MATH 2111 Matrix Algebra and Applications

Course Outline --- Fall 2023/2024

1. Instructor

Name: YE, Guibo (L1)

Contact Details: Room 3419, 3469-2615, email: magbye@ust.hk

2. Tutors

Name: LIU Zhetian (T1A/T1B)

Contact Details: zliucl@connect.ust.hk

Name: LIU Ziyun (T1C)

Email: zliueq@connect.ust.hk

3. Meeting Time and Venue

Lectures:

Date/Time: Tuesday & Thursday: 12:00 PM-1:20 PM

Venue: Rm 2407 (Lift 17-18)

Tutorials:

Date/Time/Venue:

T1A: wed /18:00-18:50/LSK1009;

T1B: Tue /18:00-18:50/Rm 2503 (Lift 25-26)

T1C: Thu /18:00-18:50)/CYTG009B;

1. Course Description

Credit Points: 3

Pre-requisite: A passing grade in AL Pure Mathematics / AL Applied Mathematics; OR MATH 1014; OR MATH 1018; OR MATH 1020; OR MATH 1024

Exclusion: MATH 2121, MATH 2131, MATH 2350

Brief Information/synopsis:

This course covers the basic concepts and computation techniques of linear algebra that are essential for various applications in science and engineering subjects.

2. Intended Learning Outcomes

On successful completion of this course, students are expected to be able to:

No.	ILOs
1	Explain the core theories and concepts of a system of linear equations.
2	Manipulate the basic algebra and computation techniques of matrices and determinants.
3	Describe the basic terminologies that appeared in vector spaces and inner product spaces.
4	Formulate the concept and properties of eigenvalues and eigenvectors of a matrix.
5	Operate the diagonalization process and the Gram-Schmidt process, and recognize their applications

3. Assessment Scheme

a. Examination duration: 1.5 hrs Mid-term Test / 3 hrs Final Examination

b. Percentage of coursework, examination, etc.:

Assessment	Assessing Course ILOs
10% Online Webwork Exercises	1, 2, 3, 4, 5
30% Mid-term Test	1, 2
60% Final Examination	1, 2, 3, 4, 5

c. The grading is assigned based on students' performance in assessment tasks/activities.

4. Student Learning Resources

Course Webpage:

Textbook: David C. Lay et al., *Linear Algebra and its Applications*, Fifth Edition, Pearson.

5. Teaching and Learning Activities

Scheduled activities: Weekly 4 hrs (lecture + tutorial)

a. Lectures: focus on main concepts and some basic simple problems to help understand the main concepts
b. Tutorials: focus on review and presenting more complicated problems that can help students understand the materials taught in lectures; answering students' questions.

Online Webwork Exercises: (~3hrs/week self-study)
https://webwork.math.ust.hk

The MATH Support Center (Rm 3010-3013)
Check more information from the website: http://www.math.ust.hk/~support

6. Course Schedule (~36 lecture hours)

Keyword Syllabus:

- **Chap 1 Systems of Linear Equations** (~10 hours)
  (i) Systems of Linear Equations; (ii) Row Reduction and Echelon Forms; (iii) Vector Equations;

(iv) The Matrix Equation $A\mathbf{x} = \mathbf{b}$; (v) Solution Sets of Linear Systems; (vi) Linear Independence;
(vii) Linear Transformations; (viii) The Matrix of a Linear Transformation.

- **Chaps 2 and 3 Matrix Algebra and Determinants** (~8 hours)
  (i) Matrix Operations; (ii) Matrix Inverse; (iii) Characterizations of Invertible Matrices;
  (iv) Introduction to Determinants; (v) Properties of Determinants;
  (vi) Cramer's Rule, Volume, and Linear Transformations

  Midterm Exam date: 2:15 pm---3:45 pm, Oct. 14, 2023

- **Chap 4 Vector Spaces** (~6 hours)
  (i) Vector Spaces and Subspaces; (ii) Null Spaces, Column Spaces, and Linear Transformations;
  (iii) Linearly Independent Sets and Bases; (iv) Coordinate Systems;
  (v) Dimension of a Vector Space and Rank of a Matrix.

- **Chap 5 Eigenvalues and Eigenvectors** (~4 hours)
  (i) Eigenvectors and Eigenvalues; (ii) The Characteristic Equation; (iii) Diagonalization;
  (iv) Applications to Dynamical Systems and Differential Equations.

- **Chap 6 Inner Product Spaces** (~6 hours)
  (i) Inner Product, Length, and Orthogonality; (ii) Orthogonal Sets; (iii) Orthogonal Projections;
  (iv) The Gram-Schmidt Process; (v) Least-Squares Problems; (vi) Applications to Linear Models.

- **Chap 7 Symmetric Matrices and Quadratic Forms** (~2 hours)
  (i) Diagonalization of Symmetric Matrices; (ii) Quadratic Forms and the Principal Axes Theorem.