

## COURSE SPECIFICATION

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.	<b>Course Title</b>	I Advanced Linear Algebra I				
2.	<b>Originating Department</b>	Department of Mathematics				
3.	<b>Course Code</b>					
4.	<b>Credit Value</b>	4				
5.	<b>Course Type</b>	Major Foundational Courses				
6.	<b>Semester</b>	Fall				
7.	<b>Teaching Language</b>	English & Chinese				
8.	<b>Instructor(s), Affiliation&amp; Contact</b> <b>For team teaching, please list all instructors</b>	<div style="text-align: center;">3 409</div> <div>huy@sustech.edu.cn</div> <div>0755-8801-5910</div> <div>Yong Hu, Department of Mathematics</div> <div>Block 3, Room 409, Wisdom Valley</div> <div>huy@sustech.edu.cn</div> <div>0755-8801-5910</div>				
9.	<b>Tutor/TA(s), Contact</b> <div style="text-align: center;">/</div>	To be announced				
10.	<b>Maximum Enrolment</b> <div style="text-align: center;">(      )</div>					
11.	<b>Delivery Method</b>	/   /	/	(      )		
		<b>Lectures</b>	<b>Tutorials</b>	<b>Lab/Practical</b>	<b>Other   Please specify</b>	<b>Total</b>
	<b>Credit Hours</b>	64	32			96

12. Pre-requisites or Other Academic Requirements	None
13. Courses for which this course is a pre-requisite	II ( II-H) Advanced Linear Algebra II (or II-H) or Advanced Linear Algebra
14. Cross-listing Dept.	

### SYLLABUS

#### 15. Course Objectives

<p style="text-align: center;">I II</p> <p>( I )</p> <p>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.</p> <p>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.</p>
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#### 16. Learning Outcomes

<p style="text-align: center;">( )</p> <p>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.</p>
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#### 17. 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.)

**(1h)**

$\mathbb{Z}_2 1$  \_\_\_\_\_

$\mathbb{Z}_2 2$  \_\_\_\_\_

**(11h)**

$\mathbb{Z}_2 1$  \_\_\_\_\_

1.1

1.2

1.3

$\mathbb{Z}_2 2$  \_\_\_\_\_

2.1

2.2

2.3

2.4

**(14h)**

$\mathbb{Z}_2 1$  \_\_\_\_\_

1.1

1.2

1.3

$\mathbb{Z}_2 R^n$  \_\_\_\_\_

2.1

2.2

2.3

2.4

$\mathbb{Z}_2 3$  \_\_\_\_\_

3.1

3.2

3.3

(16h)

$\frac{1}{2}1$ \_\_\_\_\_

1.1

1.2

1.3

1.4

$\frac{1}{2}2$ \_\_\_\_\_

2.1

2.2

2.3

$\frac{1}{2}3$ \_\_\_\_\_

3.1

3.2

3.3

3.4

(10 )

$\frac{1}{2}1$ \_\_\_\_\_

1.1

1.2

1.3

$\frac{1}{2}2$ \_\_\_\_\_

2.1

2.2

2.3

2.4

1/2 3

3.1 Cramer

3.2

3.3

(12 )

1/2 1

1.1

1.2

1.3

1/2 2

2.1 Gram-Schmidt

2.2

2.3

1/2 3

3.1

3.2

1/2 4

4.1

4.2

## **Chapter 0 Why Linear Algebra (1h)**

1/2 1 What to study

1/2 2 How to learn

## **Chapter 1 Matrices and Linear Systems (11h)**

1/2 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

½ 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)**

½ 1 Revisiting linear systems

1.1 Some geometric intuition

1.2 Solution spaces of homogeneous systems

1.3 Linear dependence and independence

½ 2 Subspaces of  $\mathbb{R}^n$

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

½ 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)**

½ 1 Linear Maps

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

## 1/2 2 Operations on linear maps

### 2.1 Matrix representations of linear maps

### 2.2 Four basic operations on linear maps

### 2.3 Linear functionals

## 1/2 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)**

## 1/2 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

## 1/2 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

## 1/2 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)**

### 1/2 1 Basic concepts

1.1 Quadratic forms and their matrices

1.2 Equivalence of quadratic forms and congruence of matrices

1.3 Orthogonal bases

### 1/2 2 Orthogonalization and canonical forms

2.1 Gram-Schmidt orthogonalization

2.2 Method of completing squares

2.3 Congruent canonical forms of symmetric matrices

### 1/2 3 Inertia index and positivity

3.1 Normal forms of real and complex quadratic forms

3.2 Positivity of quadratic forms and symmetric matrices

### 1/2 4 Classification of quadrics

4.1 Affine classification

4.2 Orthogonal classification

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### **Textbook and Supplementary Readings**

Textbook:

2007 ISBN 9787301053706

Supplementary Readings:

2008 ISBN: 9787301129050;

( ) 2006 ISBN: 9787040198706;

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

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



### ASSESSMENT

19.

Type of Assessment	Time	% of final score	Penalty	Notes
Attendance				
Class Performance		5		
Quiz		15		
Projects				
Assignments		10		
Mid-Term Test		30		
Final Exam		40		
Final Presentation				
Others (The above may be modified as necessary)				

20.

### GRADING SYSTEM

A.	Letter Grading
B.	/ Pass/Fail Grading

### REVIEW AND APPROVAL

21.

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This Course has been approved by the following person or committee of authority