Academic Year	2023-24	**Semester**	1
Course Coordinator	Gu Mile		
Course Code	MH2802		
Course Title	Linear Algebra for Scientists		
Pre-requisites	H2 maths or equivalent		
Mutually Exclusive	CE1104/CZ1104/SC1004 Linear Algebra for Computing MH1200 Linear Algebra I MH1201 Linear Algebra II CY1602/RE1021 Mathematics II		
No of AUs	3 AU		
Contact Hours	38 hours (26 hours lecture; 12 hours of tutorial)		
Proposal Date	12 July 2023		

Course Aims

This course aims to support you in acquiring a wider range of mathematical concepts related to vector spaces and linear algebra, while also developing a strong set of mathematical skills for upper-level Physical and Computing Science courses. Through a mathematical approach to problem-solving, you will have the opportunity to develop thinking, reasoning, communication, and modelling skills. Additionally, the course aims to help you connect ideas within mathematics and apply mathematical principles in the context of Physical and Computing Science courses. Ultimately, this course seeks to provide an experience that fosters an appreciation for the rigour and abstraction in the discipline.

Intended Learning Outcomes (ILO)

Upon the successful completion of this course, you (as a student) would be able to:

Basic Vector Operations (BAS)

1. perform simple vector operations (such as vector addition, subtraction and resolving a vector to its components in a given coordinate system) to solve related problems;
2. perform scalar, vector products whenever appropriate to solve related problems (such as determining the projection of a vector on another and calculating the torque of a system of forces);
3. perform scalar, vector triple products whenever appropriate to solve related problems;
4. solve basic problems in analytical geometry using vectors (such as determining distances between point and a line / plane);

Linear Spaces (LS)

5. recall and use the axioms of a linear space to determine if a given set forms a linear space;
6. apply the idea of linear independence to determine whether a given set of vectors is dependent or independent;
7. explain the idea of the space / subspace is spanned by a given set of (basis) vectors and determine if a set of (basis) vectors span a subspace;
8. apply the concepts of norms and inner products to compute for a given pair of vectors and to test if a given pair of vectors are orthogonal;

Linear Transformation and Matrices (LTM)

9. explain the concept of linear transformation, express a linear transformation as a matrix and compute the action of a linear transformation on a vector and a matrix (including the structures of rotation, reflection, scaling, stretching and shearing matrices);
10. perform basic operations on matrices (including basic algebraic operations, matrix multiplication, computing of inverses, determinants and traces of matrices);
11. solve systems of linear equations using techniques such as Gaussian elimination;
12. compute the eigenvalues, eigenvectors of a given square matrix and determine the similarity transformation that diagonalizes the given square matrix;
13. recall the definitions and use the properties of special matrices (such as Hermitian and unitary matrices); and

Applications (APP)

14. apply the techniques from ILO 1 – 13 to solve problems in Physical and Computing Science (such as analysing coupled oscillators and using Markov chains to solve problems).

Course Content

1. Vector Algebra & Analytical Geometry
2. Linear Spaces
3. Linear Transformations & Matrices
4. Eigenvalues and Eigenvectors
5. Applications of Linear Algebra to problems in Physical and Computing Science

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Weighting	Team/ Individual	Assessment Rubrics
1. Final Examination	All LOs	60%	Individual	Point-based marking (not rubrics based)
2. Pre-Lesson Assessments	All LOs	12%	Individual	Point-based marking, automated marking
3. Midterm Test	BAS / LS	28%	Individual	Point-based marking (not rubrics based)
Total		100%		

Formative feedback

[Component 2] Formative feedback is given through discussion within tutorial lessons as well as interactive, computer based online homework.

[Component 3] Feedback is also given after midterm on the common mistakes and level of difficulty of the problems.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Derivation of formulas and demonstrating problem solving (Lecture and Tutorial)	Train students to be independent learners who are able to derive ideas/concepts from first principles and take ownership of their own learning. Help students understand the motivation behind mathematical theorems, definitions and formulas. Develop the train of thought in problem solving and presentation skills in presenting mathematical solutions.
Problem solving (Lecture and Tutorial)	Develop competence in solving linear algebra related problems.
Peer Instruction (Lecture and Tutorial)	Develop communication skills and competence in mathematics, particularly in linear algebra. The students also have an opportunity to work with their peers.

Reading and References

1. David C. Lay and Steven R. Lay, *Linear Algebra and Its Applications*, 5th edition, Pearson, 2015. ISBN-13: 9780321982384
2. Gilbert Strang, *Introduction to Linear Algebra*, 5th edition, Wellesley-Cambridge Press, 2016. ISBN-13: 9780980232776
3. Howard Anton, *Elementary Linear Algebra: Applications Version*, Wiley 10th edition, 2010. ISBN-13: 9780470432051

Course Policies and Student Responsibilities

Students are expected to complete all assigned pre-class assessments before coming to lectures. They are expected to attend all computing labs, and take the mid-term test. Students are expected to take responsibility to understand the course materials, and to seek help when necessary.

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
Gu Mile	SPMS-MAS-05-42	65137175	gumile@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1,2	Vector algebra and vector products	BAS 1,2,3	#
2	Solving problems in analytic geometry using vectors	BAS 4	#
3	Linear spaces and linear independence	LS 5,6	#
4	Subspaces; Basis states and span of a space	LS 7	#
5	Inner products and orthogonality	LS 8	#
6	Linear transformations and matrices	LTM 9	#
7	Matrix algebra and operations	LTM 10	# MT
8	Solving systems of linear equations	LTM 11	#
9	Eigenvalues and eigenvectors	LTM 12	#
10	Special Matrices	LTM 13	#
11-13	Applications in Physical and Computing Science	APP 14	#

MT* Mid-term - to be conducted during regular curriculum time.
Pre/Post-lecture online assignments; Post Lecture tutorial lessons