

MAT 1120: Calculus and Analytic Geometry II

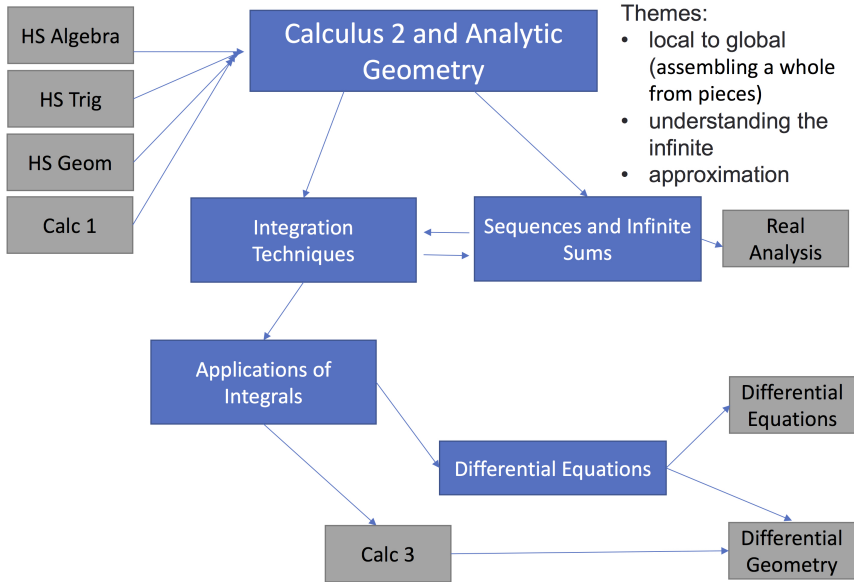
Compute the following (get it?):

1) definite integral FTC: $\int_0^{Ice} 3x^2 dx$

2) indefinite integral: $\int \frac{1}{cabin} d(cabin)$



Many big questions are answered by taking many small steps...
plus a constant



- Themes:
- local to global (assembling a whole from pieces)
 - understanding the infinite
 - approximation

Chapter 7: Integration Techniques

An algebraic formula for an antiderivative of $f(x)$ enables us to evaluate the definite integral $\int_a^b f(x)dx$ exactly in real-life applications, so how can we begin to find algebraic formulas for antiderivatives of more complicated algebraic functions?

- finance: portfolio optimization
- chemistry: rate of reaction
- physics: mechanics
- cs and engineering: machine learning (ex: proportional integral derivative controller)
- geology: radioactive age equation, heat flow

7.1 Substitution (Undoing the Chain Rule) w-sub/u-sub

- Chain rule: $\frac{d}{dx} f(g(x)) = f'(g(x)) \cdot g'(x)$
- Try to find w so that dw is in \int
- Often helpful to choose w “inside” of some other function
- You can always check an antiderivative by differentiating

What I want you to show me... w , dw , \int with respect to w



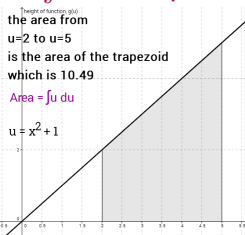
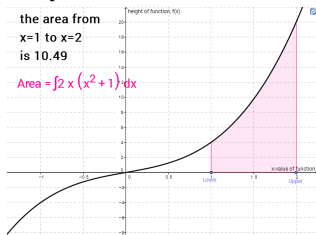
It's hard getting dumped by a mathematician.



7.1 Substitution (Undoing the Chain Rule)

- Try to find w so that dw is in \int
- Often helpful to choose w “inside” of some other function

What I want you to show me... w , dw , \int with respect to w



- An algebraic substitution of variables changes a complicated integral into a simpler one
- We must change the differential correctly— $\int f(w) dx$ is nonsensical—and careful of the limits of integration

Clicker Question: Guess the Substitution, if it Exists

- Try to find w so that dw is in \int
- Often helpful to choose w “inside” of some other function

Clicker 1. Can substitution be used for $\int \frac{1}{x \ln(x)} dx$?

- a) yes, let $w = \frac{1}{x}$
- b) yes, let $w = \ln(x)$
- c) no
- d) other

Clicker Question: Guess the Substitution, if it Exists

- Try to find w so that dw is in \int
- Often helpful to choose w “inside” of some other function

Clicker 2. Can substitution be used for $\int \frac{\sin(x)}{x} dx$?

- a) yes and I see how
- b) yes but I'm not sure how
- c) no but I'm not sure why
- d) no and I see why

Clicker Question: Guess the Substitution, if it Exists

- Try to find w so that dw is in \int
- Often helpful to choose w “inside” of some other function

Clicker 3. Can substitution be used for $\int x \sin(x^2) dx$?

- a) yes, let $w = x$
- b) yes, let $w = x^2$
- c) yes, let $w = \sin(x^2)$
- d) no
- e) other

Clicker Question

- Try to find w so that dw is in \int
- Often helpful to choose w “inside” of some other function

Clicker 4. Which of the integrals can we do by substitution?

a) $\int \frac{e^x - e^{-x}}{(e^x - e^{-x})^3} dx$

b) $\int \frac{\sin(x)}{x} dx$

- c) Both of the above
- d) None of the above