

Slope Failures and Integration



Subject area: Calculus or AP Calculus

Grade levels: 11th and 12th grade

Objective and summary:

This unit took the traditional unit on integration from the AP standards and gave it more meaning by looking at the concepts through the idea of slope failures and rainfall data. This unit will look at the concepts of: Riemann sums, Area under a curve, Definite and indefinite integrals, Properties of definite integrals, Fundamental Theorem of Calculus, Average value of a function, and Area between two curves. The hope is that students will gain a stronger connection to the material by having it be connected to a real-life problem. This connection also gives a chance to include some hands-on learning and discovery-based learning.

Connections to Civil Engineering:

This unit is focused around the idea of slope failures. A slope failure is when the structural strength of the soil fails. We will talk about a couple different conditions that are associated with slope failures and their impact.

Keywords:

Slope failure, Riemann Sums, Integration, Integrals, FTC, Area under a curve

National Standards:

- All these standards are from the AP Calculus standards from the College Board
- Approximating areas with Riemann sums
- Interpreting the behavior of accumulation functions involving area
- Finding antiderivatives and indefinite integrals: basic rules and notation
- Riemann sums, summation notation, and definite integral notation
- The fundamental theorem of calculus and definite integrals
- Applying properties of definite integrals
- Finding the average value of a function on an interval
- Finding the area between the curves expressed as functions of x
- Integration using substitution

Pacing Guide:

Lesson 1: Area under a curve – 2 to 3 days

Lesson 2: The antiderivative – 1 day

Lesson 3: Indefinite and Definite Integrals - 2 days

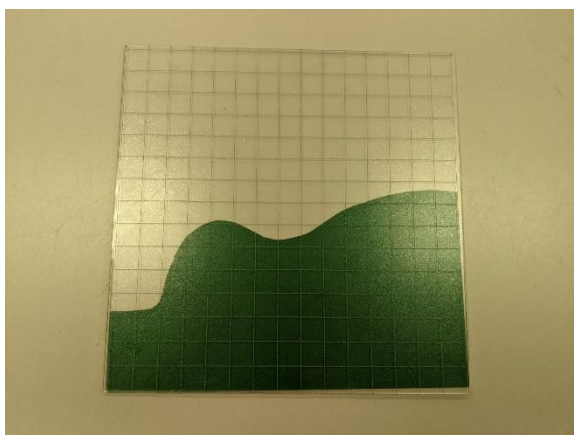
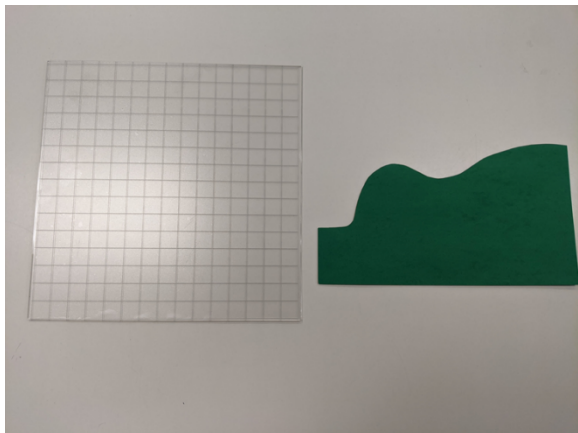
Lesson 4: Properties of Definite Integrals and further application of FTC – 2 to 3 days

Lesson 5: Area between curves – 1 day

Lesson 6: Advanced integration using substitution and the 2nd FTC – 2 to 3 days

Required Resources:

In the activities you will need to create some physical graphs and a way to measure them. You could just use printed pictures of graphs but having something more physical will help create that difference from a normal lesson. I created graphs using craft foam and a measuring device from taking clear acrylic and putting a coordinate grid on it. Another visual I created was using two clear containers with equal amount of soil in each to demonstrate the average value of a function. The use of a graphing calculator will be used on a couple of the days. See pictures below of what I used.



Picture of craft foam and acrylic coordinate grid

Picture of the two soil containers demonstrating average value of a function

Contributors/Author: Ryan Wenaas

Acknowledgements:

This curriculum was developed under National Science Foundation RET grant # 1953102. However, these contents do not necessarily represent the policies of the National Science Foundation, and you should not assume endorsement by the federal government.