

Welcome! M408L, Spring 2010. Integral Calculus.

1st day handout: <http://www.ma.utexas.edu/courses/m408L/handout.php>

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Lectures MWF 3-4p, WRW 102. [Begin at 3:00, end at 3:50 ± 2 min.]

Discussion TTh 56585 2-3p WRW 113
 56590 3:30-4:30p RLM 5124
 56595 5-6p RLM 5.116

Office hours: me MF 1:30-2:30p RLM 9.134
 James MW 11:00a-12:30p RLM 10.146

Broadly the same format as 408K:

- Homework via QUEST at <https://quest.cns.utexas.edu/> 10%
 Due 3am each Mon night/Tue morning
 One extra review assignment, due 3am Friday Jan 29
 Worst 3 (of 15) dropped in grade
 Working together strongly recommended!
- 3 midterm exams (2hr, evening) 60%
 Feb 23, Apr 6, May 4
- Final exam 30%
 Date unknown until late in the semester!
 Could be anytime during the exam period.

Significantly harder than 408K ⇒ Have to work harder to get the same grade.

Many resources available: Office hours
 UT Learning Center (Jester A332A)
 Your fellow students!

Textbook

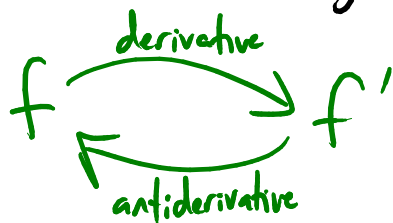
Slides available at <http://www.ma.utexas.edu/users/neitzke>
(+ on Blackboard, soon)

Antiderivatives

Recall the derivative: $f(x) \rightsquigarrow f'(x)$

- Examples:
- $f(x) = x^2 \rightsquigarrow f'(x) = 2x$
 - $f(x) = \sin(x^3) \rightsquigarrow f'(x) = 3x^2 \cos(x^3)$

Suppose we wanted to "go backwards":



Definition: $F(x)$ is an antiderivative of $f(x)$ if $F'(x) = f(x)$.

Any function $f(x)$ has many antiderivatives!

- Ex: $f(x) = x$ has antiderivatives $F(x) = \frac{1}{2}x^2$
 $F(x) = \frac{1}{2}x^2 + 7$
 $F(x) = \frac{1}{2}x^2 - 32$
 \vdots

To get all possible antiderivatives of $f(x)$, first find one particular antiderivative, and then add an arbitrary constant. (usually called C)

- Ex:
- $f(x) = \cos x$ has general antiderivative $F(x) = \sin x + C$
 - $f(x) = x^n$ " " " $F(x) = \frac{1}{n+1}x^{n+1} + C$

EXCEPT
when $n = -1$

Build more complicated examples from these simple ones:

$$f(x) = 9x^2 + 6x^{3/2} - \frac{2}{x^4} + \cos x$$

has general antiderivative

$$F(x) = 9\left(\frac{1}{3}x^3\right) + 6\left(\frac{1}{5/2}x^{5/2}\right) - 2\left(\frac{1}{-3}x^{-3}\right) + \sin x + C$$
$$= 3x^3 + \frac{12}{5}x^{5/2} + \frac{2}{3}x^{-3} + \sin x + C$$

$$\frac{1}{x^4} = x^{-4}$$

• $f(x) = \cos 2x$ has general antideriv

$$F(x) = \frac{1}{2} \sin 2x + C$$

• Is $F(x) = \frac{4}{3} \ln(1+3x)$ an antiderivative of $f(x) = \frac{4}{1+3x}$?

$$F'(x) = \frac{4}{3} \cdot \frac{1}{1+3x} \cdot 3 = \frac{4}{1+3x} \quad \text{— YES}$$

Sometimes we don't want the most general antideriv, we want some specific one:

• What is the function $f(x)$ which has $f'(x) = 4x+7$?
AND $f(1) = 6$

$$\text{Since } f'(x) = 4x+7, \quad f(x) = 2x^2 + 7x + C$$

$$\text{Since } f(1) = 6,$$

$$2+7+C = 6$$

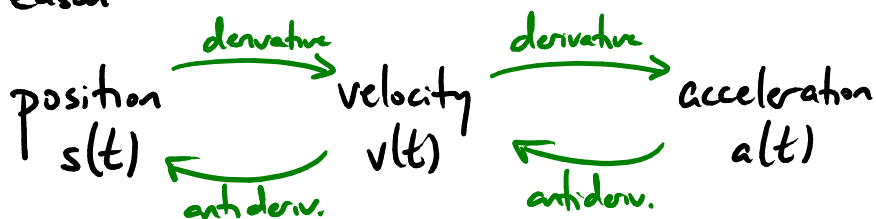
$$9+C = 6$$

$$C = -3$$

$$\text{So } \underline{f(x) = 2x^2 + 7x - 3}$$

Why care about antiderivatives?

A Standard reason:



- A train accelerates with constant accel. $a(t) = 4 \text{ ft/s}^2$
At time $t=0$ it has velocity $v(t=0) = 100 \text{ ft/s}$
and position $s(t=0) = 0 \text{ ft}$.

How far does it go in 20 s? $s(t=20 \text{ s}) = ?$

$$a(t) = 4$$

$$\left. \begin{array}{l} v(t) = 4t + C \\ v(t=0) = 100 \end{array} \right\} \Rightarrow C = 100$$

$$\text{so } v(t) = 4t + 100$$

$$\left. \begin{array}{l} s(t) = 2t^2 + 100t + D \\ s(t=0) = 0 \end{array} \right\} \Rightarrow D = 0$$

$$\text{so } s(t) = 2t^2 + 100t$$

$$\text{so } s(t=20) = 2(20^2) + 100(20) = \underline{\underline{2800 \text{ ft}}}$$