Department of Mathematics, University of Toronto

MAT224H1S - Linear Algebra II

Winter 2008

website: Blackboard - login to the Portal at https://weblogin.utoronto.ca/

Brief Course Description

Welcome to MAT224H1S Linear Algebra II. 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 second course in Linear Algebra expands on the material from Linear Algebra I (MAT223). By its nature the material is more theoretical (read: more exciting) than MAT223 but we will also see some interesting applications along the way. The course will cover: Abstract vector spaces, linear mappings, linear operators on both real and complex vector spaces, quadratic forms, Hermitian forms, inner product spaces, normal linear operators, spectral decomposition, nilpotent transformations, Jordan canonical form.

It will be assumed you know the basic material from Linear Algebra I, particularly the concepts of the vector space $\mathbb{R}^n$ including orthogonality, and diagonalization of matrices.

You will see some fabulous 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**
L0101	T1-3, W1	MP102	F. Ziltener	HU1025
L0201	T1-3, R1	LM161	K. Kaveh	ES2142
L0301	T1-3, F1	BA2155	D. Raghavan	ES2144
L5101	T6-9	SS1087	S. Uppal	UC45

The course coordinator is S. Uppal. e-mail: uppal@math.toronto.edu
Office hours: MW 3-5 or by appointment.

All announcements and handouts will be posted on the course website. Please visit the website regularly. Note that you need a valid UTORid to access the website.

Textbook
Gilbert/Gilbert: *Linear Algebra and Matrix Theory*, 2nd edition. There is no solutions manual for this book but there are solutions in the back for some exercises.

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 second week of classes**. By the end of the third week of classes tutorial location will be posted on the course website.

Tutorials begin the 4th week of classes. During your tutorials the TA will discuss some problems from the list below. 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.

There will be two, fifty minute **quizzes** given in tutorials during the 5th and 10th week of classes. Each quiz will consist of 3 or 4 questions based on the suggested homework (see Schedule and Suggested Problems below) and will be graded out of twenty. You must write your quizzes in the tutorial section in which you are registered or your mark will be recorded as zero. **There will be no make-up quizzes**.

Midterm Exam
There will be one 110 minute midterm exam common to all sections held Thursday February 26 from 6-8pm with an early sitting from 4-6pm for those with a legitimate conflict (i.e. a class secheduled during the exam time. If you have a legitimate conflict and need to register for the early sitting of the exam, contact the course coordinator as soon as possible. **There will be no make-up exam**.

The exam will consist of a mixture of true/false questions and short-answer questions. For the true/false questions you may be asked to justify your answer and you will be marked both on your final answer and justification. Your mark for the short-answer questions will depend on the clarity of your presentation and correctness of your solution.

Missed Term Work
If you miss the midterm or a quiz 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**. Under no circumstances can the final exam count for more than 80% of your final grade.

Marking Scheme
Your final grade will be calculated by the following formula:

Final Grade = 50%(Final Exam) + 30%(Midterm Exam) + 10%(Quiz 1) + 10%(Quiz 2)

Schedule and Suggested Problems
You should solve at the very minimum the problems on the list below. Your instructor may be slightly ahead or behind this schedule.

Week 1 beginning January 5.
Lecture: Fields, Vector Spaces over Fields, Subspaces.
Section 4.1: 1(a) (d) (e), 2, 3, 4, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 24, 25, 27, 30, 31, 32, 33.
Section 4.2: 1-36 (all odd numbered exercises).

Week 2 beginning January 12.
Lecture: Linear Transformations.
Section 5.1: all odd numbered exercises.
Section 5.2: all odd numbered exercises.

Week 3 beginning January 19.
Lecture: Change of Basis, Composition of Linear Transformations, Isomorphisms.
Section 5.3: all odd numbered exercises.
Section 5.4: all odd numbered exercises.
Section 4.3: 1, 5, 7, 9, 11, 12, 14-17.

Week 4 beginning January 26. **Tutorials begin**.
Lecture: Eigenvalues & Eigenvectors, Eigenspaces & Similarity, Representation by a Diagonal Matrix.
Section 7.1: 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 23, 25, 27, 28-32, 34-37.
Section 7.2: 1, 3, 5, 7, 9, 11, 13, 14 (a) (c) (e), 15, 17, 21-23, 26-28.
Section 7.3: 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 25, 26 (a) (c), 27 (a) (c), 28-32.

Week 5 beginning February 2. **Quiz 1**.
Lecture: Real Quadratic Forms, Orthogonal Matrices.
Section 8.2: 2, 3, 5, 7, 10, 11, 12.
Section 8.3: 1, 3, 5, 7-13, 15-17.

Week 6 beginning February 9.
Lecture: Reduction & Classification of Quadratic Forms, Bilinear Forms.
Section 8.4: 1-11, 13, 15, 16.
Section 8.5: 1, 2, 5 (a) (c) (e) (g) (i), 10, 11, 12.
Section 8.6: 1 (a) (c) (e), 2 (a) (c) (e), 3 (a) (c) (e), 8.

Week 7 beginning February 23. **Midterm Exam**.
Lecture: Symmetric Bilinear Forms, Hermitian Forms.
Section 8.7: 1, 2, 9.
Section 8.8: 1, 2, 4, 6, 16-19.

Week 8 beginning March 2.
Lecture: Inner Product Spaces, Norms & Distances, Orthonormal Bases.
Section 9.1: 1, 3, 4 (a) (c) (e), 6, 7, 9-11, 14-18.
Section 9.2: all odd numbered exercises.
Section 9.3: all odd numbered exercises.

Week 9 beginning March 9.
Lecture: Orthogonal Complements, Normal Matrices, Normal Linear Operators.
Section 9.4: 1-8.
Section 9.6: 1-3, 6-9.
Section 9.7: 1, 2, 3 (a) (c) (e), 5-15.

Week 10 March 16. **Quiz 2**.
Lecture: Projections & Direct Sums, Spectral Decompositions.
Section 10.1: 1, 2 (a) (c), 3-5, 8-10, 12
Section 10.2: 1-4.

Week 11 beginning March 23.
Lecture: Minimal Polynomials & Spectral Decomposition, Nilpotent Transformations.
Section 10.3: 1 (a) (c), 4 (a) (c), 7, 8, 12-14.
Section 10.4: 1 (a) (c), 2 (a) (c), 3, 5, 7.

Week 12 beginning March 30.
Lecture: Jordan Canonical Form.
Section 10.5: 4, 5.

Week 13 beginning April 6.
Catch up/Review