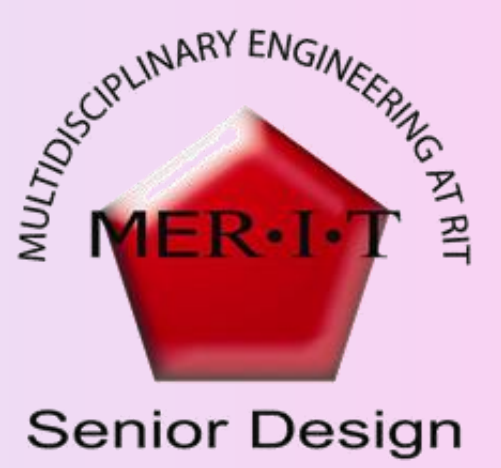




P14361: Engineering Applications Lab



PROJECT OBJECTIVE:

Design and create two laboratory modules that will be used in course MECE-301 Engineering Applications Laboratory. The modules will be used to teach the concepts of engineering analysis, practical experimentation, and introduce the students to new areas of engineering by providing a set of advanced investigative scenarios that will be simulated by theoretical and/or computational methods, and then characterized experimentally.

KEY CUSTOMER DESIGN REQUIREMENTS:

- Safe and robust
- Portable and stand alone
- Include multiple areas of analysis for students
- Provide a high level of flexibility, allowing for many engineering opportunities
- All modules produced in this project should be usable with standard engineering software and data acquisition capabilities.

RAILGUN MODULE

Concept:

The railgun module is an energy conversion system that provides students with an understanding about the use of electric potential energy to produce an electromotive force on a physical object.

Equations:

Biot-Savart Law **Lorentz Force Law** **Capacitor Stored Energy**

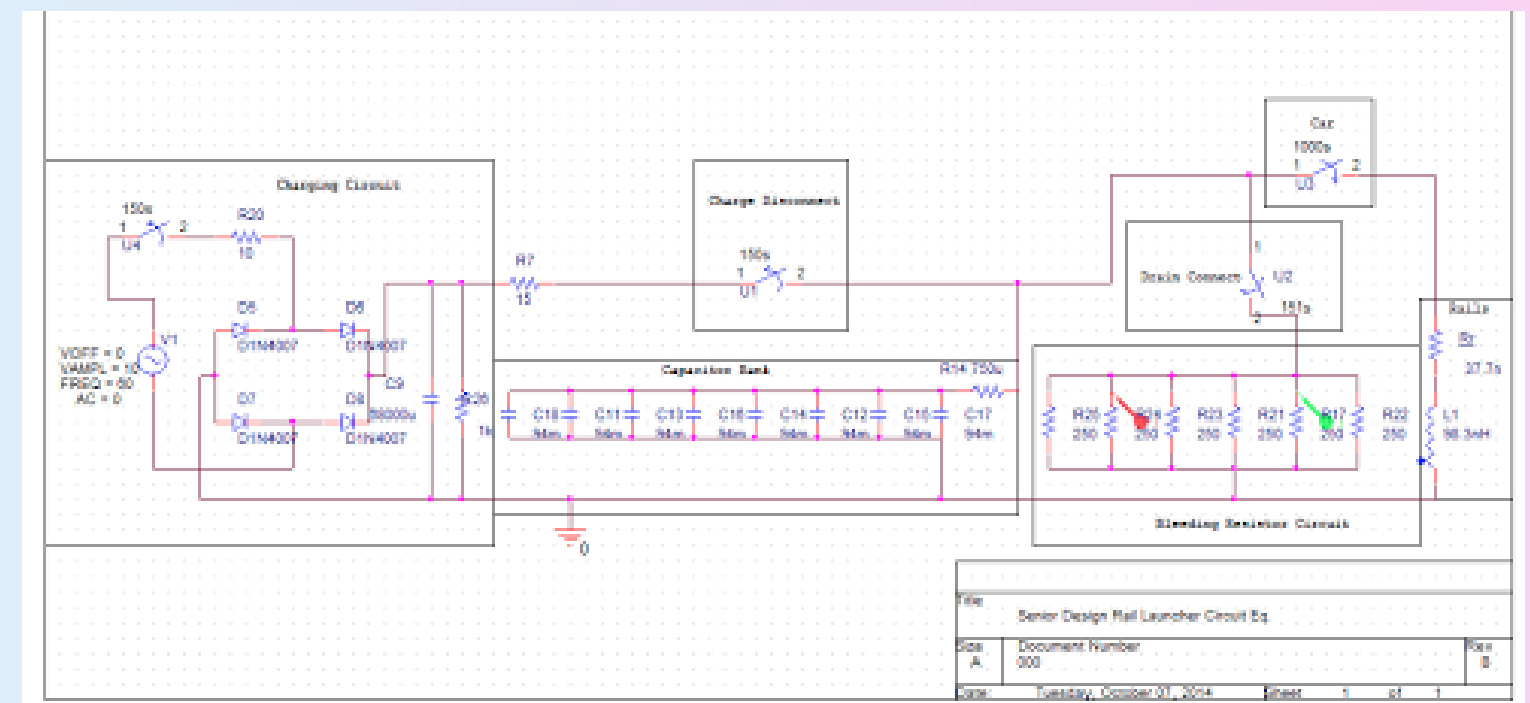
$$B(s) = \frac{\mu_0 I}{2\pi s} \quad F = IdB \quad W = \frac{1}{2} CV^2$$

How It Works:

The electrical energy would be stored in a capacitor bank that consists of multiple axial can electrolytic capacitors. The energy that is stored in the capacitor bank is then transferred through two parallel copper rails and metallic armature. The armature/projectile is used to bridge the gap between the two rails discharging the energy in the capacitor bank. The discharge of energy generates magnetic fields around the rails and armature as the armature slides through causing an electromotive force to be felt on the armature.



Team Members (front): Jennifer Leone (IE), Angel Herrera (EE), Larry Hoffman (EE), (back) Dirk Thur (ME), Saleh Zeidan (ME), and Henry Almiron (ME)



Electrical Circuit Schematic of Railgun



Enclosure with Railgun Components

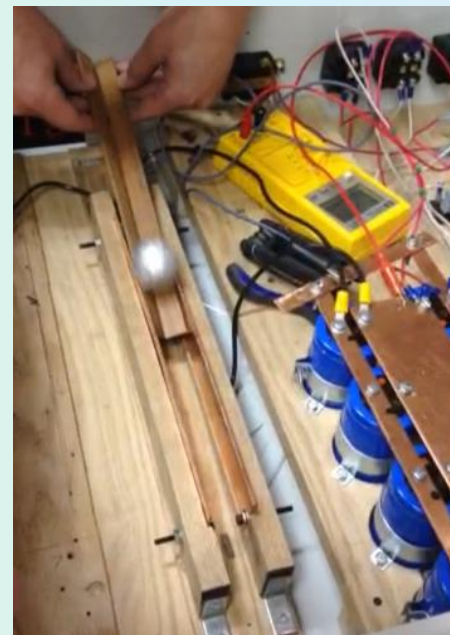
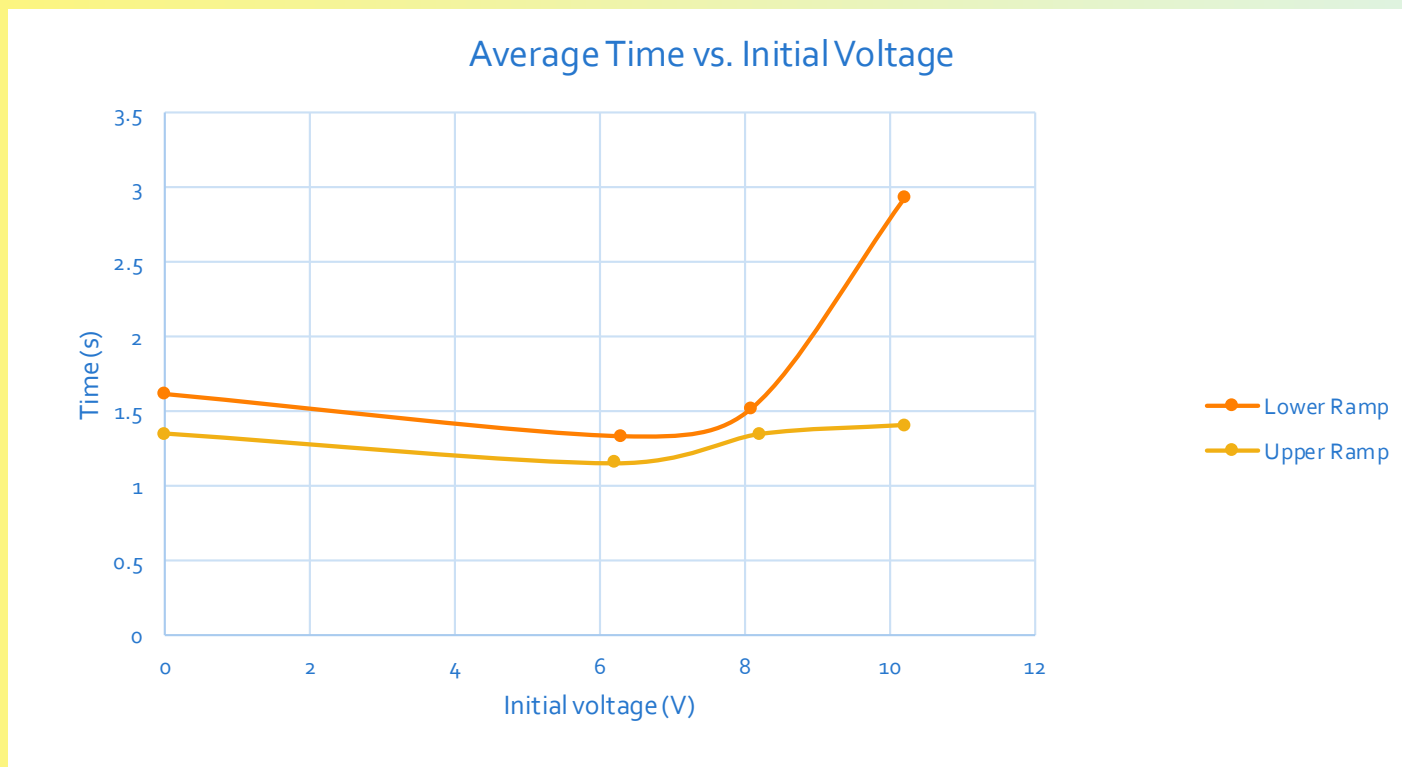


Table: Displays Projectile Movement Through Rails

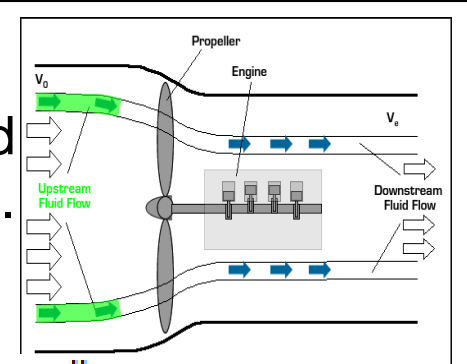


Students are able to setup laptop to gather data (left), Propeller enclosure (middle), Wiring of batteries (right)

THRUST MODULE

Concept:

Propeller efficiency and design can be simulated, tested and compared for efficiency and output thrust produced.



Simplified Thrust Derivation:

Dynamic Thrust: where ρ = density, d = the diameter of the propeller, V_e = exit velocity of the air, and V_a = the velocity of the aircraft

$$Thrust_{dynamic} = \rho \frac{\pi d^2}{4} (V_e^2 - V_a^2)$$

For static thrust assume $V_a=0$ and V_e is the pitch speed of the propeller (V_{pitch}) where:

$$V_{pitch} = RPM * pitch$$

Thus the equation for static thrust is:

$$Thrust_{static} = \rho * \frac{\pi * d^2}{4} * (V_{pitch})^2$$

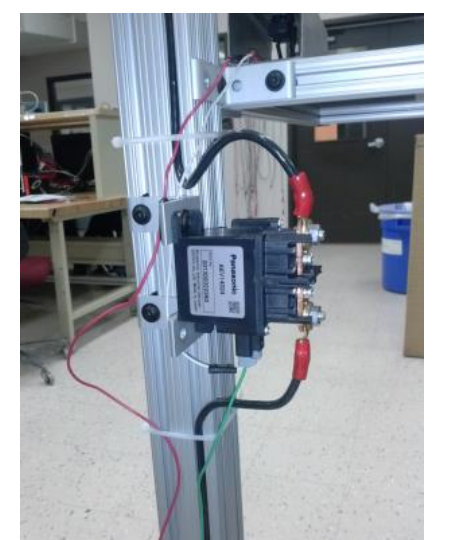
How It Works:

Theoretically

•The rotation of the propeller in a fluid creates a pressure difference between the forward and rear surfaces of the propeller's blades, which causes the fluid to accelerate behind the blade.

Module

•LabVIEW software and a Data Acquisition Device will drive a motor and propeller set up, and a load cell will read the resultant thrust.



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