Math 223: Linear Algebra (Honours Version)

Lectures: 10:00-11:00 MWF in Zoom accessed through Canvas website

Office hours (tentative): Thur 3:00 – 4:00 pm, Fri 2:00 – 3:00 pm, in Zoom

Instructor: Yaniv Plan, yaniv@math.ubc.ca

Website: On Canvas.

Textbook: There is no required textbook, instead we follow a set of notes creates by Prof. R. Anstee for this course. The following two textbooks may aid your study:

- *Linear Algebra*, by Friedberg, Insel, and Spence: This gives a more abstract introduction to Linear Algebra.
- *Linear Algebra and Its Applications*, by Lay: This is more accessible and less abstract, with intuitive explanations.

Outline: This course is aimed at excellent students who can go through the material at a faster pace than in MATH 152 or MATH 221, and who are interested in abstraction of Linear Algebra. Focus will be put on creative thinking. The following is a list of topics that will be covered although not exactly in the order given. The corresponding chapters of Lay's book are given.

- Gaussian Elimination and some of its uses. Ch.1 (1.1, 1.2, 1.3, 1.4, 1.5, 2.2)
- Determinants Ch.3 (3.1, 3.2, 3.3)
- Vector Spaces in R^n (also lines, planes). Ch.4 (1.7, 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7)
- Abstract vector spaces (Notes provided)
- Eigenvalues and Eigenvectors. Ch.5 (5.1, 5.2, 5.3, 5.5)
- Linear Transformations and matrices. (1.9, 3.3, 5.4)
- Abstract linear transformations and isomorphisms (Notes provided)
- Orthogonality and Least Squares. Ch.6 (6.1, 6.2, 6.3, 6.4, 6.5)
- Diagonalization of Symmetric Matrices. Ch.7 (7.1, 7.2)
- Singular value decomposition Ch. 7 (7.4, 7.5)

Assignments etc:

Semiweekly questions: We will have a question posted after Monday and Wednesday lectures, due by the start of the following lecture. It will be in webwork format, with unlimited attempts allowed.

Written homeworks: These will be due each Friday by 11:59pm after the first week of class. Solutions should be submitted as a single file through canvas. You may write answers by hand and scan or take pictures of your work, or you may type up solutions. The lowest homework score will be dropped.

Quizzes: There will be quizzes every two weeks, starting on the third week. These will be in webwork with a 45-minute time limit and one attempt per question. You may complete the quiz any time during a 24-hour window. Late quizzes will not be accepted. They will be open book so you are allowed to read books, notes, webpages. For further clarification, see Academic Integrity, below. You will need a

calculator. The quizzes will be mainly on the material covered in the previous two homeworks, but may also contain earlier material. The lowest quiz score will be dropped.

There will be no midterm or final exam, but there will be one last quiz, with the same weight as all other quizzes, on the final exam day.

Grading scheme:

Semiweekly questions: 10%

Homework: 25%

Quizzes: 65%

Academic integrity:

Homework: Students may work together to understand the problems, but are expected to write their solutions independently. No two homeworks should look identical. Students may research concepts online, but may not use solutions which are found online.

Quizzes: These will be open-book. However, students are prohibited from interacting with other students or any other people in order to determine the answers. Questions should absolutely not be posted online or shared anywhere.

Learning goals:

1. Solve challenging questions which require you to think outside the box (after all, this is an honours course)
2. Write simple proofs
3. Work with real numbers, complex numbers, abstract vector spaces, general inner product spaces, and abstract linear transformations
4. Add, multiply, invert matrices
5. Solve linear systems of equations via Gaussian elimination
6. Compute determinants of matrices
7. Compute eigen-value decomposition and use it to compute high powers of matrices
8. Solve linear recursion relations
9. Understand and compute change of basis of a matrix
10. Compute partial fractions
11. Compute dimension of a vector space or subspace
12. Determine whether or not a set (together with a definition of addition and scalar multiplication) is a vector space
13. Characterize null space and range of a matrix, be able to use corresponding orthogonality relationships
14. Solve systems of linear differential equations
15. Apply the Gram-Schmidt algorithm, find orthogonal projection matrices
16. Recognize and manipulate singular value decomposition
17. Solve least squares problems
18. Work both in abstract and concrete setting of vector spaces and linear transformations

Statement on UBC's Policies and Resources to Support Student Success:

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious and cultural observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available here.