King Abdul Aziz University

Faculty of Science / Department of Mathematics

Title: Linear Algebra - Math 241

Course Category: Bachelor

Winter 2020

Instructor: Dr. Jehan A. Al-bar	**Lecture:** CRN - 16527
Office: 3 - 131	**Time:** Sunday, Tuesday 9:00 – 9:50, 13:00 – 13:50
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Course prerequisite: math 251, math 202 and math 203.

Course Overview: Linear algebra is the study of linear systems of equations, vector spaces, and linear transformations. Solving systems of linear equations is a basic tool of many mathematical procedures used for solving problems in science and engineering. In this course you will become competent in solving systems of linear equations, performing matrix algebra, calculating determinants, as well as finding eigenvalues and eigenvectors. Also you will come to understand a matrix as linear transformations relative to a basis of a vector space. In addition you will study the vector space R_n and explore vector spaces more generally by working on examples with polynomials in P_n and continuous functions in $C[a,b]$.

Course goals: After successfully completing the course, you are expected to:

1- Develop abstract reasoning skills.

2- Be adept at matrix computations.

3- Apply reasoning skills in writing proofs and verifying theoretical properties of vector spaces.

4- Apply algebra of matrices to solve system of linear equations in matrix form.

5- Translate a matrix into a system of linear equations.

6- Apply Gaussian elimination & Gaussian elimination with back-substitution to solve system of linear equations.

7- Solve homogeneous system of linear equations.

8- Find the eigenvalues and corresponding eigenvectors of a linear transformation, as well as the characteristic equation and the eigenvalues and corresponding eigenvectors of a matrix A.

9- Determine" inspect" whether a non-empty set W together with addition and scalar multiplication defined on W is a vector space.

10- Write a linear combination of a finite set of vectors in V.

11- Determine "inspect" whether a set S of vectors in a vector space V is a basis of V.

12- Recognize standard bases in the vector spaces R^n, $M_{m,n}$, P_n.

13- Determine "inspect" if a vector space is finite dimensional or infinite dimensional.

14- Find the dimension of a subspace of R^n, $M_{m,n}$, P_n.

15- Find a basis and dimension for the column or row space and a basis for the nullspace of a matrix.

16- Find a general solution of a consistent system AX = b in the form x_p + x_h, where x_p is the solution of AX= b, and x_h is the solution of AX= 0.

17- Determine "inspect" whether a function from one vector space to another is a linear transformation.

18- Find the kernel, the range and the bases for the kernel and range of a linear transformation T, and determine the nullity and rank of T.

19- Inspect whether two vector spaces are isomorphic.

20- Find the standard matrix for a linear transformation and use it to find the image of a vector.

21- Determine whether a linear transformation is invertible and find its inverse if exist.

22- Construct a polynomial whose curve is the best fitting for a number of points in the xy-plane.

23- Setup a system of linear equations to represent the flow through a network composed of several junctions; solve the system to give analysis of this flow.

24- Create a method to encode and decode messages using matrix multiplications.

Course Content:

1- Introduction to solving system of linear equations.

2- Gaussian elimination and Gauss-Jordan elimination.

3- Operation with matrices and properties of matrix operations.

4- The invers of a matrix.

5- The determinant of a matrix.

6- Evaluation of a determinant using elementary operations, properties of determinants.

7- The adjoint of a matrix and Crammer's rule.

8- Vectors in R^2, R^3, and R^n with addition and scalar multiplication.

9- The vector spaces R^n, M_{m,n}, P_n, C[a,b], C(-infinity, infinity), and some nonexamples.

10- Subspaces of vector spaces.

11- Spanning set and linear independence.

12- Basis and dimension.

13- Rank of a matrix and system of linear equations.

14- Coordinate and change of Basis.

15- Linear Transformations; definition, properties, and a linear transformation defined by a matrix.

16- Kernal, range, rank and nullity of a linear transformation, isomorphism of vector spaces.

17- Standard matrix of a linear transformation, standard matrix for composition of linear transformations, and transformation matrix for nonstandard basis.

18- Eigenvalues and eigenvectors, eigenspaces, and finding the eigenvalues/ eigenvectors of linear transformations.

Grading:

Your final grade will be calculated according to the table

Exam 1 & 2	50%
report	10%
Final Exam	40%

Learning Resources:

Required Textbook	Elementary Linear Algebra, Larson & Falvo.
Electronic Materials	Some are available on www.cengage.com
Other Learning Materials	Website MIT Open coursewhere. https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/