NHERI

Natural Hazards Engineering Research Infrastructure

ATLSS Engineering Research Center – Lehigh University

Summary: Introduction to basic concepts in calculus and their applications.

Engineer Connection: Calculus is integral to any engineering discipline. Areas of application include structural vibrations, fluid dynamics, solid mechanics, and more.

Audience: Highschool (9-12)

Lesson Objectives:

1) Introduce concepts from differential calculus.
2) Understand applicability through ramp-and-ball experiment.
3) Learn to apply concepts in other areas of physics and engineering.

Educational Standards:

- Mathematical Standards
  - **Number and quantity**
  - Functions
  - Modeling
- F = ma
  https://www.nextgenscience.org/pe/hs-ps2-1-motion-and-stability-forces-and-interactions

Material List:

- Ball and a ladder or a stack of books, ramp
- Timer
- Tape Measure/Ruler
- Calculator
- Pen and Paper
- Scale
- Snacks!

Introduction: This lesson motivates the fundamentals of differential calculus in engineering applications. A historically relevant experiment conducted by Galileo is recreated. By rolling a ball down an inclined plane, making relevant measurements, and carrying out basic calculations, students will gain insight into the relationship between an object's position, velocity, and acceleration. The lesson concludes with a discussion of gravity and its relationship to an object acceleration.

Procedure:

- Background – equations of motion
- Before – Galileo and history, position-time, velocity-time, and acceleration-time graphs
- During – Measurements (length, time, etc.)
- After – Basic calculations (average velocity, acceleration, etc.)

Assessment: Students will be provided with a short quiz of word problems similar to the one discussed. Problems will be both conceptual and calculation based.

Wrap-up: The lesson will conclude with a recap of discussed material and the brainstorming of other areas the calculus techniques developed could be applied. Students will then share their ideas with the group.