COURSE TITLE: LINEAR ALGEBRA III
Lecture time and location: MWF 12:00-12:50 CAB 269
Instructor: Xi Chen
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Office and Office Hours: CAB 479, MWF 1-2 or by appointment

PREREQUISITE: Math 225 or equivalent. This course depends heavily on the previous two courses Math 125/225. It is absolutely necessary to understand well the materials covered in 125/225 in order to be successful in this one. Although we will review some topics in 125/225 in class from time to time, it is ultimately your responsibility to review the old contents on your own whenever necessary. Topics covered in 125/225 and required by this course include (but are not limited to): vectors, matrices, matrix operations, solutions of systems of linear equations, determinants, matrix inverses, abstract vector spaces, subspaces, dimension and basis, linear transformations, rank, range, kernel, Rank Theorem, injectivity, surjectivity, bijectivity, matrix representations of linear transformations, change of basis, similarity, characteristic polynomials, eigenvalues, eigenvectors, eigenspaces, diagonalization, inner products, orthogonal decompositions, Gram-Schmidt algorithm, orthogonal matrices, orthogonal diagonalization of symmetric matrices.

TEXTBOOK: There is no mandatory textbook. The following two books are recommended:


In addition, the following books are convenient references to the materials covered by Math 125/225:


Answer Keys for Self-Assessment: TFTFT FFTTT TTTFF FFTTF.
TOPICS: Jordan canonical form; Cayley-Hamilton Theorem; Spectral Theorem; matrix exponentials and differential equation; Hermitian and unitary matrices; bilinear forms; positive definiteness; Sylvester’s law of inertia. We will roughly cover Chap. 5-7 in FIS and Chap. 7 & 9 in LADW.

HOMEWORK ASSIGNMENTS: There will be 10 weekly assignments. Assignments are to be placed in the slots that are labeled for each section on the assignment boxes on the third floor of CAB before 4pm on the due day. Late assignments cannot be accepted since the solutions to the assignments will be posted on the course website shortly after the assignments are due. Your assignment will be returned to you as soon as possible after grading. If you do not understand or agree with the grading for a particular problem, please check the posted solutions on the web. After checking the solutions, if you think an error has been made in grading, please write a note on your assignment pointing out the error and pass it in again with next week’s assignment. If you still think it has been graded improperly after it is returned to you again, please see your instructor.

EXAMS: There will be one midterm and final. No CACULATORS, FORMULA SHEETS, NOTES or BOOKS are allowed in exams. You should bring a photo ID to all exams.
Midterm: Friday Feb. 27, 2015, 12-12:50, in class. Note that Feb. 16-20 is the reading week.
Final: Thursday Apr. 16, 2015, 2-4pm, Room TBA. Note that the last day of class is Apr. 10, 2015.

GRADING: I use the following formula to compute your total score

\[ 15\% \text{ homework} + 30\% \text{ midterm} + 55\% \text{ final}. \]

Your letter grade is then determined by a curve, roughly, 20% A, 25% B and 30% C (this ratio is subject to change). In addition, you are guaranteed an A- or above if your total score is at least 90% and you are guaranteed a D or above if your total score is at least 50%.

MISSED MIDTERM: A student who cannot write a midterm due to religious conviction, incapacitating illness, severe domestic affliction or other compelling reasons may apply for an excused absence. To apply for an excused absence, the student must present supporting
documentation pertaining to the absence to the instructor within two
working days following the scheduled date of the missed term work, or
as soon as the student is able. In the case of religious conviction, the
student must inform the instructor by the end of the second week of
classes. In the case of an incapacitating illness, either a medical note or
a statutory declaration (which can be obtained at the student’s Faculty
Office) will be accepted.

An excused absence is a privilege and not a right; there is no guar-
antee that an absence will be excused. Misrepresentation of facts to
gain an excused absence is a serious breach of the Code of Student
Behavior.

If an excused absence is granted, the weight of the midterm will be
added to the final exam.

MISSED FINAL: A student who cannot write the final examination
due to incapacitating illness, severe domestic affliction or other com-
pelling reasons may apply for a deferred final examination. Such an
application must be made to the student’s Faculty office within 48
hours of the missed examination and must be supported by a Statutory
Declaration (in lieu of a medical statement form) or other appropriate
documentation (Calendar section 23.5.6).

Deferred examinations are a privilege and not a right; there is no
 guarantee that a deferred examination will be granted. Misrepresenta-
tion of facts to gain a deferred examination is a serious breach of the
Code of Student Behavior.

The deferred final examination is scheduled as follows:

  Date: Saturday May 2, 2015
  Time: 9:00 am (register at 8:30 am)
  Location: TBA

RE-EXAMINATION: A student who writes the final examination and
fails the course may apply for a re-examination. Re-examinations are
rarely granted in the Faculty of Science. These exams are governed by
University (Calendar section 23.5.5) and Faculty of Science Regulations
(Calendar section 192.5.9). Misrepresentation of facts to gain a re-
examination is a serious breach of the Code of Student Behavior.

STUDENTS ELIGIBLE FOR ACCESSIBILITY-RELATED ACCOM-
MODATIONS (students registered with Specialized Support & Disability
Services - SSDS): Eligible students have both rights and responsi-
blities with regard to accessibility-related accommodations. Conse-
quently, scheduling exam accommodations in accordance with SSDS
deadlines and procedures is essential. Please note adherence to procedures and deadlines is required for U of A to provide accommodations. Contact SSDS (www.ssds.ualberta.ca) for further information.

ACADEMIC INTEGRITY: UOA is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty. Students are particularly urged to familiarize themselves with the provisions of the Code of Student Behavior and avoid any behavior which could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and participation in an offense. Academic dishonesty is a serious offense and can result in suspension or expulsion from the university.

WEBSITE: All lecture notes, homework assignments and other course-related materials will be available at eClass and the course homepage http://www.math.ualberta.ca/~xichen/math32515w. To save time and environment, I wont make hard copies of these handouts anymore. Please go to eClass and download/print them out yourself.
A Quick Self-Assessment (Math 125/225 or equivalent)

True or False:

1. If a system of linear equations has more than one solution, it has infinitely many solutions.
2. $\det(-A) = -\det(A)$ for every square matrix $A$.
3. Every $2015 \times 2015$ skew symmetric matrix is singular.
4. $(AB)^{-1} = A^{-1}B^{-1}$ for all invertible $n \times n$ matrices $A$ and $B$.
5. For $n \times n$ matrices $A$ and $B$, $AB$ is nonsingular if and only if both $A$ and $B$ are nonsingular.
6. $(A + B)^2 = A^2 + 2AB + B^2$ for all $n \times n$ matrices $A$ and $B$.
7. The products of symmetric matrices are symmetric.
8. If $\{v_1, v_2, v_3\}$ is a basis of $\mathbb{R}^3$, so is $\{v_1 + v_2, v_2 + v_3, v_3 + v_1\}$.
9. $A$ and $A^T$ have the same rank.
10. If the characteristic polynomial of $A$ is $x^3 + x^2 + x$, then $A$ is singular.
11. A linear transformation $T : \mathbb{R}^3 \to \mathbb{R}^3$ is 1-1 if and only if it is onto.
12. For all linear transformations $T_1 : \mathbb{R}^3 \to \mathbb{R}^4$ and $T_2 : \mathbb{R}^5 \to \mathbb{R}^3$, $\text{rank}(T_1 \circ T_2) \leq 3$.
13. If $A$ is a nonsingular $2 \times 2$ real matrix, then $I, A, A^{-1}$ are linearly dependent in $M_{2\times2}(\mathbb{R})$, where $M_{m\times n}(\mathbb{R})$ is the vector space of $m \times n$ real matrices.
14. Let $V$ be a vector space and $v_1, v_2, \ldots, v_n$ be $n \geq 2$ vectors in $V$. Then $v_1, v_2, \ldots, v_n$ are linearly dependent if and only if $v_1$ is a linear combination of $v_2, \ldots, v_n$.
15. Let $S_1$ and $S_2$ be two subsets of a vector space $V$. If $\text{Span}(S_1) \subset \text{Span}(S_2)$, then $S_1 \subset S_2$, where $\text{Span}(S)$ is the subspace spanned by the vectors in $S$.
16. Two square matrices with the same characteristic polynomial must be similar.
17. For every linear transformation $T : V \to V$, $K(T^2) \subset K(T)$, where $K(T)$ is the kernel of $T$.
18. For all real matrices $A$, $A^T A$ is always diagonalizable.
19. For every subspace $V \subset \mathbb{R}^n$, $\dim V + \dim V^\perp = n$, where $V^\perp$ is the orthogonal complement of $V$.
20. Let $V_1$ and $V_2$ be subspaces of $\mathbb{R}^n$. If $V_1 \subset V_2$, then $V_1^\perp \subset V_2^\perp$. 