COURSE OUTLINE: MH1200

Course Title	**Linear Algebra I**		
Course Code	**MH1200**		
Offered	Study Year 1, Semester 1		
Course Coordinator	Andrew James Kricker (Assoc Prof)	ajkricker@ntu.edu.sg	6513 7458
Pre-requisites	None		
Mutually exclusive	CE1104, CY1602, CZ1104, MH2800, MH2802, SC1004		
AU	4		
Contact hours	Lectures: 39, Tutorials: 12		
for delivery from	AY2023/24 semester 1		
Last revised	28 June 2023		

Course Aims

This is a core course for mathematics students and a suitable elective for engineering students. This course provides a grounding on vectors, matrices, and solving systems of linear equations that is fundamental for future mathematics courses and also many practical applications.

Intended Learning Outcomes

Upon successfully completing this course, you should be able to:

Vectors:

1. Do basic vector manipulation: addition, scalar multiplication, matrix-vector product.
2. Compute dot products, and interpret in terms of length and angle.
3. Visualize linear combinations of vectors in 2 and 3 dimensions.

Solving systems of linear equations:

4. Apply the principle of Gaussian elimination to solve linear equations.
5. Identify the number of solutions to a system of linear equations in row echelon form.
6. Apply the column and row pictures of matrix multiplication as appropriate to solve problems.
7. Find the LU decomposition of a matrix.
8. Identify when a matrix is invertible and compute inverses in this case.

Determinants:

9. Compute determinants via Gaussian elimination.
10. Derive the cofactor and “big” formulas for the determinant.

Vector Spaces:

11. Determine if a given set is a vector space.
12. Apply the concepts of linear independence and span.
13. Find bases for the four fundamental subspaces associated to a matrix.
14. Derive the relationships between these four fundamental subspaces.

Orthogonality:

15. Find the projection of a vector onto a subspace.
16. Find the least squares solution to an inconsistent system of linear equations.

Course Content

The course begins by introducing vectors and matrices, and basic operations on them. We then move into the fundamental topic of solving system of linear equations and learn the Gaussian elimination algorithm, an idea that pervades the entire course. In the second half of the course, we revisit these ideas in a more abstract way, learning about general vector spaces, linear independence, and the fundamental subspaces associated with a matrix. These ideas are then applied to finding the least squares solution to an inconsistent system of linear equations.

Assessment

Component	Course ILOs tested	Weighting	Team / Individual	Assessment Rubrics
Continuous Assessment				
Tutorials				
Quizzes (5)	All	20	individual	See Appendix for rubric
Mid-term Test				
Short Answer Questions	1-8	30	individual	See Appendix for rubric
Examination (2 hours)				
Short Answer Questions	All	50	individual	See Appendix for rubric
	Total	**100%**		

Formative Feedback

Feedback will be given to you through the continuous assessment quizzes given throughout the course and the weekly problem sets that are covered in tutorial.

Common mistakes on a quiz or in the midterm will be discussed in the provided solution sets.

Learning and Teaching Approach

Lectures (39 hours)	Examples and Explanation: Motivates the concepts in the learning objectives through examples. The general theory and principles are then explained. This also introduces more abstract mathematical reasoning. Problem Solving: Develops competence in solving a variety of problems and gaining familiarity with mathematical proofs.

Tutorial (12 hours)	Examples and Explanation: Motivates the concepts in the learning objectives through examples. The general theory and principles are then explained. This also introduces more abstract mathematical reasoning. Problem Solving: Develops competence in solving a variety of problems and gaining familiarity with mathematical proofs. Peer Instruction: You will work together to gain experience in explaining concepts to others and presenting solutions.

Reading and References

Reading –

Elementary Linear Algebra: Applications Version, Howard Anton, Chris Rorres, Anton Kaul. Wiley, 12th Edition (2019).
ISBN-10: 1119666147

References –

Introduction to Linear Algebra, Gilbert Strang, Wellesley-Cambridge Press and SIAM, 2016 (78-09802327-7-6)

Course Policies and Student Responsibilities

Absence due to medical or other reasons

If you are unable to attend a quiz or midterm due to a medical or other valid reason you should follow the SPMS guidelines for applying for short leave given here:
https://forms.office.com/r/w3G1XF2tVd

No make-up quizzes or exams will be given. If the absence is approved by SPMS then the quiz or exam will be exempted. In the case of a quiz, this means the 20% quiz score will be taken from the average of the remaining quizzes. In the case of the midterm, the 30% midterm weighting will be put on the final.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any

of these terms, you should go to the Academic Integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
Andrew James Kricker (Assoc Prof)	SPMS-MAS-04-18	6513 7458	ajkricker@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course ILO	Readings/ Activities
1	Course info, introduction to vectors	1	Anton-Rorres 3.1
2	Vector operations, dot product	2,3	Anton-Rorres 3.2-3.5
3	Linear equations, Gaussian elimination	4,5	Anton-Rorres 1.1, 1.2
4	Matrix view of elimination, matrix operations	6,7	Anton-Rorres 1.3
5	LU decomposition, matrix inverse	7,8	Anton-Rorres 1.4, 1.5
6	Definition of determinants	9	Anton-Rorres 2.1
7	Computing determinants	10	Anton-Rorres 2.2
8	Finish determinants	10	Anton-Rorres 2.3
9	Vector spaces, subspaces	11,12	Anton-Rorres 4.1, 4.2
10	Independence, basis, dimension	12	Anton-Rorres 4.3-4.6
11	Dimension of 4 spaces, matrix rank	13,14	Anton-Rorres 4.8
12	Orthogonality, projection	14,15	Anton-Rorres 6
13	Least squares approximation	16	Anton-Rorres 6

Appendix 1: Assessment Rubrics

Rubric for Quizzes (20%)

Point-based marking (not rubric based)

Rubric for Mid-term Test (30%)

Point-based marking (not rubric based)

Rubric for Final Examination (50%)

Point-based marking (not rubric based)