



Hunan University

MATH 26: Matrix Algebra

Professor: To be announced
Total contact hours: 54 hours
Credit: 4

Course Description

This course starts with providing a clean and concise introduction to the basic theory of matrices, and then it continues to present many interesting applications of matrices to different aspects of mathematics and also other areas of science and engineering. In this course, it also provides students with a useful and reliable reference. What's more, this course mixes together algebra, analysis, complexity theory and numerical analysis, and students will have a systematic and full understanding of the most commonly-known mathematical knowledge.

Required Material

Textbook: *Matrices: Theory and Applications*
Author: Denis Serre
Publisher: Springer-Verlag New York Inc. (Aug. 21, 2002)

Grading

- 4 Quizzes 40%
- 3 Mid-term Exams 30%
- Final Exam 30%

A+ 96-100	A 90-95	A- 85-89
B+ 82-84	B 78-81	B- 75-77
C+ 71-74	C 66-70	C- 62-65
D 60-61	F < 60	

Course Schedule

The course has 24 class sessions in total. All sessions are 2 hours and 15 minutes in length.
Note: the course outline and required readings are subject to change.



Class 1:

Introduction to the course and syllabus-related materials

Chapter 1: Elementary Theory

1.1 Basics

1.2 Change of Basis

Class 2:

Chapter 2: Square Matrices

2.1 Determinants and Minors

2.2 Invertibility

2.3 Alternate Matrices and the Pfaffian

Class 3:

Chapter 2: Square Matrices (Cont.)

2.4 Eigenvalues and Eigenvectors

2.5 The Characteristic Polynomial

2.6 Diagonalization

Class 4:

Chapter 2: Square Matrices (Cont. 2)

2.7 Trigonalization

2.8 Irreducibility

Quiz 1

Class 5:

Chapter 3: Matrices with Real or Complex Entries

3.1 Eigenvalues of Real- and Complex-Valued Matrices

3.2 Spectral Decomposition of Normal Matrices

Class 6:

Chapter 3: Matrices with Real or Complex Entries (Cont.)

3.3 Normal and Symmetric Real-Valued Matrices

3.4 The Spectrum and the Diagonal of Hermitian Matrices

Class 7:

Review of Chapter 1 to Chapter 3

Mid-term Exam 1

Class 8:

Chapter 4: Norms

4.1 A Brief Review

4.2 Householder's Theorem



Class 9:

Chapter 4: Norms (Cont.)

4.3 An Interpolation Inequality

4.4 A Lemma about Banach Algebras

4.5 The Gershgorin Domain

Quiz 2

Class 10:

Chapter 5: Nonnegative Matrices

5.1 Nonnegative Vectors and Matrices

5.2 The Perron-Frobenius Theorem: Weak Form

Class 11:

Chapter 5: Nonnegative Matrices (Cont.)

5.3 The Perron-Frobenius Theorem: Strong Form

5.4 Cyclic Matrices

5.5 Stochastic Matrices

Class 12:

Review of Chapter 4 to Chapter 5

Mid-term Exam 2

Class 13:

Chapter 6: Matrices with Entries in a Principal Ideal Domain; Jordan Reduction

6.1 Rings, Principal Ideal Domains

6.2 Invariant Factors of a Matrix

6.3 Similarity Invariants and Jordan Reduction

Quiz 3

Class 14:

Chapter 7: Exponential of a Matrix, Polar Decomposition, and Classical Groups

7.1 The Polar Decomposition

7.2 Exponential of a Matrix

Class 15:

Chapter 7: Exponential of a Matrix, Polar Decomposition, and Classical Groups (Cont.)

7.3 Structure of Classical Groups

7.4 The Groups $U(p, q)$

Class 16:

Chapter 7: Exponential of a Matrix, Polar Decomposition, and Classical Groups (Cont.)

7.5 The Orthogonal Groups $O(p, q)$



7.6 The Symplectic Group Sp_n
7.7 Singular Value Decomposition

Class 17:
Review of Chapter 6 to Chapter 7
Mid-term Exam 3

Class 18:
Chapter 8: Matrix Factorizations
8.1 The LU Factorization
8.2 Choleski Factorization

Class 19:
Chapter 8: Matrix Factorizations (Cont.)
8.3 The QR Factorization
8.4 The Moore-Penrose Generalized Inverse

Class 20:
Chapter 9: Iterative Methods for Linear Problems
9.1 A Convergence Criterion
9.2 Basic Methods
9.3 Two Cases of Convergence

Class 21:
9.4 The Tridiagonal Case
9.5 The Method of Conjugate Gradient
Quiz 4

Class 22:
Chapter 10: Approximation of Eigenvalues
10.1 Hessenberg Matrices
10.2 The QR Method

Class 23:
Chapter 10: Approximation of Eigenvalues (Cont.)
10.3 The Jacobi Method
10.4 The Power Methods
10.5 Leverrier's Method

Class 24:
Final Exam



Attending Policy

Regular and prompt attendance is required. Under ordinary circumstances, you may miss two times without penalty. Each absence over this number will lower your course grade by a third of a letter and missing more than five classes may lead to a failing grade in the course. Arriving late and/or leaving before the end of the class period are equivalent to absences.

Policy on “Late Withdrawals”

In accordance with university policy, appeals for late withdrawal will be approved ONLY in case of medical emergency and similar crises.

Academic Honesty

Hunan University expects all students to do their own work. Instructors will fail assignments that show evidence of plagiarism or other forms of cheating, and will also report the student's name to the University administration. A student reported to the University for cheating is placed on disciplinary probation; a student reported twice is suspended or expelled.

General Expectations:

Students are expected to:

- Attend all classes and be responsible for all materials covered in class and otherwise assigned;
- Complete the day's required reading and assignments before class;
- Review the previous day's notes before class and make notes about questions you have about the previous class or the day's reading;
- Participate in class discussions and complete required written work on time;
- Refrain from texting, phoning or engaging in computer activities unrelated to class during the class period;
- While class participation is welcome, even required, you are expected to refrain from private conversations during the class period.

Special Needs or Assistance

Please contact the Administrative Office immediately if you have a learning disability, a medical issue, or any other type of problem that prevents professors from seeing you have learned the course material. Our goal is to help you learn, not to penalize you for issues which mask your learning.