

# NERC-Aero Competition

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## Rationale:

Agricultural development is the most crucial part in the development of Pakistan's economy having a share of 23.4% and engaging almost 45% of the workforce. Local Farmers deal with countless pressures and challenges such as increasing sustainability, maximizing yields to meet demands, maintaining margins, and managing water usage. Around the world, to cope with the challenges farmers are using precision agricultural techniques with the aid of aerial and ground robots. Farmers have always collected field data. This process can be as simple as walking through a field and making observations, but farmers are limited by time, data recording and the capabilities of analysis tools when making visual observations. A farmer simply cannot walk every row of the crop field to collect data. Drones or



unmanned aerial vehicles represent a prime example of a new technology that has the potential to provide even more valuable decision making data to farmers. Recently, the Government of Punjab announced the permission of using drone technology in Agriculture. Drone technology is being used for crop monitoring, pesticide spraying, and fruit picking. Drones have tremendous potential to be an eye in the sky for farmers. There is a huge opportunity for innovators to bring ideas that can help to integrate information systems, current mobile networks, and drone technology to bring a system that can revolutionize precision agriculture in Pakistan.

The Unmanned Aerial Vehicles (UAVs) specially the multi-copters have been used in agricultural applications worldwide for a decade. Since 2019, researchers at the National Center for Robotics and Automation (NCRA) have been working to test the feasibility of using aerial spraying drones for local crops pesticide applications. The scientists at NCRA have introduced the commercial activities of aerial spraying to farmers in Pakistan and helped local service providers to learn to use, fly, and maintain the aerial spraying drone. The center has found it a very useful tool for pesticide applications and many local companies have adopted it to provide services to local farmers in Pakistan. One of the challenges identified along the way is the availability of good drone pilots. With the increased use of these technologies, more human resources will be required that can fly and have a basic understanding of these remote controlled (RC) UAVs, particularly the quadcopters. To this end, the Department of Mechatronics Engineering, NUST College of Electrical and Mechanical Engineering is organizing an aerial drone competition (with a focus on rotary wings drones/UAV) as a part of the NERC 2024, to promote and produce human resource for drone technology. The contest is aimed to provide a real world UAV build and fly experience to the participants

by giving them the opportunity to apply the skills learnt during their studies. The department will also conduct workshops to teach building and flying quadcopters before the event.

## Introduction

The participants are aimed to design, fabricate, and demonstrate the flight capabilities of an unmanned, electric powered, radio controlled UAV that can best meet the specified mission profile. Here, the goal is to encourage participants for a simple, efficient and cost-effective UAV design, and to learn and demonstrate flight handling capabilities.

**It is the responsibility of the teams to understand and follow all provided rules, the FAQs, and all contest day briefings.**

## Categories

The NERC-Aero has two categories for people to participate as follows:

1. Build And Fly Quadcopter
2. Exhibition Flying - Quadcopters, Helis, Planes

## Build and Fly Quadcopter Contest

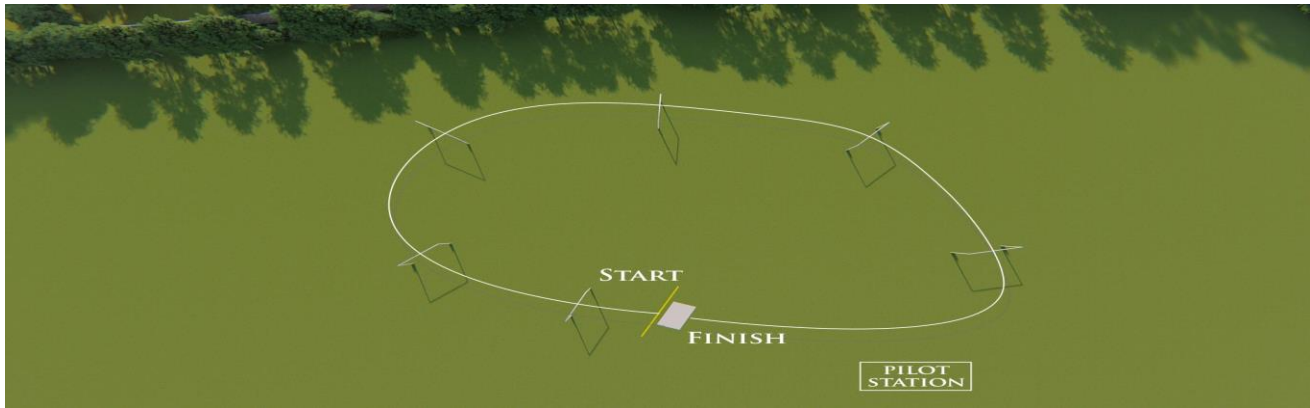
The Build and Fly Quadcopter Contest will separately be run in parallel for the **two groups** of participants.

- **Group 1** will comprise of participants studying at **A level/Intermediate level (or equivalent), or below.**
  - *The will be a separate competition each for pilots employing 'FPVs' and those relying on 'line of sight'. If there are not enough number of participants in either of the two sub-categories as needed to conduct separate competitions, the judges will make the decision on whether to club two sub-categories.*
- **Group 2** will include participants that are **university students or professionals.**
  - *The will be a separate competition each for pilots employing 'FPVs' and those relying on 'line of sight'. If there are not enough number of participants in either of the two sub-categories as needed to conduct separate competitions, the judges will make the decision on whether to club two sub-categories.*

The Build and Fly Quadcopter Contest (for each group) consists of four stages.

1. In the first stage each team will have an interview as a part of which an inspection of the built quadcopter will be carried out with the inspection panel. The successful teams will qualify for the second stage.

2. In the second stage the teams are supposed to demonstrate their skills by flying the quadcopter in front of the panel of judges to show various aspects including stability, basic maneuvering, and fixed point hovering. The successful teams will qualify for the third stage.
3. The third stage consists of one lap of the course circuit shown in Figure 1. The quadcopter needs to fly through all air gates, having varying shapes and sizes and placed along the circuit at varying distances, as shown in Figure 1 to complete a lap. The teams are required to complete a lap in the shortest time possible and will therefore be ranked based on the time taken to finish the one laps.
4. The top two teams will qualify for the fourth and the final stage in which each participant needs to complete two laps of the course circuit. The team completing the two laps in the shortest time possible will be declared as the winner.



**Figure 1: Visualization of the arena for the Build and Fly Quadcopter contest. Note that the shape of the course circuit could differ from the one shown in this figure that is just for reference. Note also that gates can have varying shapes and sizes and are to be placed along the circuit at varying distances.**

## Exhibition Flying

EME Build and Fly Exhibition segment does not actually have any contest *per se*. It is indeed open to all types of electric aerial vehicles, i.e helicopters, quadcopters, planes etc with no size limits. All teams are required to follow the field and safety rules as mentioned in the rules section below. Each registered team will exhibit their aerial platform in the exhibition area. Each team will be given four minutes each to exhibit their flying capabilities, based on which the panel of judges will chose the best team that will be awarded with certificate and shield.

## Rules and Requirements

### Team Requirements:

Whether belonging to Group 1 or Group 2, each team can comprise of 5 students at maximum. Two or more schools, colleges, or universities may join hands to submit a single entry.

Any member of the team can fly the UAV, while rest of the team members can assist in navigation. For teams representing schools, colleges or universities, it is desirable, but not essential, for an advisor or a responsible faculty member to attend.

Each educational institution may have more than one participating teams. Each team must have their own quadcopter to fly. During the inspection stage the team has to register a quadcopter that they will use during the competition. A flight order list will be generated using a draw during the inspection and will be communicated to the teams prior to the fly-off time.

### Quadcopter Requirements:

- **Group 1:**

Each team needs to **build** their quadcopter using an off-the-shelf RTF solution, kit, etc., while taking into account the following requirements:

- Allowed Frame for quadcopter race is 'X' or 'H' type, propelled by 4 motors.
- Maximum allowed frame size is 450mm.
- Max allowed battery size and type is 3 or 4 Cell 1p 3400mah lipo.
- All off-the-shelf ready to use **FPV goggles** are allowed. There will be a separate competition among ('line-of-sight') teams not using FPVs, subject to participation of enough number of teams.

- **Group 2:**

Each team needs to **build** their quadcopter (and NOT simply buy an off-the-shelf RTF solution, kit, etc.) while taking into account the following requirements.

- Allowed Frame for quadcopter race is 'X' or 'H' type, propelled by 4 motors.
- Carbon fiber, glass fiber, aluminium or plastic frames can be used to assemble the quadcopter.
- Maximum allowed frame size is 450mm.
- Max allowed battery size and type is 3 or 4 Cell 1p 3400mah lipo.
- The participants are required to build their quadcopters from scratch, using off-the-shelf parts (but **NOT** kits) i.e brushless motors, ESCs, Flight controllers, Video TX/RX and frames . No pre-assembled RTF quads are allowed in the race.
- All off-the-shelf ready to use **FPV goggles** are allowed. There will be a separate competition among ('line-of-sight') teams not using FPVs, subject to participation of enough number of teams.

### Technical and Safety Inspection

All vehicles will undergo a safety inspection by a designated contest safety inspector prior to being allowed to make any competition flight. All decisions of the safety inspector are final.

- All UAVs will be inspected against the given requirements.
- All UAVs will enter Tech Inspection fully assembled and flight ready.
- Verify all components adequately secured to the UAV.
- Clevises on flight controls must have an appropriate safety device to prevent their disengaging in flight.
- Verify propeller structural and attachment integrity.
- Visual inspection of all electronic wiring to assure adequate wire gauges and connectors in use.
- Radio range check, motor off and motor on.
- Verify all controls move in the proper direction.
- Check general integrity of flying and control surfaces.
- All quadcopter radios must have a fail-safe mode that is automatically selected during loss of transmit signal.
- Proper functioning of FPV setup, integrity of the video signal and range of VTX.

### Ground Rules - Quadcopter

- Only pilot and one spotter is allowed to enter pilot station
- All participating teams must keep their quads unarmed and batteries disconnected while on the ground.
- Participants in the active race can only power and arm their quads once they are in the pilot station.
- In case of FPV race, a spotter can stay with the FPV pilot in the pilot station.
- In case a video signal is lost, the FPV pilot is required to reduce the throttle to zero immediately.
- No teams except the ones participating in the active race are allowed to power on or test the Video TX while on the ground.
- A team can only use the transmission channel assigned to them while on the ground.

### Sponsorship:

Teams may solicit and accept sponsorship in the form of funds or materials and components from commercial organizations. All design, analysis, and fabrication of the contest entry is the sole responsibility of the student members for school/college/university teams.

### Communications: Website and email

The Department of Mechatronics Engineering, NUST College E&ME maintains the NERC website (<https://nerc.ceme.nust.edu.pk/>) page containing the latest information regarding the contest schedules, rules, and participating teams. FAQs are maintained to share queries with all the other teams. Queries regarding the contest, schedules, or rules interpretation may be sent to the NERC coordinator through email at: [info@nerc.com.pk](mailto:info@nerc.com.pk)

### **Registration for NERC Aero:**

All registration to NERC Aero will be through the online form given on the NERC website (<https://nerc.ceme.nust.edu.pk/>). Please ensure to include all information requested in the form. One registration per team is required for any of the competition. The corresponding team member or team lead will register by filling the online form, who needs to mention details of all team members properly. The name of team members mentioned during the registration can be changed if requested during the inspection session. The registration fee could be submitted through bank challan generated and sent to the team leader via e-mail.

## **Judging criteria**

### **Quadcopter**

- Build and Fly Quadcopter Contest does not have a point based scoring. It is based on time taken to complete the laps. Team with the shortest lap times advances through the stages and wins the final.
- Going through each air gate is mandatory.
- A team may attempt multiple times to go through a gate but cannot proceed to the next gate unless having gone through the previous gate.
- The time starts when the quadcopter lifts off the ground and finishes when it passes through the last gate.