

# Linear Algebra Homework and Study Guide

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## HOMEWORK PROBLEM SETS ORGANIZED BY LEARNING OUTCOMES

### Test I: Systems of Linear Equations; Matrices

#### Lesson 1

1. **Give examples of linear equations using the definition.**  
Generate at least three examples of linear equations on your own and write them down in a list.
2. **Distinguish linear equations from nonlinear equations.**
  - (a) Which of the following are linear equations in  $x$ ,  $y$ , and  $z$ ?
    - i.  $x^2 - 3y + 5z = 31$
    - ii.  $xyz = 12$
    - iii.  $2x - 3z = -2$
  - (b) Which of the following are linear equations in  $x_1$ ,  $x_2$ , and  $x_3$ ?
    - i.  $2x_1 - \frac{1}{3}x_2 + \sqrt{5}x_3 = 1$
    - ii.  $x_1 = -5x_2 + 7x_3$
    - iii.  $x_1 + x_2^{-1} + 12x_3 = 4$
    - iv.  $x_1 + 5x_2 + x_1x_3 = 8$
    - v.  $x_1^{2/3} + 2x_2 - 4x_3 = 11$
    - vi.  $\pi x_1 + \sqrt{2}x_2 + \frac{3}{5}x_3 = 5^{3/2}$
  - (c) If  $k$  is a real-valued constant, which of the following are linear equations?
    - i.  $x_1 - x_2 + x_3 = \sin k$
    - ii.  $kx_1 - \frac{1}{2}x_2 = 10$
    - iii.  $2^k x_1 + 7x_2 - x_3 = 0$
3. **Write solutions sets to linear equations using standard mathematical notation, including parametric notation for linear equations with an infinite number of solutions.**
  - (a) Find the solution set of the following linear equations.
    - i.  $5x - 7y = 4$
    - ii.  $3x_1 - 5x_2 + 4x_3 = 7$
    - iii.  $3x_1 - 8x_2 + 2x_3 - x_4 + 4x_5 = 0$
  - (b) Find a linear equation in  $x$  and  $y$  that has the general solution  $x = 5 + 2t$ ,  $y = t$ .

An equation of  $n$  variables  $x_1, x_2, \dots, x_n$  is said to be **linear** if it is in the form  $a_1x_1 + a_2x_2 + \dots + a_nx_n = b$  where  $a_1, a_2, \dots, a_n$  and  $b$  are real number constants.

A **linear combination of unknowns for variables** is the weighted sum of the unknowns, each term of which is the product of one real number and one unknown. For example,  $3x + 5y$ ,  $2x_1 - 3x_2 + 5x_3$ , and  $ax + by + cz$  (with  $a, b, c$  real-valued constants) are linear combinations of  $\{x, y\}$ ,  $\{x_1, x_2, x_3\}$ , and  $\{x, y, z\}$  respectively. A linear combination of unknowns set equal to a constant is said to be a **linear equation**. Thus, the following are linear equations:  $3x + 5y = 11$ ,  $2x_1 - 3x_2 + 5x_3 = -3$ , and  $ax + by + cz + d = 0$ .

The **solution set** of a linear equation is a list or description of the numbers that make the linear equation true.

# Linear Algebra Study Guide

**Anthony S. Fauci**



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