an email which deals with specific questions about course concepts or homework/tutorial problems - please post such questions on Piazza or ask your instructor after class or during office hours. **If the answer to your question is contained within the course outline or announcement page of the course webpage,**

**you will not receive a response to your email.**

### **Accessibility Needs**

The University of Toronto is committed to accessibility. If you require accommodations for a disability, or have any accessibility concerns about the course, the classroom or course materials, please contact Accessibility Services as soon as possible: [disability.services@utoronto.ca](mailto:disability.services@utoronto.ca) or <http://studentlife.utoronto.ca/accessibility>

### **Academic Integrity**

Academic integrity is fundamental to learning and scholarship at the University of Toronto. Participating honestly, respectfully, responsibly, and fairly in this academic community ensures that the U of T degree that you earn will be valued as a true indication of your individual academic achievement, and will continue to receive the respect and recognition it deserves.

Familiarize yourself with the University of Toronto's Code of Behaviour on Academic Matters:

<http://www.governingcouncil.utoronto.ca/policies/behaveac.htm>

It is the rule book for academic behaviour at the U of T, and you are expected to know the rules. Potential offences include, but are not limited to:

#### **In papers and assignments:**

- Using someone else's ideas or words without appropriate acknowledgement
- Copying material word-for-word from a source (including lecture and study group notes) and not placing the words within quotation marks.
- Submitting your own work in more than one course without the permission of the instructor.
- Making up sources or facts.
- Including references to sources that you did not use.
- Obtaining or providing unauthorized assistance on any assignment including working in groups on assignments that are supposed to be individual work, or having someone rewrite or add material to your work while editing.
- Lending your work to a classmate who submits it as his/her own without your permission.

#### **On tests and exams:**

- Using or possessing any unauthorized aid, including a cell phone.
- Looking at someone else's answers
- Letting someone else look at your answers.
- Misrepresenting your identity.
- Submitting an altered test for re-grading.

#### **Misrepresentation:**

- Falsifying or altering any documentation required by the University, including doctors' notes.

- Falsifying institutional documents or grades.

The University of Toronto treats cases of academic misconduct very seriously. All suspected cases of academic dishonesty will be investigated following the procedures outlined in the Code. The consequences for academic misconduct can be severe, including a failure in the course and a notation on your transcript. If you have any questions about what is or is not permitted in this course, please do not hesitate to contact me. If you have questions about appropriate research and citation methods, seek out additional information from me, or from other available campus resources like the U of T Writing Website. If you are experiencing personal challenges that are having an impact on your academic work, please speak to me or seek the advice of your college registrar.

## Schedule and Suggested Problems

We may be slightly ahead or behind this schedule. **This schedule is subject to change.**

**Week 1** beginning September 8.

**Lecture:** Systems of Linear Equations.

- Introduction to the course.
- Section 1.1: Lines and linear equations.
- Section 1.2: Linear Systems and Matrices (Elementary operations & Gaussian Elimination).

**Week 2** beginning September 15.

**Lecture:** Systems of Linear Equations (continued), Introduction to Euclidean Space.

- Section 1.4: Applications of Linear Systems.
- Section 2.1: Vectors.
- Section 2.2: Span.

**Week 3** beginning September 22. **Tutorials begin.**

**Lecture:** Euclidean Space (continued). Introduction to Linear Transformations. Matrices.

- Section 2.3: Linear Independence.
- Section 3.1: Linear Transformations.

**Week 4** beginning September 29.

**Lecture:** Matrices (continued).

- Section 3.2: Matrix Algebra.
- Section 3.3: Inverses.

**Week 5** beginning October 6.

**Lecture:** Matrices (continued).

- Section 3.4: LU Factorization.
- Section 3.5: Markov Chains.

**Week 6** beginning October 13.

**Lecture:** Subspaces.

- Section 4.1: Introduction to Subspaces.

- Section 4.2: Basis and Dimension.

**Week 7** beginning October 20. **Midterm Exam.**

**Lecture:** Subspaces (continued). Determinants.

- Section 4.3: Row and Column Spaces.
- Section 5.1: The Determinant Function.

**Week 8** beginning October 27.

**Lecture:** Determinants (continued).

- Section 5.2: Properties of the Determinant.
- Section 5.3: Applications of the Determinant.

**Week 9** beginning November 3.

**Lecture:** Eigenvalues & Eigenvectors.

- Section 6.1: Eigenvalues and Eigenvectors.
- Section 6.3: Change of Basis.

**Week 10** beginning November 10.

**Lecture:** Eigenvalues & Eigenvectors (continued). Orthogonality.

- Section 6.4: Diagonalization.
- Section 8.1: Dot Products and Orthogonal Sets.

**Week 11** beginning November 17. **No Monday or Tuesday classes.**

**Lecture:** Orthogonality (continued).

- Section 8.2: Projections and the Gram-Schmidt Process.
- Section 8.5: Least Squares Regression.

**Week 12** beginning November 24.

**Lecture:** Additional Topics.

- Section 11.1: Quadratic Forms.
- Section 11.2: Positive Definite Matrices.

**Week 13** beginning December 1. **Monday & Tuesday classes only.**

**Lecture:** Catch up/Review for Final Exam.