UFUG 2102 Summer 2025

Matric Algebra and Appplications

Course Info:

Lecture Time: Jun 16 2025 to Jul 8 2025. TuWeThFr 9:00 AM – 11:50 AM
Tutorial Time: Jun 16 2025 to Jul 8 2025. TuWe 2:00 PM – 3:50 PM
Venue: Rm 101, E4
Course website: Canvas

Instructor:

Name: Xiaotong Sun
Office: W1 513
E-mail: xtsun@ust.hk
Office Hour: TUE 2:00PM-3:00PM

Grader:
TBD

Course Description:

Matrix algebra is a branch of mathematics that studies systems of linear equations and the properties of matrices. The use of
matrix algebra for physics, engineering, and social sciences has been increasing at a rapid pace in recent years. Due to its broad range of applications, matrix algebra is one of the most widely taught subjects in college-level mathematics. The course will have three important objectives: 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 approaches to analyze and solve problems using concepts of matrix algebra.

Intended Learning Outcomes

By taking this course, students should be able to

- Develop an understanding of the core ideas and concepts of matrix algebra, such as linear transformations, eigenvectors, and inner product spaces.
- Recognize the power of abstraction and generalization, carry out mathematical work with independent judgement.
- Apply rigorous, analytical, and numeric approaches to analyze and solve problems using concepts of matrix algebra.
- Be able to communicate problem solutions using correct mathematical terminologyand good English.

Lecture Schedule

Week/Day	Topic	Content	Remark
Week 1/June 17th	Lecture #1: Systems of Linear Equations	• Systems of Linear equations • Row Reduction and Echelon Forms of Matrix • Vector Euations	Homework #1 out
Week 1/June 18th	Lecture #2: The Matrix Equation	• Matrix Equation • Solution Sets of Linear Systems • Linear Independence • Linear Transformations	
Week 1/June 19th	Lecture #3: Linear Transformations	• The Matrix of Linear Transformation • Summary of Chapter 1	
Week 1/June 20th	Lecture #4: Matrix Algebra	• Matrix Operatioins • The Inverse of a Matrix • Characters of Invertible Matrices	
Week 2/June 24th	Lecture #5: Matrix Factorizations	• Partitioned Matrices • LU factorization • Subspaces of $\mathbb{R}^n$ • Dimension and Rank	Homework #1 due Homework #2 out
Week 2/June 25th	Lecture #6: Determinants	• Introduction to Determinants • Properties of Determinants • Cramer's Rule	
Week 2/June 26th	Lecture #7: Vector Spaces, Part I	• Vector Spaces and Subspaces • Null, Column and Row Spaces • Linearly Independent Sets; Bases	
Week 2/June 26th	Mid-term Exam	14:00-15:50	
Week 2/June 27th	Lecture 8: Vector Spaces, Part II	• Coordinate Systems • The Dimension of a Vector Space • Change of Basis • Application to Difference Equations	
Week 3/July 1st	Lecture 9: Eigen systems	• Eigenvalues and eigenvectors • Characteristic equation	Homework #2 due Homework #3 out

		• Diagonalization • Applications to Principal Components Analysis	
Week 3/July 2nd	Lecture 10: Inner product and orthogonality	• Inner product, Length, and Orthogonality • Orthogonal Sets • Orthogonal Projections	
Week 3/July 3rd	Lecture 11: Least square method	• Gram-Schmidt Process • Least Square Method • Applications to Linear Models	
Week 3/July 4th	Lecture 12: Special matrices	• Diagonalization of Symmetric Matrices • Quadratic Forms • Application to Constrained Optimization • Applications to Image Processing	
Week 4/July 8th	Review and Q&A		Homework #3 due
Week 4/July 9 or 10th	Exam		

Tutorials Schedule (Tentative)

Week/Day	Topic	TA
Week 1/June 17th	Q&A, Exercises: Overview and Lecture 1	Yijie Chen
Week 1/June 18th	Q&A, Excercises: Lecture 1 to 2	Jiazhou Zhou
Week 2/June 24th	Q&A, Exercises: Lecture 3 to 5	Jiazhou Zhou
Week 2/June 25th	Q&A, Excercises: Lecture 5 to 6	Yijie Chen
Week 3/July 1st	Q&A, Excercises: Lecture 7 to 9	Yijie Chen
Week 3/July 2nd	Q&A, Excercises: Lecture 9 to 10	Jiazhou Zhou
Week 4/July 8th	Review and Q&A: Lecture 11 to Lecture 12	Yijie Chen, Jiazhou Zhou

Reference Books:

(1) Linear Algebra and its Applications by David C. Lay, Stephen R. Lay, Judi J. McDonald 5th edition. Pearson.
(2) Matrix Algebra – Theory, Computations and Applications in Statistics by James E. Gentle, second edition, Springer.

Homework Assignments:

There are four assignments planned. Each will be delivered per week covering relevant topics introduced in class. Students can discuss in groups; however, they are expected to hand-in their own solutions. ***Plagiarism is forbidden.***

Exams:

One mid-term exam and final exam will be given to evaluate students' abilities in modeling, calculation, and analysis.

Participation and Expectation:

Students are expected to attend class and to notify the instructor if they are not able to.

Grading:

Grading for the course will be based on the following:

•Homework assignments: 15%, each time 5%

•Mid-term exam: 35%

•Final exam: 45%

•Class participation: 5%

Grading Scale:

The grading scale for the class is: A (90, 100], A- (85, 90], B+ (80, 85], B (75, 80], B-(70, 75], C (60, 70], F [0, 60]. Curving might occur in any assignment/exam if the average result is too low. A+ is only given to students who have supreme performance in this course.

The HKUST(GZ) Academic Honor Code:

Honesty and integrity are central to the academic work of HKUST(GZ). Students at the University must observe and uphold the highest standards of academic integrity and honesty in all the work they do throughout their program of study. As members of the University community, students have the responsibility to help maintain the academic reputation of HKUST(GZ) in its academic endeavors. Sanctions will be imposed on students, if they are found to have violated the regulations governing academic integrity and honesty.