

Week 1

### Challenge 3

ECE 510

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Use the power of the internet and of LLMs to identify a physical system that solves differential equations inherently, through its physical properties, without executing instructions as a traditional processor does.

#### Differential Analyzer (DA)

A Differential Analyzer (DA) is a mechanical machine that solves differential equations by using moving parts to physically model how the solution changes over time. Before digital computers existed, we used machines to solve complex equations, DAs showing how solutions to equations behave, because you can see the math happening through the machine's motion.

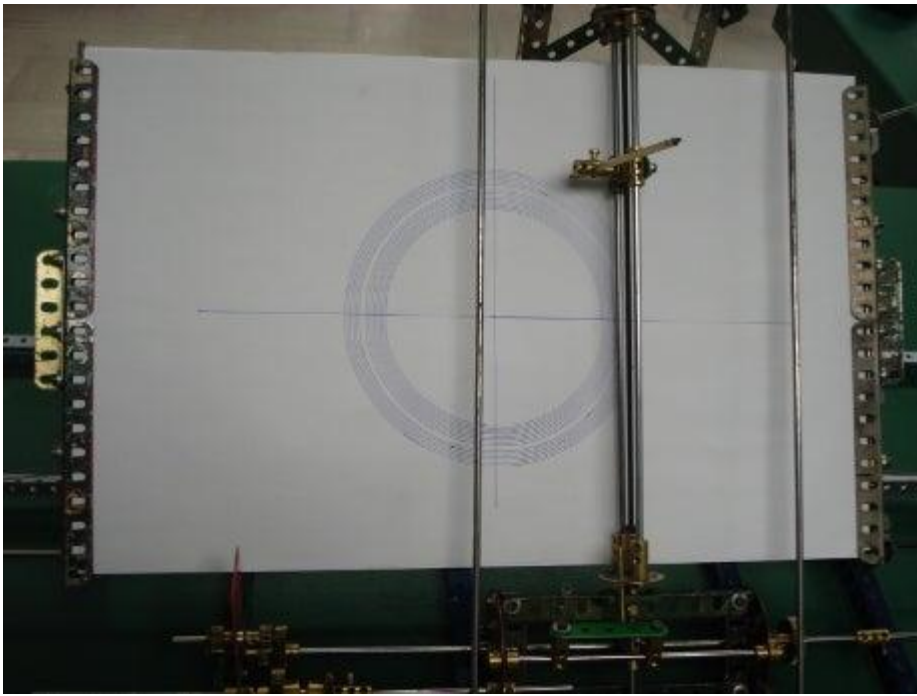
The most important part of a DA is called the integrator. It takes in something that represents a changing quantity (like a speed or rate) and produces something that shows the total change over time (like a distance). The more integrators a DA has, the more complex equations it can solve. For example:

A DA with two integrators can solve one second-order equation (like motion with acceleration), or two first-order equations (like velocity and position together). A DA with four integrators can handle even more – like two second-order equations at once, or a second-order equation that's being driven by another second-order process.

A Differential Analyzer lets us watch equations come to life through gears and wheels, making abstract math easier to understand by turning it into real movement.



Differential Analyzer, nicknamed "Lizzie"



**Output consists of a plot of a solution drawn on paper**

Reference: <https://www.marshall.edu/math/research/differential-analyzer/>