Department of Mathematics & Statistics
Concordia University

MAST 235
Linear Algebra and Applications II
Winter 2016

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Office hours: Wednesday 12:00-13:30, Thursday 13:30-15:00

Textbook: *Linear Algebra, Theory and Applications*, by Ward Cheney & David Kincaid. 2nd edition. Publisher: Jones & Bartlett.

Prerequisites: Math 234 or equivalent is a prerequisite for this course.

The objective: This course will focus on applications of the theory studied in Math 234 and its further development. There are two major concepts involved, (a) *Linear Systems & Operators,* such as Economic Models or Dynamical systems, where the *Eigentheory* is applied**,** and (b) the *Inner Product Spaces*, leading to applications like Orthogonalization and Least Square solutions, on which this course is based. The general objective of the course is to master your understanding and skills in these key concepts of Linear Algebra that will be critical for further Algebra courses in your curriculum.

Pedagogy: Classes take place in a computer lab equipped with *Maple*. The structure of the classes includes lecture time on the theory and examples, alternating with problem solving tasks done in class by students individually. Mathematical issues that arise during problem solving are discussed in class.

Software: *Maple (15 or higher)*. The Waterloo *Maplesoft* is making Maple ("Student's edition", quite sufficient for the course) available to Concordia students at a special price. In this course the software is only used as a computational *tool*, ***not* as an object of study** in itself.
All the tests, the final examination and the assignments are done using *Maple.*

Assignments: Assignment are done using Maple and are submitted online through Moodle. Late assignments ***will not*** be accepted. Assignments contribute 10% to your final grade (see the Grading Scheme). Working regularly on the assignments, as well as class attendance and working on the problems in the class, is essential for success in this course.

Midterm Test: There will be **one midterm test** (based on the material of weeks 1-6) which will contribute up to 25% to your final grade (see the Grading Scheme). It will be held in class in the week 7, on **Wednesday February 17, 2016.**

NOTE: It is the Department's policy that tests missed for any reason, **including illness,** cannot be made up. If you missed the midterm because of illness **(to be confirmed by a valid medical note)** the final exam can count for 85% of your final grade, and 15% will be contributed by the assignments and quizzes (see the **Grading Scheme**).

Final Exam: The Final Examination will be 3 hours long (**closed-book** exam, no notes are allowed) written using Maple. Students are responsible for finding out the date and time of the final exam once the schedule is posted by the Examinations Office. Conflicts or problems with the schedule of the final exam must be reported directly to the Examinations Office, ***not*** to the Instructor. **Students are to be available until the end of the final exam period.** Conflicts due to travel plans **will not** be accommodated.

NOTE: There are **no supplemental exams** for this course.

Grading Scheme: The final grade will be based on the higher of (***a***) and (***b***) below:

(a) 10% for the assignments.
5% for the best of 2 quizzes (written in class)
25% for the class test
60% for the final examination.

(b) 10% for the assignments
5% for the best of 2 quizzes
10% for the class test
75% for the final examination.

IMPORTANT: **PLEASE NOTE THAT THERE IS NO "100% FINAL EXAM" OPTION IN THIS COURSE.**
The term work contributes at least 25% to the final grade. Therefore active participation in classes and continuous work on the course material **during** the semester is essential for success in this course.

Disclaimer: The instructor reserves the right to make changes to the course outline and course content should this be necessary for academic or other reasons. Every effort will be made to minimize such changes.

CONTENTS

Week	Textbook	Topics	Recommended Problems
1	**Sections 1.3, 2.3, 2.3** LINEAR SYSTEMS: NETWORKS	• Systems of Linear Equations (Sec.1.3), and Linear Mapping (Sec. 2.3): an ***Overview*** • Network Problems (Sec. 2.1, pp.99-100)	G.Ex. 1.3 # 5, 13, 25, 47, 63 G.Ex 2.3: 1, 21,39 G.Ex. 2.1: # 6, 30, 42
2	**Sections 2.4, 6.1, 8.3** LINEAR SYSTEMS: ECONOMIC MODELS	• Economic Models (pp.177-180, 385-388, 548-551) ○ Theorem 14 (p.177), Theorem 4 (p.549) ○ Closed Leontieff Model ○ Open Leontieff Model	Comp.Ex. 2.4 # 1, 2, 3.
3	**Sections 4.1, 4.2/3.2** *DETERMINANTS* PROPERTIES & APPLICATIONS	• Determinants: overview and basic properties • Applications: ○ Interpolation Problem (pp. 231-233). ○ Vandermonde matrix (pp. 279-280).	Gen.Ex. 3.2 # 19, 69, 73, 75 Gen.Ex. 4.2 # 7, 27, 33, 45
4	**Quiz 1** **Sections 6.1, 2.2** EIGENTHEORY AND DYNAMICAL SYSTEMS	QUIZ 1 (based on Weeks 1-3) • Diagonalization and powers of a matrix (pp. 371-380) • Application: Dynamical Systems (pp. 380-385). ○ Systems with Real eigenvalues ○ The Predator-Prey simulation (pp. 125-126) ○ Systems with Complex eigenvalues	Comp.Ex. 2.2 # 1, 2 Comp. Ex. 6.1 # 1, 2, 7, 13
5	**Section 7.1** INNER PRODUCT SPACES	• The concept of inner product space over real and complex numbers (pp. 403-408) ○ Definition ○ Properties • The norm in an inner product space (Theorem 1, p. 409) ○ The Cauchy-Schwartz Inequality ○ The Triangle Inequality ○ The Pythagorean Theorem	G.Ex. 7.1 # 5, 15, 17, 19, 35, 67, 71, 77
6	**Section 7.1** ORTHOGONAL PROJECTION	• Orthogonality of vectors (Theorems 2, 4, pp.411, 412). • Orthogonal Projection (Theorem 5, p.413) • Angle (p.415). • Orthogonal complements (pp. 416-419)	G.Ex. 7.1 # 3, 11, 13, 51, 57
7	**CLASS TEST** **Section 7.1** SUBSPACES	MIDTERM based on the material of the Weeks 1-6. • Orthonormal bases & subspaces , unitary matrices (pp. 419-423, Theorems 9-15)	G.Ex. 7.1 # 27, 31, 39
	Midterm Break	(no classes, Feb. 22 – Feb. 28)	
8	**Section 7.2** APPLICATIONS OF ORTHOGONALITY	• The Gram-Schmidt Process (pp.432-439), Theorems 1 & 2.	G.Ex. 7.2 # 7, 9, 23, 25, 27, 29
9	**Section 7.2** LEAST SQUARES SOLUTION	• Normal Equations and the Least Squares solutions to an inconsistent system; Theorem 3. (pp. 439-445) • Geometrical interpretation of the least-square approximations in terms of distance, projections and hyperplanes.	G.Ex. 7.2 # 1, 3, 5, 11, 13
10	**Section 8.1** HERMITIAN MATRICES & SELF-ADJOINT OPERATORS	• Hermitian matrices, symmetric matrices • Self-adjoint mappings • Eigenvalues of Hermitian and symmetric matrices	G.Ex. 8.1 # 1, 3, 9, 17, 25, 33

	QUIZ 2	QUIZ 2 (based on Weeks 8, 9, 10)	
11	**Section 8.1** SPECTRAL THEOREM & APPLICATIONS. QUADRATIC FORMS	• Spectral Theorem (Theorems 6 and 7) • Cayley-Hamilton Theorem and applications (pp. 470-472) • Quadratic Forms	G.Ex. 8.1 # 27, 29, 39, 47 G.Ex. 8.1 # 11, 61
12	**Sections 8.2** SVD FACTORIZTION	• Singular Value Decomposition (pp. 501-502)	
13	**REVIEW**	***Review classes for the Final Examination***	