Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MA0M20A	**Advanced Linear Algebra**	BTECH MINOR S4	3	1	0	4	2020

Preamble: This course introduces the concept of a vector space which is a unifying abstract frame work for studying linear operations involving diverse mathematical objects such as n-tuples, polynomials, matrices and functions. Students learn to operate within a vector and between vector spaces using the concepts of basis and linear transformations. The concept of inner product enables them to do approximations and orthogonal projects and with them solve various mathematical problems more efficiently.

Prerequisite: A basic course in matrix algebra**.**

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify many of familiar systems as vector spaces and operate with them using vector space tools such as basis and dimension.	Apply
CO 2	Understand linear transformations and manipulate them using their matrix representations.	Apply
CO 3	Understand the concept of real and complex inner product spaces and their applications inconstructing approximations and orthogonal projections	Apply
CO 4	Compute eigen values and eigen vectors and use them to diagonalize matrices and simplify representation of linear transformations	Apply
CO 5	Apply the tools of vector spaces to decompose complex matrices into simpler components, findleast square approximations, solution of systems of differential equations etc.	Apply

Syllabus

Module 1

Vector Spaces, Subspaces -Definition and Examples. Linear independence of vectors, Linear span, Bases and dimension, Co-ordinate representation of vectors. Row space, Column space and null space of a matrix

Module 2

Linear transformations between vector spaces, matrix representation of linear transformation, change of basis, Properties of linear transformations, Range space and Kernel of Linear transformation, Inverse transformations, Rank Nullity theorem, isomorphism

Module 3

Inner Product: Real and complex inner product spaces, properties of inner product, length and distance, Cauchy-Schwarz inequality, Orthogonality , Orthonormal basis, Gram Schmidt orthogonalization process. Orthogonal projection. Orthogonal subspaces, orthogonal compliment and direct sum representation.

Module 4

Eigen values, eigenvectors and eigen spaces of linear transformation and matrices, Propertiesof eigen values and eigen vectors, Diagonalization of matrices, orthogonal diagonalization real symmetric matrices, representation of linear transformation by diagonal matrix, Power method for finding dominant eigen value

Module 5

LU-decomposition of matrices, QR-decomposition, Singular value decomposition, Least squares solution of inconsistent linear systems, curve-fitting by least square method, solution of linear systems of differential equations by diagonalization

Text Books

1. Richard Bronson, Gabriel B. Costa, *Linear Algebra-an introduction,* 2nd edition, Academic press, 2007
2. Howard Anton, Chris Rorres, *Elementary linear algebra: Applications versio,* 9th edition, Wiley

References

1. Gilbert Strang, *Linear Algebra and It's Applications,* 4th edition, Cengage Learning, 2006
2. Seymour Lipschutz, Marc Lipson, *Schaum's outline of linear algebra*, 3rd Ed., Mc Graw Hill Edn.2017
3. David C Lay*, Linear algebra and its applications,3rd edition, Pearson*
4. Stephen Boyd, Lieven Vandenberghe, I*ntroduction to Applied Linear Algebra: Vectors, Matrices,and Least Squares,* Cambridge University Press, 2018
5. W. Keith Nicholson, *Linear Algebra with applications*, 4th edition, McGraw-Hill, 2002

Course Contents

No	Topic	No. of Lectures
1	**Vector spaces-** Defining of vector spaces , example, Subspaces, Linear dependence, Basis , dimension, Row space, column space, rank of a matrix, Co ordinate representation	12
2	**Linear Mapping -** General linear transformation, Matrix of transformation, Kernel and range of a linear mapping, Properties of linear transformations, Rank Nullity theorem, Change of basis . Isomorphism	12
3	**Inner product spaces-** Inner Product: Real and complex inner product spaces, Properties of inner product, length and distance, Triangular inequality, Cauchy-Schwarz inequality, Orthogonality, Orthogonal complement, Orthonormal bases, Gram Schmidt orthogonalization process, orthogonal projection, Direct sum representation.	12
4	**Eigen values and Eigen vectors-** Eigen values and Eigen vectors of a linear transformation and matrix, Properties of Eigen values and Eigen vectors, Diagonalization., orthogonal diagonalization, Power method, Diagonalizable linear transformation	12
5	**Applications-** LU decomposition, QR Decomposition, Singular value decomposition, Least square solution, Curve fitting, Solving systems of differential equations	12
	Total hours	60

i) ASSESSMENT PATTERN

Bloom's Taxonomy Level	Continuous Assessment Exams (Marks)		End Semester Exam (Marks)
	CA Exam I	CA Exam II	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

ii) CONTINOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	**10 marks**
CA Exams (2 numbers)	:	**25 marks**
Assignment/Project/Case study etc.	:	**15 marks**
Total	:	**50 marks**

iii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- **Two tests of 50 marks** each (half the syllabus to be covered in each exam – 2 ½ modules)
- Duration – **2 hours**

iv) END SEMESTER EXAMINATION PATTERN

Duration – **3 hours**

Total marks **-100**