Using Electrical and Mechanical Systems to Observe Motion of an Object

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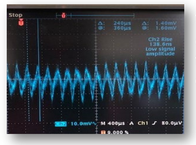
Summary

The beginning activity was to learn how to measure the frequency of a tuning fork (converting a mechanical signal to an electrical signal). This task was done by coming up with a simple circuit that uses a microphone to interpret the frequency and sound coming from a tuning fork. This circuit was to be connected to an oscilloscope in order to see the waveform being generated by the tuning fork. The next goal was to do the opposite (reverse piezoelectric effect) and go from an electrical system (electrical energy) to a mechanical system (mechanical energy). A logic gate is a simple building block of a digital circuit, which usually has two inputs and one output. Logic gates are how hardware works. There are three gates that can be used for every design, they are the NOT (inverse), AND (A·B=C or 1·1=1), and OR (A+B=C) gates. Boolean uses true and false or 1's and 0's. CodingBat and scratch were used to introducing coding since Vivado was not able to be installed on many laptops. Scratch is a website that allows its users to create, program, and interact with stories, games, and animations. Scratch seems like a great program to introduce young students, and have them be actively engaged and having fun playing a game while still learning. CodingBat is a website that allows it users practice coding problems in Java and Python. Scratch has several already made interactives that I can use to show simulations of certain physics topics. A protocol is a standard set of rules that allow electronic devices to communicate with each other. Some of these rules can be what type of data may be transmitted, what commands are used to send and receive data, and how data transfers are confirmed. This can be translated into the classroom by relating how a protocol is a standard set of rules that allow electronic devices to communicate with each other can be similar to how there are rules and laws in physics. In order for mechanical and electrical systems to work and communicate properly that have to obey certain rules.

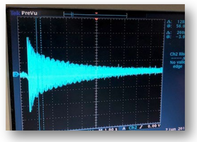
Research Activities

Created simple circuit that uses a microphone to interpret the frequency and sound coming from a tuning fork.

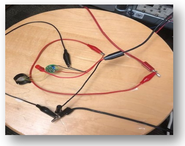


The waveform created by the tuning fork on the oscilloscope.

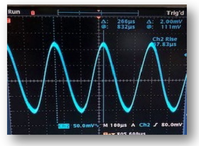
The piezoelectric sensor was taped to down to the tuning fork at the bottom (where max pressure/ strain occurred).



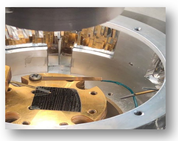
Results using piezoelectric setup.



A feedback circuit setup used to find the resonance frequency by using the signal generator.



Room temperature 23°C resonance frequency.



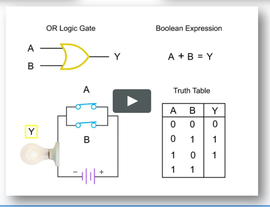
Vacuum chamber with MEMS device.

Enlarged MEMS image from the microscope

Network Analyzer used to observe the frequency change

	4	2	1
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1

Binary notation (base 2) is used similar to an ON/OFF switch.



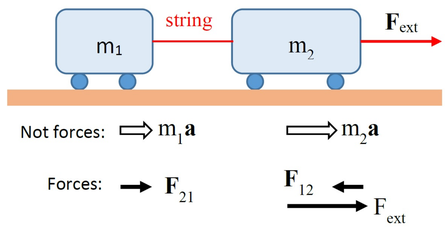
Logic gates are how hardware works. Logic circuits allows for the combinations of ON's and OFF's to get either an ON or OFF signal.

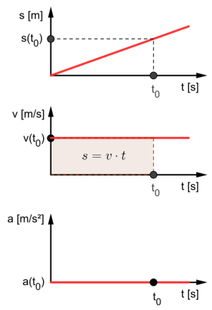
Lesson Plan

It is important to know how things work. Physics like engineering helps to try to explain that. Many things work together (mechanical and electrical systems) to deliver a desirable outcome. Applying the concept of logic gates to properties that the students cans visualize (motion) helps to reinforce the concepts.

- Learning Goals
  - Qualitatively and quantitatively explore the relationships among position, velocity, and acceleration.
  - Interpret diagrams of motion in terms of the x and y components of time, position, velocity, and acceleration.

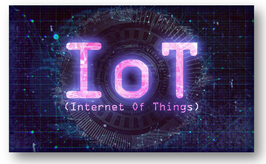
- Instructional Activities and Strategies
  - Setting goals or objectives
  - Summarizing & Note Taking – students will be introduced to the new topic with guided notes.
  - Reinforcing Effort/Providing Recognition – students will reinforce their new knowledge on the topics by competing an online Canvas assignment where they can use their guided notes as reference.
  - Generating & Testing Hypotheses - students will do two labs on motion. One lab the students will calculate the results with by hand, and another lab they will use the calculations interpreted by the Bluetooth devices on the lab equipment. The results will be compared and they will come up with their own conclusions about the advantages (or disadvantages) of using Bluetooth sensors.
  - Cooperative Learning – students will work in groups on Quizlet Live and use their new knowledge to relate velocity and acceleration with the same concept that is used for Logic Gates.
  - Provide opportunities for student practice – lastly students will do a Kahoot! (online multiple choice game) as a review of their material for their post test.





Lesson Learned and Assumptions

I feel as if I have gained much from this RET Site program. I thoroughly enjoyed and thought it was very useful and helpful being the MEMS sensor group. I teach both AP Mechanics and E&M. It gave me great ideas of how to show how these two topics and interrelated and work well together. I also had a fun time learning how to code and about the binary system, and logic gates. Every new coding practice example seemed like a new puzzle that needed to be completed and I feel that I will have students that have the same enthusiasm as well. Lastly we ended with the Raspberry PI. I still want to learn more about these, they seem like they can be a very useful and helpful tool once I have more practice.



Implementation Strategy

- Have students perform an experiment in reverse. Once they feel comfortable and confident of performing an experiment one way (mechanical to electrical system response), then have the student to try to think of way to of how the experiment can work or performed in the reverse way (electrical to mechanical system response). This is also a great way to show that the two systems are interrelated and connected. It will connect the knowledge for my honors physics students from the first semester to the second, and for my AP students the transition from AP Mechanics to AP E&M.
- Relating the binary base 2 system to physics. Using derivatives and integrals for AP students. For example a position function is given, the derivative is taken if it is zero than the velocity is zero. It would be a great project for students to be given a position function, and then have to take the derivatives to find their velocity and acceleration equations. Then they would be given different values to plug into their equations and see when motion of an object would or would not be produced.
- They would then relate their findings to logic gates and how they can use the logic gates to help reinforce certain laws in physics.

physics

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