MATH 4151
Introduction to Lie Groups
2024-25 Fall

Midterm Exam date: 12:00-13:20pm Oct. 25, 2024

Lecture

Time	Monday 16:30 -17:50 and Friday: 12:00 -13:20
Venue	Room 2302
Instructor	**Professor Weiping LI**
E-mail	mawpli@ust.hk
Office	Room 3444, Department of Mathematics

Tutorial

session	T1
Time	Wednesday 16:30-17:20
Venue	LG426(LIB)
Teaching Assistant	**Wang, Zi**
E-mail	zwanghk@connect.ust.hk

Course Description

Course outline: This course is an introduction course for Lie groups, Lie algebras and their representations. It covers basic concepts and theorems of symmetry, compact Lie groups and Lie algebras as well as root systems, representations of Lie algebras and compact Lie groups.

Credits: 3

Prerequisites: Abstract Algebra or its equivalent

Intended Learning Outcomes (ILOs)

Upon completion of this course, students are expected to be able to:

(1) Recognize and use appropriately important technical terms and definitions.
(2) Use calculus and linear algebra to formulate and apply the fundamental theorems in concise form.
(3) Understand and apply the theory of root systems for classification and representations of simple Lie algebras

Assessment and Grading

Homework: There will be 9 or 10 problem sets. The homework is assigned during classes.

Examinations: There will be a 1 hour and 20 minutes midterm exam on Oct. 25 12:00–13:20, and a 3-hour final exam arranged by ARO.

Make-up midterm policy:

- Under any circumstance, students who are unable to attend the midterm exam will **not** be offered a make-up midterm that takes place after the regular exam session.
- For students who have valid reasons for missing the midterm (such as time crash with another midterm), the instructor may approve an early midterm, or assign the midterm marks according to the final exam performance.
- On other hand, for students who miss the midterm without a valid reason, the midterm score will be regarded as 0. This includes self-claimed sickness without any medical statement.

The course will follow the make-up exam policy set by ARO for the final exam. Approval from the instructor, the dean, and ARO will be needed for applying for a make-up final exam.

Grading Scheme:

This course will be assessed using **criterion-referencing**, and grades will **not** be assigned using a curve (nor a surface). Your course total will be calculated by taking the following scheme:

	Scheme	Address ILOs
Homework	15%	1, 2, 3
Midterm	35%	1, 2
Final	50%	1, 2, 3
Course Total	100%	

Letter Grades: Students should aim at getting a course total of 85% or above for A-/A/A+ and about a course total of 40% or above to get a pass grade.

Grade Descriptors:

Grades	Short Description A	Elaboration on subject grading description
A	Excellent Performance	The student has mastered almost all concepts and techniques of linear algebra taught in the course, has excellent understanding of the deepest content of the subject, and acquired workable knowledge for further studies of system of linear equations, vectors, matrices, eigenvalues and eigenvectors of a matrix and their applications.
B	Good Performance	The student has mastered most computational techniques of system of linear equations, vectors, matrices, eigenvalues and eigenvectors taught in the course, yet the understanding of some challenging concepts may not be deep enough for further studies on related advanced subjects.
C	Satisfactory Performance	The student meets the minimum expectation of the instructor, has acquired some basic computational techniques of the subject, yet some concepts were not clearly understood.
D	Marginal Pass	The student is only able to recall some fragments of topics and is able to complete some of the easiest computations.
F	Fail	The student does not have sufficient understanding of even some fragments of topics, and is not even able to complete some of the easiest computations.

RECOMMENDED READING:

(1) Fulton & Harris, "Representation Theory, a First Course", Springer.
(2) J.-S. Huang, "Lectures on Representation Theory", World Scientific, 1999.

COURSE SCHEDULE (ABOUT 36 HOURS)

Chapter 1 Matrix Groups (about 12 hours)
(i) Matrix Groups;
(ii) Lie Groups;
(iii) Group Actions;
(iv) Tangent Spaces;
(v) Adjoint Action and Lie Algebras;
Chapter 2 Lie Algebras (12 hours)
(i) Lie algebras;
(ii) Nilpotency and Engel's Theorem;
(iii) Solvable Lie Algebras and Lie's Theorem;
(iv) Lie Algebra Representations and Weyl's Theorem;
(v) Jordan-Chevalley Decomposition;
(vi) Killing Form, Cartan's Criterion and Semi-Simplicity
Chapter 3 Root Systems (about 12 hours)
(i) SL_2 and SL_n;
(ii) Root Systems;
(iii) Dynkin Diagrams;
(iv) Weyl Groups;

(v) Weight Systems.

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct.