UNIVERSITY OF MASSACHUSETTS LOWELL
DEPARTMENT OF MATHEMATICAL SCIENCES
MATH 4750
UPDATED PROPOSAL FOR SENIOR SEMINAR

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REVISION 1

1. Background

Scientists express physical laws of the universe in the language of differential equations. The reason for this is not immediately obvious, though my personal work with differential equations has provided me with an intuition as to why. Fortunately for me, one scientist describes three necessary properties of a physical law that are satisfied by a differential equation as:

- "The mathematical relation must be sufficiently general"
- "It must define connections between neighboring points"
- "It must imply the continuity of change"[Siddiqui, 2014]

Differential equations satisfy all three of these properties since they are general enough that changes to the initial values of a system do not violate the constraints defined by a general solution and the relationship between a function and one or more of its derivatives defines the connection between points in the domain of the function and implies that change in the system is continuous due to the nature of calculus.

2. Proposal: Verification of physical laws

For my senior seminar project, I propose a study of the differential equation describing a physical law by way of verification using hardware sensors for the Raspbery Pi computer.

Specifically, I plan to verify Newton's law of cooling using a sensor such the DS18D20, a waterproof temperature sensor compatible with the Raspberry Pi. These sensors are relatively innexpensive, with a 5 pack selling for $12.98 on Amazon [Gikfun, 2020].

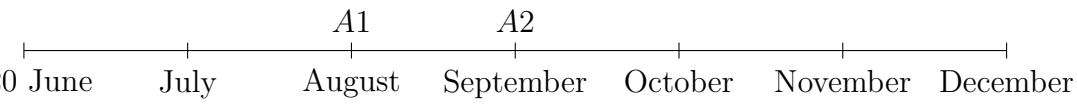

FIGURE 1. Proposed timeline for this project

Newton's law of cooling states that "the rate of heat loss of a body is directly proportional to the difference in the temperatures between the body and its surroundings" [Wikipedia, 2020].

If we let $T : \mathbb{R} \to \mathbb{R}$ be the temperature of some body at a time t and let A be the ambient temperature surrounding the body, we have that equation 1 describes Newton's law of cooling.

$$\frac{dT}{dt} = -k(T - A) \text{ for some } k \in \mathbb{R} \tag{1}$$

I will determine the value of k relative to a particular environment by experimentation.

3. Timeline

I propose a timeline for this project in figure 1 in the same manner as I propose the timeline for my larger honors project to which this mathematical project is related [Savitz, 2020].

3.1. **Essential goals.**

A1. Verification of Newton's law of cooling
A2. Submission of archivable document describing this work

References

Shabnam Siddiqui. Why are differential equations used for expressing the laws of physics?, 2014.

Gikfun. Amazon.com: Gikfun ds18b20 temperature sensor waterproof digital thermal probe sensor for arduino (pack of 5pcs) ek1083: Computers & accessories, 2020. (Accessed on 06/25/2020).

Wikipedia. Newton's law of cooling - wikipedia. `https://en.wikipedia.org/wiki/Newton%27s_law_of_cooling`, 2020. (Accessed on 06/25/2020).

Joel Savitz. rpi_plan/plan.pdf at master · underground-software/rpi_plan. `https://github.com/underground-software/rpi_plan.git`, 2020. (Accessed on 06/25/2020).