



## Nanchang University MATH 26: Matrix Algebra

**Credit:** 4

### ***Contact Hours***

This course is composed of 24 lecture sessions, 3 tutorial sessions and 9 office contact hours. Each lecture session takes 2 contact hours in length; each tutorial session takes 3 contact hours in length; There will be a Q-A review session(3 contact hours) and Final Exam (3 contact hours) at the end of this term. This course has 72 contact hours in total.

### ***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 Textbook***

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

### ***Grading***

- Participation 10%
- Quizzes 30%
- 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 contact hours in length. At the end of this term, there will be a Q-A review session(3 contact hours) and Final Exam (3 contact hours).

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

Basics; Change of Basis

Class 2:

Chapter 2: Square Matrices

Determinants and Minors; Invertibility

Alternate Matrices and the Pfaffian

Class 3:

Chapter 2: Square Matrices (Cont.)

Eigenvalues and Eigenvectors

The Characteristic Polynomial; Diagonalization

Class 4:

Chapter 2: Square Matrices (Cont. 2)

Trigonalization; Irreducibility

Quiz 1

Class 5:

Chapter 3: Matrices with Real or Complex Entries

Eigenvalues of Real- and Complex-Valued Matrices; Spectral Decomposition of Normal Matrices

Class 6:

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

Normal and Symmetric Real-Valued Matrices

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

A Brief Review; Householder's Theorem

Class 9:

Chapter 4: Norms (Cont.)



An Interpolation Inequality  
A Lemma about Banach Algebras; The Gershgorin Domain  
Quiz 2

Class 10:  
Chapter 5: Nonnegative Matrices  
Nonnegative Vectors and Matrices; The Perron-Frobenius Theorem: Weak Form

Class 11:  
Chapter 5: Nonnegative Matrices (Cont.)  
The Perron-Frobenius Theorem: Strong Form  
Cyclic Matrices; 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  
Rings, Principal Ideal Domains; Invariant Factors of a Matrix  
Similarity Invariants and Jordan Reduction  
Quiz 3

Class 14:  
Chapter 7: Exponential of a Matrix, Polar Decomposition, and Classical Groups  
The Polar Decomposition; Exponential of a Matrix

Class 15:  
Chapter 7: Exponential of a Matrix, Polar Decomposition, and Classical Groups (Cont.)  
Structure of Classical Groups; The Groups  $U(p,q)$

Class 16:  
Chapter 7: Exponential of a Matrix, Polar Decomposition, and Classical Groups (Cont.)  
The Orthogonal Groups  $O(p,q)$   
The Symplectic Group  $Sp_n$ ; Singular Value Decomposition

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

Class 18:  
Chapter 8: Matrix Factorizations  
The  $LU$  Factorization; Choleski Factorization



Class 19:

Chapter 8: Matrix Factorizations (Cont.)

The  $QR$  Factorization; The Moore-Penrose Generalized Inverse

Class 20:

Chapter 9: Iterative Methods for Linear Problems

A Convergence Criterion; Basic Methods; Two Cases of Convergence

Class 21:

Chapter 9: Iterative Methods for Linear Problems

The Tridiagonal Case; The Method of Conjugate Gradient

Quiz 4

Class 22:

Chapter 10: Approximation of Eigenvalues

Hessenberg Matrices;

Class 23:

Chapter 10: Approximation of Eigenvalues (Cont.)

The Jacobi Method; The  $QR$  Method

Class 24:

Chapter 10: Approximation of Eigenvalues (Cont.)

The Power Methods; Leverrier's Method

### ***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***

Nanchang 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.