

Semester 3

Course Specifications: Linear Algebra

Course Title	Linear Algebra
Course Code	MTC211A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Mathematical and Physical Sciences

1. Course Summary

The aim of the course is to introduce the concepts of linear algebra and various algorithms to solve system of linear equations. In this core course the students are taught basic operations of matrices. The course describes vector spaces, its subspaces and span of vectors, the linear dependence and independence of vectors. Matrix representation of linear transformations, Eigen value problems and computation of eigen values are dealt in this course.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After the successful completion of this course, the student will be able to:

- CO-1. Illustrate the principles of matrix theory, vector spaces, linear transformation, inner product spaces and decomposition of matrices
- CO-2. State and prove important theorems in linear algebra
- CO-3. Solve simple mathematical problems in matrix theory, vector spaces, linear transformation, inner product spaces and decomposition of matrices
- CO-4. Apply numerical algorithms to solve linear systems and to decompose matrices
- CO-5. Solve complex real world problems associated with matrix theory, vector spaces, linear transformation, inner product spaces and decomposition of matrices

4. Course Contents

Unit 1 (Review of Matrix Algebra):

(8 hours)

Review of systems of linear equations and Cramer's rule, row reduction and echelon forms, Gaussian elimination and Gauss Jordan elimination. Matrix operations, including inverses and block matrices. Determinants and their properties. LU factorization.

Unit 2 (Vector Spaces):

(22 hours)

Vector spaces, linear dependence and independence, subspaces and bases, dimensions and Span Rank, Rank-Nullity theorem. Linear transformations, Algebra of linear transformations, Isomorphism

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Matrix representation, Linear functional, Annihilator, Double dual, Transpose of a linear transformation.

Unit 3 (Inner Product Spaces):

(10 Hours)

Inner product spaces, Orthonormal bases, Gram-Schmidt process, QR decomposition, Best approximation – Least square solutions, Orthogonal projections, Adjoint operator, Unary operators, Self-Adjoint operators, Normal operators – Spectral theorem.

Unit 4 (Eigen values):

(20 hours)

Characteristic values and characteristic vectors of linear transformations, Diagonalizability, Minimal polynomial of a linear transformation, Cayley-Hamilton theorem, Invariant subspaces, Direct-sum decompositions, Invariant direct sums, The primary decomposition theorem, Cyclic subspaces and annihilators, Cyclic decomposition, Rational and Jordan forms, Singular Value Decomposition.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3	2			2						3		
CO-2	3	2									3		
CO-3	3	2	3		3			2			3		
CO-4	3	2	3		3			2	1	1	3		1
CO-5	3	2	3		3			2	1	1	3		1

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	15
Numeracy		
1. Solving Numerical Problems	15	00
Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	

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72

6. Model Studio	00	00
Others		
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		70

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Sc. (Hons.) (Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (60% Weightage)				Component 2: SEE (40% Weightage)
Subcomponent ►	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Term Test	Assignment	Assignment	
Maximum Marks ►	15	15	20	10	50 Marks
CO-1	x	x			x
CO-2	x	x			x
CO-3	x	x			x
CO-4			x	x	x
CO-5			x	x	x
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment

5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class notes
2. Leon, S. J., 2005, Linear Algebra with Applications, 7th edition, Pearson.
3. Friedberg, S. H., Insel, A. J., and Spence, L. E., 2022, Linear Algebra, 5th edition, Pearson Education India.
4. Kumaresan, S., 2018, Linear algebra: a geometric approach, Prentice-Hall of India.

b. Recommended Reading

1. Strang, G., 2009, Introduction to Linear Algebra, 4th edition, Wellesley-Cambridge Press
2. Trefethen, L. and Bau, D., 1997, Numerical Linear Algebra, SIAM: Society for Industrial and Applied Mathematics.
3. Demmel, J. W., 1997, Applied Numerical Linear Algebra, 1st edition, SIAM.
4. Hoffman K. and Kunze R., 2003, Linear Algebra, Pearson Education (India).

c. Magazines and Journals

1. The College Mathematics Journal, Mathematical Association of America. <https://www.maa.org/press/periodicals/college-mathematics-journal/the-college-mathematics-journal>
2. SIAM Undergraduate Research Online, Society for Industrial and Applied Mathematics, <http://www.siam.org/students/siuro/index.php>
3. Involve – A Journal of mathematics, <https://msp.org/involve/about/journal/about.html>
4. Rose-Hulman Undergraduate Mathematics Journal, Rose-Hulman Institute of Technology. <https://scholar.rose-hulman.edu/rhumi/>

d. Websites

1. <http://nptel.ac.in/>
2. <https://ocw.mit.edu/index.htm>

e. Other Electronic Resources

1. <https://www.khanacademy.org/>
2. tutorial.math.lamar.edu/

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