Curriculum for Unmanned Aircraft Systems (Drone)
Competition

Objective. This activity promotes STEM learning through two activities; 1) Written test covering subjects contained in the FAA's Remote Pilot Written Exam (Part 107) and 2) Indoor, RC, line of sight flying of a basic quadcopter. The intent is for all 6 team members to participate; Four team members take the written exam and two other team members fly the quadcopter.

Event 1- Written Exam.

Conditions. The written exam is a multiple choice test, where the cadet has 60 minutes to answer 50 questions covering topics from the FAA's Airman Certification Standards for Remote Pilot (FAA-S-ACS-10A). These topics include: Regulations, Airspace & Requirements, Weather, Loading and Performance and Operations. Four cadets from the team will take the written exam and their scores (each correct question is worth 2 points) will be averaged for a team score. There are 2 versions of the test with each team getting 2 of each of the versions.

Event 2 Remote control, line of sight , search and rescue course challenge

Conditions. This event is conducted using the Hubsan X-4 drone contained in the CAP AE STEM kit.

Overview. Teams will compete by flying their UAS through a simulated search and rescue course. Their attempts will be timed with penalties (time added to their actual course time) for specific rule violations

Equipment. The teams will compete with *Hubsan X-4* drone acquired from NHQ through the AE STEM Kit. No modifications are permitted to the drone or controller. Teams are permitted to purchase their own replacement batteries and propellers provided they are exactly the same as the original batteries (in mah) and propellers (in length and pitch). Teams may purchase upgraded battery chargers (such as the type which charge 6 batteries at once) and battery voltage checkers at their own expense and discretion. Teams must fly with the blade protection accessory attached.

Mission. The course will be an indoor course adjusted to the size of the room (typically the size of a high school basketball gymnasium). The flight is expected to be conducted by line of sight (no First-Person-View FPV allowed) and will encompass flying search grid patterns with the drone required to maintain orientation to direction of travel (the front of the drone must generally face the direction the drone is traveling). A landing will be required to be executed to a specific spot, with distance from bullseye resulting in time penalty. Two team members are each given one chance to fly the course. Their completion times, plus any penalty times are averaged for a team score. The fastest team receives ***XX*** points, the second fastest receives ***XX*** points, the third fastest team receives …..

Scoring. Each teams written average scores are added to their course average scores to determine placement in the event.
Set-up for the competition. **Not to be shared with the teams!**

Team prep. Teams are required to show up at the site with their own drones and transmitters. They must also have their own batteries for the transmitters and the drones. (The transmitters use AAA style batteries and the drone batteries can be carried aboard commercial aircraft (they cannot be in checked baggage, tho).

Site prep.

1. Written test.
    a. Sufficient copies of each of the two versions of the tests for 4 members of each team.
    b. Pens/Pencils
    c. Answer keys (for each test version)
2. Flying course
    a. Course. The course should be in a room about the size of a basketball court with 2 stories of altitude available
    b. Course boundary. The course boundary should be marked off with blue painters type tape and should provide at least 5 feet clearance from the walls.
    c. Pilot's station. An area about 5 foot square should be marked off for the pilot and visual observer to be in when they are flying the course. This station should be at one end of the course, opposite where the landing site will be
    d. Course lanes and obstacles. Each lane of the course should have a vertical marker about 5' tall to serve as a pylon to be flown around at the end of each "leg". Other course obstacles made from PVC and pool noodles will simulate obstacles which may be encountered in a search area; towers, trees, etc.
    e. Landing site. An elevated landing platform should be made from a 3" piece of PVC with the top covered to create s suitable landing platform for the drone. It should be about 1' off the floor. Alternatively a 3" circle can be marked on the floor and a tape measure used to measure the closest part of the drone to the circle.
    f. Scoring. The base measurement is the time from when the timer says "GO!" until the drone is landed at the landing site. Penalties (amount of time TBD) are added for:
        i. Going over 6' from the floor
        ii. Failing to execute an obstacle (not going thru the circle or between the gates)
        iii. Hitting the floor
        iv. Crashing requiring the observer to come on the course and right the drone to complete flying
        v. Failing to land on the elevated platform or the number of inches the drone was away from the landing circle

Obstacles and Gates

End of lane marker. This is a 5'tall pvc pipe covered with a pool noodle or brightly painted and placed at the end of each leg to make the point where the drone will change directions.
Materials required: 1 - 10'x1" pvc pipe, 4 - 90° connectors, 3 - "T" connectors, pool noodle or paint
To build:

1. Cut the 10' pipe into to two 5' sections
2. Cut one 5' section into 5-1' sections
3. Cut 3 of the 1' sections into 6" sections
4. Build the base;
    a. Put the 90° connectors onto the end of the 2 1' sections place them opposite of each other.
    b. Put the 6" pipes into the thru portions of the "T" fittings and connect them to the two sections from step 4a. The openings of the "T" fittings should face each other toward the center of the square.
    c. The remaining 6" pipes are put onto the remaining "T" fitting and fitted to the openings of the previously assembled square with the "T" fitting opening in the center and facing upward.
5. Place the 5' pvc pipe into the opening of the "T" fitting in the middle. Cover with pool noodle or paint with bright colored paint.

Two 5' poles can be put together to form an "gate" requiring the drone to be flown between them

A circle gate can be made for the drone to be flown thru. It can be made more challenging by making the circle various degrees from vertical by rotating the fittings/pool noodle:
Material required: 2 - 10'x1" PVC pipe, 6 – 90° connectors, 4 "T" fittings, 2 pool noodles
To build:

1. To build the base
    a. Cut one 10' pvc pipe into five 2' sections
    b. Cut two 2' sections into 1' sections
    c. Put 90° connectors onto the ends of two of the 2' pvc pipes
    d. Put two 1' sections onto each thru opening of two of the "T" connectors
    e. With the parts from steps c and d, make a square with the two "T" connections on the opposite sides from each other and their openings pointing upward
    f. Cut one 10' section of PVC pipe into:
        i. Two 1' sections, three 2' sections, six 4" sections
    g. Put one of the 1' sections into each "T" fitting on the base
    h. Cap each 1' section with a "T" fitting, with their thru openings going up and the 3rd openings facing each other
    i. Insert a 2' section into the "T" fittings
    j. Put two 2' sections into the "T" fittings
    k. Top off the 2' sections with 90° connectors
    l. With the remaining "T" Connectors, put 4" pvc pipe into each opening
    m. Put the perpendicular opening of the "T" fitting into the 90° connector opening
    n. Connect pool noodles to the 4" sections coming from each "T" fitting