THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY | HKUST Summer School

MATH 2111 – Matrix Algebra and Applications

School:	**School of Science**
Subject Area:	**Mathematics**
Course Credit:	**3**
Instructor:	**LIU Stephen**
Pre-requisite/co-requisite:	**Details Here**

Notes:

- The syllabi provided here is for reference only and may be subject to changes and adjustments as determined by the course instructors.

Math2111 Matrix Algebra and its Applications
Course Outline - Summer Session 2025-2026

1 Instructor(s)

Name: Dr. LIU, Stephen Shang Yi
Office: Room 3446 Email: masyliu@ust.hk (also stephen.liu@ust.hk)
Office Hours: TueWed 15:00-17:00 at Room 3446, please email beforehand.

2 Teaching Assistant(s)

TBD.

3 Meeting Times and Venue:

Instructor	Lecture/Tutorial Section	Date and Time	Room
LIU Stephen Shang Yi	*TBD*	*TBD*	*TBD*
TBD	*TBD*	*TBD*	*TBD*

4 Course Description

Credit Points: 3
Pre-requisite: A passing grade in AL Pure Mathematics / AL Applied Mathematics; OR MATH 1014 OR MATH 1020 OR MATH 1024.
Exclusion: MATH 2121, MATH 2131, MATH 2350.

Brief Information/synopsis:
Systems of linear equations; vector spaces; linear transformations; matrix representation of linear transformations; linear operators, eigenvalues and eigenvectors; similarity invariants and canonical forms.

5 Intended Learning Outcomes

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

No.	ILOs
1	Develop an understanding of the core ideas and concepts of matrix algebra, linear transformations, eigenvectors and inner product spaces.
2	Recognize the power of abstraction and generalization, carry out mathematical work with independent judgement.
3	Apply rigorous, analytical and numeric approach to analyze and solve problems using concepts of linear algebra.
4	Communicate problem solutions using correct mathematical terminology and good English.

6 Assessment Scheme

a. Homework online via WebWork: https://webwork.math.ust.hk

b. Examinations: Midterm Exam, Final Exam (both in class).

c. Percentage of coursework, examination, etc.:

Assessment	Assessing Course ILOs
10% by Online WeBWork Homework (https://webwork.math.ust.hk)	1, 2, 3, 4
35% by Midterm Exam (Time and Date: *TBD*)	1, 2, 3, 4
55% by final exam	1, 2, 3, 4

d. AI Policy: No restriction in using AI for self-studying, but the students should be aware that AI tools are not permitted in the written exams of the course.

e. Academic Integrity: Students are expected to adhere to the HKUST academic integrity policy.

Grade Descriptors:

Grade	Short Description	Elaboration on subject grading description
A	Excellent Performance	The student has mastered almost all concepts and techniques of linear algebra taught in the course, has excellent understanding of the deepest content of the subject, and acquired workable knowledge for further studies of system of linear equations, vectors, matrices, eigenvalues and eigenvectors of a matrix and their applications.
B	Good Performance	The student has mastered most computational techniques of system of linear equations, vectors, matrices, eigenvalues and eigenvectors taught in the course, yet the understanding of some challenging concepts may not be deep enough for further studies on related advanced subjects.
C	Satisfactory Performance	The student meets the minimum expectation of the instructor, has acquired some basic computational techniques of the subject, yet some concepts were not clearly understood
D	Marginal Pass	The student is only able to recall some fragments of topics and is able to complete some of the easiest computations.
F	Fail	The student does not have sufficient understanding of even some fragments of topics, and is not even able to complete some of the easiest computations.

7 Student Learning Resources

Text/Reference:
David C. Lay, et. al., "Linear Algebra and its Applications", Fifth Edition, Pearson.

8 Teaching and Learning Activities

Scheduled activities: 4hrs (lecture + tutorial)

9 Course Schedule

1. **Chapter 1:** Systems of Linear Equations
   (i) Systems of Linear Equations;
   (ii) Row Reduction and Echelon Forms;

(iii) Vector Equations;
(iv) The Matrix Equation $Ax = b$;
(v) Solution Sets of Linear Systems;
(vi) Linear Independence;
(vii) Linear Transformations;
(viii) The Matrix of a Linear Transformation.

2. **Chapters 2 and 3:** Matrix Algebra and Determinants
   (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.
3. **Chapter 4:** Vector Spaces
   (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.
4. **Chapter 5:** Eigenvalues and Eigenvectors
   (i) Eigenvectors and Eigenvalues;
   (ii) The Characteristic Equation;
   (iii) Diagonalization;
   (iv) Applications to Dynamical Systems and Differential Equations.
5. **Chapter 6:** Inner Product Spaces
   (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.
6. **Chapter 7:** Symmetric Matrices and Quadratic Forms
   (i) Diagonalization of Symmetric Matrices;
   (ii) Quadratic Forms and the Principal Axes Theorem.