CubeSat Club Meeting 10/21/2010

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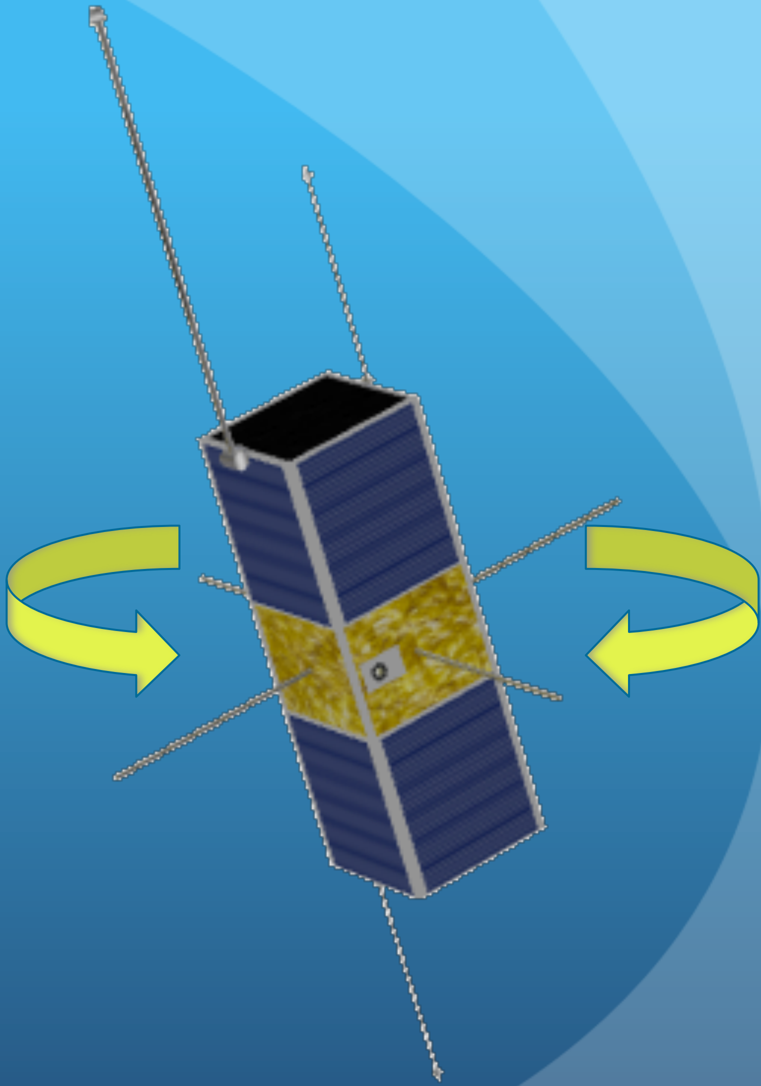
Last Week

- Attitude Control
- Electricity
- Magnetic Torquers



Electricity

- Electricity = flow of electrons
- Voltage (V)= difference in charge between points
- Current (I)= measure of the flow
- Resistance (R)= difficulty of flow through material
- Power (P)= rate of energy transfer

$$V=IR$$

$$P=IV$$

Magnetic Torquer

- Running a current through it gives our CubeSat a magnetic field
- CubeSat magnetic field interacts with Earth’s magnetic field
- CubeSat rotates into the right position
- If we are using our reaction wheels then the magnetic torquer slows down the wheels
  - We’ll learn about reaction wheels in 2 weeks!

Magnetic Torquer

- Produces a torque that can be described using a VECTOR
- Right-hand rule
- Magnitude and direction of our torque depend on:
  - Current vector: our current's magnitude and direction
  - Number of times wire is wound around the torque rod (N)
  - Demagnetization factor (N_d): dependent on rod geometry

$$\tau = \frac{\pi r^2 N I}{\frac{1}{\mu_r} + N_d}$$

Today

- Problem-Solving Tips
- Our Torquer Design
- Testing!

Problem-Solving

- Converting Units
- Using Multiple Equations
- Keeping Track of Variables

Unit Conversion

- Before starting a problem, convert units that are not in standard SI form!
- 3500 mm = ___ m?
  - $3500 \text{ mm} \times \dfrac{1 \text{ m}}{1000 \text{ mm}} = 3.5 \text{ m}$
- 2460 cm^2 = ___ m^2?

Multiple Equations

- Not all the variables we know are in the same equation as the value we are trying to find
- An answer is based on something that we know, but isn't given in the problem
- Rule of Thumb: # equations = # unknowns

System Problems

- Sometimes you will need to determine how one component in a system affects another component. This is exactly what we are doing with magnetic torquers!
- It is important to understand how components work together before doing calculations. If you try to solve a problem you don't understand, you won't get the right answer. Knowing which component each variable applies to will keep you on the right track.
- Take your time! Calculate carefully, not blindly.

Design

- Here are the things we know:
  - Power = 5 Watt
  - Battery = 12 Volts
  - Resistivity = 1.678×10^{-8} Ohm-meters
  - Maximum Current I_{max} = 0.53 Amps
  - Wire area: A = 0.03 mm^2
  - Rod Dimensions: l = 9 cm , r = 0.6 cm
  - N_d=0.3564
  - μ_r=2000 N/m^2
- These are things we want to know:
  - N?
  - Does I exceed I_{max}?
  - What is the torque produced?

Test!

- Build a magnetic torque rod
- Measure the magnetic field it produces
- The magnetic flux should be equal to:

$$B = \frac{\mu_0 N I}{l\,[(1/\mu_r)+N_d])}$$

where $\mu_0 = 4\pi \times 10^{-7}$ [N-A^{-2}]

DO THEY MATCH?