Department of Mathematics **COURSE OUTLINE**
Bangladesh University of Engineering and Technology

PART A: General Information

1.	**Course Number**	MATH 143
	Course Title	Linear Algebra
	Credit (Contact) Hours	3.0 (3.0)
2.	**Level and Term (Section)**	Level-1, Term-2
	Academic Session	July 2024
3.	**Type of Course**	Core Course
	Offered to	Department of Computer Science and Engineering
4.	**Pre-requisite Course(s)**	None
5.	**Course Website**	https://---.math.buet.ac.bd
6.	**Lecture Schedule**	Xday (00:00-00:00 am) Yday (00:00-00:00 am) Zday (00:00-00:00 am)
7.	**Important Dates**	For important dates and examination schedules and latest updates, please follow the course website

8. Course Teacher(s)

Name (Initials):	Office:	Email:	Consultation Hour(s)
Afroza Akter	Dept. of Math	afrozamath@math.buet.ac.bd	Xday (00:00-00:00 am)
Teacher 2	Dept. of Math	y@math.buet.ac.bd	Yday (00:00-00:00 am)

PART B: Course Details

9. Course Content (As approved by the Academic Council)

Introduction to vectors, their products, matrices and systems of linear equations; Solving linear systems: Gaussian elimination, inverse and transpose of a matrix, factorization into $\boldsymbol{A} = \boldsymbol{LU}$; Vector spaces and subspaces: four fundamental subspaces, solving $\boldsymbol{Ax} = \boldsymbol{0}$ and $\boldsymbol{Ax} = \boldsymbol{b}$, independence, basis and dimension, dimensions of the four subspaces; Orthogonality: orthogonality of the four subspaces, projections, least squares, orthonormal bases and Gram-Schmidt; Determinants: properties, formulas, Cramer's rule, inverses and volumes; Eigenvalues and eigenvectors: eigen decomposition, systems of differential equations, symmetric and positive definite matrices; Singular value decomposition (SVD): bases and matrices in the SVD, geometry of the SVD; Linear transformations: the matrices of linear transformations; Complex vectors and matrices: complex numbers, polar coordinates, Hermitian and unitary matrices; Applications of linear algebra in computer science and engineering.

10. Course Objectives

- To solve systems of linear equations by different methods and demonstrate ability to compute eigenvalues, eigenvectors and factorize a matrix into the products of matrices.
- To learn about linear transformations from $\mathbb{R}^n$to $\mathbb{R}^m$, vector space, subspace, rank and nullity, inner products, their uses and apply to some relevant problems.
- To comprehend the Euclidean n-space, vector spaces, subspaces, linear span, and determine the basis and dimension of vector spaces.

11. Knowledge required

Familiarity with basic properties of matrix and determinants, fundamental concepts of set theory, real and complex number system, and preliminary knowledge of geometry and precalculus.

12. Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Define** the fundamental concepts and methods of Matrix Algebra	PO(b)	C1	Lectures, Homework	Written exams (Quiz / Class Test / Final Exam)
2	**Explain** the idea of Matrix Algebra, Linear system, rank, polynomials, eigenvalues and eigenvectors, space, quadratic problem, basis and dimension, Gram-Schmidt process, QR-decomposition, Linear transformations, Kernel and Range, and Complex vector	PO(a)	C2	Lectures, Homework	Written exams (Quiz / Class Test / Final Exam)
3	**Apply** the idea of Linear Algebra in real- life situations	PO(a)	C3	Lectures, Homework	Written exams (Quiz / Class Test / Final Exam)

*PO (a): Engineering knowledge; PO(b): Problem analysis; PO (c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning.

**The cognitive domain (C) and its Taxonomy Levels (1 to 6) aim to develop the mental skills and the acquisition of knowledge of the individual. The cognitive domain encompasses of six categories which include:

C1- knowledge/remember; **C2-**understand/explain/estimate; **C3-**apply; **C4-**analysis; **C5-**evaluate/judge/verify; **C6-**synthesis/design/create/construct

13. Assessment Strategy

- **Class Participation**: Class participation and attendance will be recorded in every class.
- **Continuous Assessment**: Continuous assessment for any of the activities such as quizzes, assignment, presentation etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- **Final Examination**: A comprehensive term final examination will be held at the end of the term following the guideline of academic council.

14. Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

15. Textbooks

- Advanced Engineering Mathematics by Erwin Kreyszig, Herbert Kreyszig and Edward J. Norminton.
- Elementary Linear Algebra: Applications Version by Howard Anton and Chris Rorres.
- Introduction of linear Algebra by Gilbert Strang.

16. Reference Books

- Theory and Problems of Linear Algebra (Schaum's Outline Series) by Seymour Lipschutz.
- Advanced Engineering Mathematics, S. Chand Publishing, H. K. Dass.
- Matrices and Linear Transformation by Mohammad Iman Ali.

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

17. Lecture Plan

Weekly Schedule for Linear Algebra

Weeks	**Topics**	**COs**
Week-1	Introduction to vectors, their products, matrices and systems of linear equations	
Week-2	Solving linear systems: Gaussian elimination, inverse and transpose of a matrix, factorization into $\boldsymbol{A} = \boldsymbol{LU}$	
Week-3,4	Vector spaces and subspaces: four fundamental subspaces, solving $\boldsymbol{Ax} = \boldsymbol{0}$ and $\boldsymbol{Ax} = \boldsymbol{b}$, independence, basis and dimension, dimensions of the four subspaces	
Week-5	Orthogonality: orthogonality of the four subspaces, projections, least squares, orthonormal bases and Gram-Schmidt	
Week-6,7	Determinants: properties, formulas, Cramer's rule, inverses and volumes	
Week-8	**Class Test**	
Week-9	Eigenvalues and eigenvectors: eigen decomposition, systems of differential equations, symmetric and positive definite matrices	
Week-10	Singular value decomposition (SVD): bases and matrices in the SVD, geometry of the SVD	
Week-11	Linear transformations: the matrices of linear transformations	
Week-12	Complex vectors and matrices: complex numbers, polar coordinates, Hermitian and unitary matrices	
Week-13	Applications of linear algebra in computer science and engineering	
Week-14	**Class Test**	

18. Important University Policies

- Rules and regulations for the undergraduate programmes: https://www.buet.ac.bd/info/Academicinformation/RulesUndergradprogram

Course Outline Prepared by	SAC	
Course Outline Reviewed by		