南方科技大学 SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

课程详述

COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	课程名称 Course Title	高等代数 I Advanced Linear Algebra I
2.	授课院系 Originating Department	数学系 Department of Mathematics
3.	课程编号 Course Code	
4.	课程学分 Credit Value	4
5.	课程类别 Course Type	专业基础课 Major Foundational Courses
6.	授课学期 Semester	秋季 Fall
7.	授课语言 Teaching Language	中英双语 English & Chinese
8.	授课教师、所属学系、联系方式（如属团队授课，请列明其他授课教师） Instructor(s), Affiliation& Contact （For team teaching, please list all instructors）	胡勇，数学系 慧园 3 栋 409 huy@sustech.edu.cn 0755-8801-5910 Yong Hu, Department of Mathematics Block 3, Room 409, Wisdom Valley huy@sustech.edu.cn 0755-8801-5910
9.	实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact	待公布 To be announced
10.	选课人数限额(可不填) Maximum Enrolment （Optional）	

11. 授课方式 Delivery Method	讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other（Please specify）	总学时 Total
学时数 Credit Hours	64	32			96

12.	**先修课程、其它学习要求 Pre-requisites or Other Academic Requirements**	无 None
13.	**后续课程、其它学习规划 Courses for which this course is a pre-requisite**	高等代数 II (或 II-H) 或 线性代数精讲 Advanced Linear Algebra II (or II-H) or Advanced Linear Algebra
14.	**其它要求修读本课程的学系 Cross-listing Dept.**	

教学大纲及教学日历 SYLLABUS

15. **教学目标 Course Objectives**

本课程主要为数学系数学与应用数学专业设计，分成 I、II 两部分，按两个学期连贯教学。课程旨在引导学生深入系统地学习该专业所需要的代数学基本知识，为数学专业高年级的后续课程打下扎实的基础。课程内容将按照高于同类课程的标准进行教学和考核，以培养出代数学基础最扎实的学生为目标。

本课程(高等代数 I)内容主要包括：矩阵和线性方程组，向量空间及其子空间，线性映射及其矩阵，行列式及其应用，二次型及其几何应用。

This course is primarily designed for students majored in pure and applied mathematics, and is divided into Parts I and II, lasting ideally for two consecutive semesters. It aims at leading students into systematic and thorough studies of the fundamentals of modern algebra, thus getting them to lay a solid foundation for subsequent, more advanced courses in math major. The contents of the course and the standards of assessment will normally surpass the other courses in the same series, the objective being to foster students with best background in algebra.

Main topics of this course (Advanced Linear Algebra I) include：Matrices and systems of linear equations, vector spaces and their subspaces, linear maps and their matrices, determinants and applications, quadratic forms with geometric applications.

16. **预达学习成果 Learning Outcomes**

通过对本课程的学习，学生能够理解和掌握高等代数的基本理论(包括矩阵、线性空间和线性算子等)和在坐标几何中的重要应用。同时，学生应当逐渐培养出较好的抽象思维能力和进行严密数学推理和证明的能力。

An adequate training through this course should help the students to understand the basics of advanced linear algebra (such as matrices, linear spaces and linear operators) as well as some important applications in coordinate geometry. Also, students are expected to gradually foster the ability of abstract thinking and doing logically rigorous arguments and proofs in math.

17. **课程内容及教学日历 （如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）**
Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)

第零章 线性代数为哪般 (1h)

§1 线性代数学什么

§2 线性代数怎么学

第一章 矩阵和线性方程组 (11h)

§1 解线性方程组

1.1 方程组的初等变换

1.2 系数矩阵和高斯消元法

1.3 用行阶梯形确定解集性态

§2 矩阵算术

2.1 矩阵基本运算

2.2 初等矩阵和矩阵等价

2.3 秩和逆矩阵

2.4 分块矩阵

第二章 向量空间及子空间 (14h)

§1 再论线性方程组

1.1 几何直观

1.2 齐次方程组的解空间

1.3 线性相关与无关

§2 R^n 中的子空间

2.1 例子多多益善

2.2 向量组和线性组合

2.3 基和维数

2.4 子空间的交与和

§3 抽象向量空间

3.1 多项式与函数空间

3.2 抽象向量空间

3.3 有限维向量空间

第三章 线性映射及矩阵表示 (16h)

§ 1 线性映射

1.1 平面和空间中的线性变换

1.2 矩阵视为线性映射

1.3 一般的线性映射

1.4 核与像

§ 2 线性映射的运算

2.1 线性映射的矩阵表示

2.2 线性映射四则运算

2.3 线性泛函

§ 3 基变换与矩阵相似

3.1 矩阵变换与基变换

3.2 特征值和特征向量

3.3 几何解释

3.4 矩阵对角化

第四章 行列式及其应用 (10 学时)

§ 1 低阶行列式

1.1 二阶行列式与平面几何

1.2 向量的数量积、向量积与混合积

1.3 三阶行列式与空间几何

§ 2 高阶行列式

2.1 行列式的多线性

2.2 行列式函数的构造

2.3 一些常用性质

2.4 计算举例

§ 3 行列式的应用

3.1 Cramer 法则

3.2 矩阵的秩和逆

3.3 检验特征值

第五章 二次型及几何应用 (12 学时)

§ 1 基本概念

1.1 二次型及其矩阵表示

1.2 二次型等价与矩阵相合

1.3 正交基

§ 2 正交化与标准形

2.1 Gram-Schmidt 正交化

2.2 配方法

2.3 对称矩阵的相合标准形

§ 3 惯性指数与正定性

3.1 实系数和复系数二次型的规范形

3.2 二次型和对称矩阵的正定性

§ 4 二次超曲面的分类

4.1 仿射分类

4.2 正交分类

Chapter 0 Why Linear Algebra (1h)

§ 1 What to study

§ 2 How to learn

Chapter 1 Matrices and Linear Systems (11h)

§ 1 Solving systems of linear equations

1.1 Elementary transformations of equations

1.2 Coefficient matrix and Gaussian elimination

1.3 Determining solution sets using row echelon forms

§ 2 Matrix arithmetic

2.1 Basic operations on matrices

2.2 Elementary matrices and matrix equivalence

2.3 Rank and inverses of matrices

2.4 Partitioned matrices

Chapter 2 Vector Spaces and Subspaces (14h)

§ 1 Revisiting linear systems

1.1 Some geometric intuition

1.2 Solution spaces of homogeneous systems

1.3 Linear dependence and independence

§ 2 Subspaces of R^n

2.1 More and more examples

2.2 Collections of vectors and linear combinations

2.3 Basis and dimension

2.4 Intersections and sums of subspaces

§ 3 Abstract vector spaces

3.1 Polynomials and function spaces

3.2 Abstract vector spaces

3.3 Finite dimensional spaces

Chapter 3 Linear Maps and Their Matrix Representations (16h)

§ 1 Linear Mpas

1.1 Linear transformations in the plane and the space

1.2 Matrices as linear maps

1.3 General linear maps

1.4 Kernel and image

§ 2 Operations on linear maps

2.1 Matrix representations of linear maps

2.2 Four basic operations on linear maps

2.3 Linear functionals

§ 3 Change of bases and similarity of matrices

3.1 Matrix changes and basis changes

3.2 Eigenvalues and eigenvectors

3.3 Geometric interpretation

3.4 Diagonalization of matrices

Chapter 4 Determinants and applications (10h)

§ 1 Low order determinants

1.1 Determinants of order 2 and plane geometry

1.2 Scalar products, vector products and mixed products of vectors

1.3 Determinants of order 3 and space geometry

§ 2 Higher order determinants

2.1 Multilinearity of determinants

2.2 Construction of the determinant function

2.3 Frequently used properties

2.4 Examples of computations

§ 3 Applications of determinants

3.1 Cramer's rule

3.2 Rank and inverse matrices

3.3 Test of eigenvalues

Chapter 5 Quadratic Forms with Geometric Applications (12h)

§ 1 Basic concepts

1.1 Quadratic forms and their matrices

1.2 Equivalence of quadratic forms and congruence of matrices

1.3 Orthogonal bases

§ 2 Orthogonalization and canonical forms

2.1 Gram-Schmidt orthogonalization

2.2 Method of completing squares

2.3 Congruent canonical forms of symmetric matrices

§ 3 Inertia index and positivity

3.1 Normal forms of real and complex quadratic forms

3.2 Positivity of quadratic forms and symmetric matrices

§ 4 Classiciation of quadrics

4.1 Affine classification

4.2 Orthogonal classification

18. 教材及其它参考资料 Textbook and Supplementary Readings

教材 Textbook:

蓝以中，《高等代数简明教程》上册，第二版，北京大学出版社，2007，ISBN：9787301053706

推荐参考书 Supplementary Readings:

蓝以中，《高等代数学习指南》，北京大学出版社，2008，ISBN: 9787301129050;

李尚志，《线性代数》(数学专业用)，高等教育出版社，2006，ISBN: 9787040198706;

Sheldon Axler, Linear Algebra Done Right, 3rd edition, Springer, 2015, ISBN: 9783319110790;

Peter D. Lax, Linear Algebra and its applications, 2nd edition, 2007, ISBN 9780471751564

课程评估 ASSESSMENT

19.

评估形式 Type of Assessment	评估时间 Time	占考试总成绩百分比 % of final score	违纪处罚 Penalty	备注 Notes
出勤 Attendance				
课堂表现 Class Performance		5		
小测验 Quiz		15		
课程项目 Projects				
平时作业 Assignments		10		
期中考试 Mid-Term Test		30		
期末考试 Final Exam		40		
期末报告 Final Presentation				
其它（可根据需要改写以上评估方式） Others (The above may be modified as necessary)				

20. 记分方式 GRADING SYSTEM

☑ A. 十三级等级制 Letter Grading
☐ B. 二级记分制（通过/不通过） Pass/Fail Grading

课程审批 REVIEW AND APPROVAL

21. 本课程设置已经过以下责任人/委员会审议通过
This Course has been approved by the following person or committee of authority