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# Linear Algebra (Quickstudy: Academic)

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## Quick Study ACADEMIC

# LINEAR ALGEBRA

### MATRICES

#### MATRICES - SOME DEFINITIONS

- **Matrix:** A rectangular array of numbers (marked with capital letters) called **entries** with the size of the matrix described by the number of rows (horizontal) and columns (vertical); for example, a 3 by 4 matrix (3×4) has 3 rows and 4 columns:  
$$\begin{bmatrix} 3 & -2 & 0 & 6 \\ -1 & 9 & 5 & 0 \\ 0 & -3 & 6 & 3 \end{bmatrix}$$
 is a 3 by 4 matrix.
- **Square matrix:** Has the same number of rows and columns.
- **Diagonal matrix:** A square matrix with all entries equal to zero, except the entries on the **main diagonal** (diagonal from upper left to lower right); for example, this is a **main diagonal** matrix:  
$$\begin{bmatrix} 3 & & & \\ -1 & 2 & & \\ 0 & & -5 & \\ 1 & -2 & & 5 \end{bmatrix}$$
 and this is a diagonal matrix:  
$$\begin{bmatrix} 3 & & & \\ & 2 & & \\ & & -2 & 0 \\ & & & 0 & 1 \end{bmatrix}$$
- **Identity matrix** (denoted by **I**): A square matrix with entries that are all zeros except entries on the main diagonal, which must all equal the number one.
- **Triangular matrix:** A square matrix with all entries below the main diagonal equal to zero (upper triangular), or with all entries above the main diagonal equal to zero (lower triangular).
- **Equal matrices:** Are the same size and have equal entries.
- **Zero matrix:** Every entry is the number zero.
- **Scalar:** A magnitude or a multiple.
- **Row equivalent matrices:** Can be produced through a sequence of **row operations**, such as:
  - **Row interchange:** Interchanging any 2 rows
  - **Row scaling:** Multiplying a row by any nonzero number
  - **Row addition:** Replacing a row with the sum of itself and any other row or multiple of that other row
- **Column equivalent matrices:** Can be produced through a sequence of **column operations**, such as:
  - **Column interchange:** Interchanging any 2 columns
  - **Column scaling:** Multiplying a column by any nonzero number
  - **Column addition:** Replacing a column with the sum of itself and any other column or multiple of that other column
- **Elementary matrices:** Square matrices that can be obtained from an identity matrix, **I**, of the same dimensions through a single row operation.
- **The rank of matrix A**, denoted  $\text{rank}(A)$ , is the common dimension of the row space and column space of matrix A.
- **The nullity of matrix A**, denoted  $\text{nullity}(A)$ , is the dimension of the nullspace of A.

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#### MATRIX OPERATIONS

- **Addition:** If matrices A and B are the same size, calculate  $A + B$  by adding the entries that are in the same positions in both matrices.
- **Subtraction:** If matrices A and B are the same size, calculate  $A - B$  by subtracting the entries in B from the entries in A that are in the same positions.
- **Multiplying by a scalar:** The product of  $kA$ , where  $k$  is a scalar, is obtained by multiplying every entry in matrix A by  $k$ .
- **Multiplying matrices:** If the number of columns in A equals the number of rows in B, calculate the **product AB** by multiplying the entries in row  $j$  of A by the entries in column  $j$  of B, adding these products and placing the resulting sum in the  $j$  position of the final matrix; the final resulting product matrix will have the same number of rows as matrix A and the same number of columns as matrix B.
- **Multiplicative inverses:** If A and B are square matrices and  $AB = BA = I$  (remember I is the identity matrix), then A and B are inverses; the inverse of a matrix A may be denoted as  $A^{-1}$ ; therefore,  $B = A^{-1}$  and  $A = B^{-1}$ , to find the inverse of an invertible matrix A:
  - First, use a sequence of row operations to change A to I, the identity matrix; then,
  - Use these exact same row operations on I; this will result in the inverse matrix  $A^{-1}$  of matrix A.
- **The transpose of A** with dimensions of  $m \times n$  is the matrix  $A'$  of dimensions  $n \times m$  whose columns are the rows of A in the same order; that is, row one becomes column one, row two becomes column two, etc.
- **Orthogonal matrix:** A square, invertible matrix such that  $A^{-1} = A'$ ; that is,  $AA' = AA^{-1} = I$ .
- **Normal matrix:** A square matrix that satisfies  $AA' = AA^{-1}$ ; that is, commutes with its transpose.
- **The trace of a square matrix A** is the sum of all of the entries on the main diagonal, and is denoted as  $\text{tr}(A)$ .

#### COMPLEX MATRICES

- Entries are all complex numbers,  $a + bi$ .
- The **conjugate** of a complex matrix A, entries are all conjugates of the complex matrix A; remember that the conjugate of  $a + bi$  is  $a - bi$  and conversely.
- **Conjugate transpose:**  $A^* = \overline{(A')}$  (notice that  $A^*$  means matrix A was both transposed and conjugated).
- **Hermitian complex matrix:** A if  $A^* = A$ .
- **Skew-Hermitian complex matrix:** A if  $A^* = -A$ .
- If A is a complex matrix and  $A^* = A^{-1}$ , then it is **unitary**.
- A complex matrix is **normal** if  $A^*A = AA^*$ .

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## Synopsis

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## Customer Reviews

BarCharts are a great little reference. I would not recommend them as a study aid, but as a quick reference, they are great! I have used them for Chem, Physics, Electronics and Math. They are great for what they are.

Very handy and has all the basic information needed for the linear algebra class I am taking! Well organized and easy to find the quick reference of information I am looking for working through practice problems and while preparing for the tests!

It contains a lot of information well but it misses a few key topics, such as kernel, null space, and transformations, while including many topics my specific class didn't go over. It mentions null space as part of a definition for another term: it says the nullity of a Matrix is the dimension of the nullspace, but it doesn't go into what a nullspace is.

Awesome product for learning. Carry as you go. made easily to review where ever you go. not to bulky as well.

These study guides are so user friendly and compacted, and gives an example of each section.  
Awesome!

useful information of the high points in a concise form.

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