# Math 19. Lecture 8
# Vectors

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## 1 The General Equation

We can write the system

$$\frac{dx}{dt} = f(x, y)$$
$$\frac{dy}{dt} = g(x, y)$$

as

$$\frac{d\mathbf{v}}{dt} = \mathbf{F},$$

where

$$\mathbf{v}(t) = \left( \begin{array}{c} x(t) \\ y(t) \end{array} \right) \text{ and } \mathbf{F}(x, y) = \left( \begin{array}{c} f(x, y) \\ g(x, y) \end{array} \right).$$

## 2 Definition of Vectors

A *vector* is a pair of numbers

$$\left( \begin{array}{c} a \\ b \end{array} \right).$$

The numbers $a$ and $b$ are called *components*.

# 3 Vectors as Functions

We can talk about vector functions such as

$$\mathbf{v}(t) = \left( \begin{array}{c} x(t) \\ y(t) \end{array} \right).$$

We can integrate and differentiate such functions by integrating and differentiating their components.

# 4 Functions of Vectors

We can think of of $f(x, y)$ as $f(\mathbf{v})$.

# 5 Operations with Vectors

- *Adding Vectors.*

- *Scalar Multiplication.*

- *The Dot Product Measures Lengths and Angles.*

# 6 Vectors with Three Components

# Homework

- Chapter 7. Part 1: Exercise 1; Part 2: Exercises 1, 2, 3, 4, 5, 6; pp. 125–126.

# Reading and References

- C. Taubes. *Modeling Differential Equations in Biology.* Prentice Hall, Upper Saddle River, NJ, 2001. Chapter 7.