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SPARC 2014

Student Payload and Rocketry Challenge

Hosted by AIAA OC Section NAR #718

Welcome to SPARC – an engineering adventure sponsored by the AIAA Orange County Section and the National Association of Rocketry (NAR) Section #718 where students in 7th through 12th grades will:

- Participate as an individual or a team of 2 to 5 members
- Build a kit rocket and fly it to an altitude of 1,000, 1,500, or 2,000 ft
- Fly a simple scientific or engineering payload on your rocket
- Write up your project as you go
- Obtain a Level 1 Junior High Power Participation certificate (JrHPP - the High Power Level 1 certificate equivalent for NAR members 14 – 17 years of age) http://www.nar.org/hpcert/jrhppreq.html
- Fly your rocket at the ROCtober launch (October 2014) at Lucerne Dry Lake with the Rocketry Organization of California
- Participate in a "Rocket Science Fair" at ROCtober with a display and written report
- Entry fee is $10.00 per team
- Teams are responsible for all costs of their project
- Plaques will be awarded to winners of each category

This challenge starts on June 1st and finishes October 11, 2014 at ROCtober where you will officially fly your rocket and show the results during the "Rocket Science Fair". Visit the SPARC web pages at AIAA OC Rocketry: http://aiaaocrocketry.org/?page_id=915

Rules

Safety: Your rocket must comply with the NAR safety code (http://www.nar.org/NARmrsc.html).

The Team: Your team should be small enough so that everyone can make a significant contribution to the project. We recommend no more than five members to make things manageable, but there is no minimum number of participants. Each person on the team above 14 years of age can earn their certificate for the Level 1 Junior High Power Participation program. To earn your certificate, you must build your own rocket and be a member of the National Association of Rocketry (NAR). You will also need a mentor with at least a Level 1 High

Power certificate whenever you fly your rocket using the “H” motor. All High Power Rocketry (HPR) flights performed by a member under the age of 21 must be directly supervised by an adult who is HPR certified Level 1 or greater, because only they can legally purchase and possess the motor or reload kit used for the flight.

The Rocket: The focus of this challenge is the payload so you will select a 4” diameter single stage kit from the approved list to simplify integration. All approved kits will be able to lift your project to the target altitude on an “H” motor.

The Payload: Use your imagination! The payload can be categorized as either a scientific or an engineering payload. Scientific payloads gather and record data which is used to test a hypothesis of your design or choosing while engineering payloads push the state of the art in model rocket technology to create new solutions to engineering challenges or improve on existing ones. Your payload must be based on the Arduino Open Source electronics prototyping platform. Arduino has an extremely strong and diverse following because it is easy to learn, the software development tools are freely-available, and a wide array of hardware is available inexpensively from many vendors with supporting software libraries. Application-specific “shields” are available for a wide variety of purposes which plug directly into the standard Arduino hardware and provide additional functionality easily while many sensors are available on breakout boards which simplify interfacing with your project. There are a plethora of articles and video tutorials available online which demonstrate how to develop projects with Arduino. Many of the vendors also provide links to data sheets and project tutorials for the hardware they carry. We’ll also provide tutorials, classes and mentors to help.

You will need some way to get data from your payload, either recording it on board your rocket or transmitting it wirelessly to a ground station – the choice is yours. Some examples of the things you might choose to measure are altitude, temperature, speed and velocity (measured or calculated), acceleration; or pitch, yaw, and roll rate of your rocket. You might consider using wireless telemetry and a GPS or radio direction finding to locate your rocket. You might control a small onboard camera using CHDK (Cannon Hack Development Kit) or carry a small camera and record or send video back to the ground with a text overlay such as altitude or velocity. We are open to anything you might want to suggest. To keep things simple though, your payload must be based on an Arduino or compatible electrics prototyping environment. Your software can contain both original code you write and code sourced from the Arduino community.

Documentation

Proposal: Before you begin your project, your team needs to submit a short proposal describing your experiment. Your proposal must be reviewed by SPARC officials and approved before proceeding on to the project. Your proposal must include

- The name of your team and list of team members and identify the team leader
- The name of your team mentor with at least a level 1 High Power Rocketry certification
- Short description of your payload including the scientific or engineering goal and how your payload satisfies that goal
- Short description of your rocket and candidate motors
- Target altitude (1,000, 1,500, or 2,000 ft). This cannot be changed after the proposal is submitted
- Your safety plan showing how you will build your rocket and where you will fly your rocket safely.
- Your schedule

Report: Once your project is complete (and preferably flight tested), you will need to submit a report documenting your project two weeks before the ROCtober launch. You will also include the report as part of your exhibit at the Rocket Science Fair. It must include the following information:

1. Team name and members
    a. Name of your team's mentor
    b. Name and short bio of each team member and their role in the project
    c. Name of the club and location where you made any test flights
2. Your safety plan showing how you built and flew your rocket safely
3. Your rocket design
    a. Description and drawing of your rocket with payload as-installed in the rocket for flight as well as deployed if applicable
    b. Identify the motor and manufacturer that you used
    c. Show simulation results of your test flights of that carrier rocket with payload and motor
4. Payload design
    a. Identify the intent of your payload
    b. Show how your payload functions and satisfies that intent
        i. Scientific payloads must clearly state the purpose of the experiment including the hypothesis under test, which parameters are controlled and which are varied; and should discuss uncertainty, error sources, and employ appropriate numerical precision
        ii. Engineering payloads must clearly state what problem in model rocket technology you wanted to solve or what solution you are improving upon. Show how existing designs cope with the problem you are trying to solve and how your design improves on the status quo. Discuss the reliability and robustness of your solution and how well it scales between rockets of different sizes and capabilities.
    c. Include the following diagrams

i. System block diagram showing your payload and launch vehicle as well as ground station (if any)
ii. Functional block diagram of the payload showing how data moves through your system
iii. Flow chart or functional description of your payload software

d. Discuss how well your payload performed and areas in which opportunities for further improvement exist
e. Include a bill of materials

5. Include your test plan showing
   a. How you tested your payload and carrier rocket
   b. The results of those tests justifying any exceptions to expected results
   c. What you did not test and why
6. Risk management – Identify what you think can go wrong and how you intend to mitigate those risks
7. Your schedule
8. Your budget

Flights and Rocket Science Fair

Junior High Power Participation Program: You can optionally obtain a Jr High Power Participation program certificate. To fly a rocket with an "H" motor you will need a certificate that shows you have qualified for the Level 1 Junior High Power Participation Program from NAR. You must be at least 14 years of age and a member in good standing with NAR. You will need to fly your rocket at an organized launch that permits high power rocketry and have your flight witnessed. The witness will inspect your rocket before and after the flight to make certain it meets the program requirements and observe your flight to verify it flew safely, and was not damaged during the flight. Each person wanting to join the Junior HPR Level 1 Participation program must have built their own rocket. You may obtain this certification any time during the challenge including at the final launch at ROCtober. All High Power Rocketry (HPR) flights made by the team (before and after someone receives their JrHPP certificate) must be directly supervised by an adult who is HPR certified level 1 or greater and who can legally purchase and possess the motor or reload kit for the flight. This applies to all flights using an HPR motor including your final qualification flight.

ROCtober Flight: You and your team will have one official flight at ROCtober on October 11, 2014. During that flight you will gather your data to include in your presentation at the "Rocket Science Fair". It is highly suggested that you fly your rocket and gather data during the summer before that flight and include that data in your report and use the official flight as validation of that data. You may fly your rocket as often as you wish during this challenge subject to these rules:

- First flight on mid power ("G") motor or "H" motors with a mentor with at least a level 1 certification. The mentor will need to purchase your "H" motor, supervise and take responsibility for all high power flights
- Flying prior to ROCtober is recommended but not required
- The ROCtober flight is your flight of record.

Rocket Science Fair: We will have a "Rocket Science Fair" area at the ROCtober launch with ROC at Lucerne Dry Lake. Your team will have a six foot table for your display. You should have a science fair type display describing your rocket and payload. And you should have your rocket and payload on display. You should also show the results of any testing and test flights. At least one team member should be present to answer questions. AIAA Young Professional members will be judging your projects for

- Technical Excellence
- Exceptional Presentation
- Scientific Merit for Scientific Payloads
- Outstanding innovation for Engineering Payloads

Costs and Schedule

Costs: Students are responsible for all costs for their projects. Reasonable estimates are:

- Rocket kit with payload section: $75 - $100
- Arduino controller board $20 - $35
- Arduino sensors and shields: $10 - $100 (dependent upon your payload)
- "H" motor $35 each (Cesaroni)
- Cesaroni motor casing $35 – we will have some casings to loan

Schedule:

June 1 – June 30, 2014	Signup period
July 14, 2014	Proposal submission deadline (Submit proposals early for approval to give yourself plenty of time to work on your rocket and payload)
July 28, 2014	Resubmission deadline (if changes are needed after review)
September 29, 2014	Report submission deadline (with or without flight data)
October 11, 2014	ROCtober – final flight and Rocket Science Fair
Recommended Launches in Southern California for a rocket with an "H" motor	
June 13 – 15, 2014	ROCstock at Lucerne Dry Lake with Rocketry Organization of California
July 12, 2014	ROC launch at Lucerne Dry Lake
August 9, 2014	ROC launch at Lucerne Dry Lake
September 13, 2014	ROC launch at Lucerne Dry Lake
October 11-13, 2014	ROCtober launch at Lucerne Dry Lake

Rocket and Electronics Sources

Rocket Vendors: You will need a 4" diameter rocket kit with a payload bay. Two Southern California vendors have suitable rocket kits with payload bays:

Discount Rocketry: http://www.discountrocketry.com

Mad Cow Rocketry: http://www.madcowrocketry.com

A list of approved kits will be posted on our web site at http://aiaaocrocketry.org/?page_id=1545.

Rocket motors: You need to be at least 18 years of age and hold at least a level 1 certification or have an attempt scheduled to purchase "H" motors. Shipping and Hazmat fees can get very expensive. When we need to purchase motors, we will batch the team orders and share shipping and Hazmat fees. If no one on your team wishes to obtain the High Power Participation certificate, you will need a mentor with at least a NAR HPR Level 1 certification to purchase the motor, load, and be responsible for your rocket. You can obtain a free Cesaroni motor casing with purchase of a reload for anyone obtaining their certification (http://cart.amwprox.com).

Rocket Design & Simulation software: Rocksim is available for purchase and Open Rocket can be downloaded free:

RockSim (Apogee Rocketry): http://www.apogeerockets.com/Rocksim/Rocksim_information

Open Rocket (Sourceforge Projects): http://openrocket.sourceforge.net

Payload Electronics: We have provided a list of Arduino electronics vendors and tutorials on our web site at http://aiaaocrocketry.org/?page_id=1545. The Arduino home web site is http://www.arduino.cc. You can Google Arduino to find many, many more sources for hardware an tutorials. You may use the carrier board from the S4 (Small Satellites for Secondary Students) in your project (http://s4.sonoma.edu/?page_id=169).

After teams have participated in SPARC for at least one year, they may choose to go on to a more advanced challenge (details to be released at ROCtober).

For more information visit http://aiaaocrocketry.org or contact:

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