REPUBLIC OF TURKEY

MINISTRY OF NATIONAL EDUCATION

The General Directorate of Technical and Vocational Education

14. INTERNATIONAL MEB ROBOT CONTEST

UNMANNED AERIAL VEHICLES (UAV) (MINI DRONE)

CATEGORY RULES

2022 – SANLIURFA

MINI DRONE CATEGORY RULES

1. AIM

Unmanned aerial vehicles (UAV) commonly known as Drone are used nowadays in many fields. Although aerial imaging and mapping are most common applications of drone ,there are various applications too such as transportation, fire fighting , first aid and live saving etc.

Technological revolutions are jumping times which increase level of developments and prosperities of countries. We can give steam engine, invention of car and plane , atomic engery, computer and space Technologies, industrial robots for these jumping moments on the timeline of history. We are working hard to follow these technolohical developments in our country. Nowadays jumping time in technology is UAV technologies. It is seen how UAVs support country's defence because of successful implementations in military fieds. Because of these reasons, there are a lot of studies and R&D researchs in many countries and products in market.

Aim of this competition is to increase the culture of producing and using UAV in our country. While doing so, it is intended to make young people combine technology with entertainment and increase their skills and knowledge. This competition hereby will contribute to the development of the human resources that our country will need in the near future both for the use of UAV (pilot) and for the production of UAV.

2. SCOPE

Types of UAV can be basically divided into 3 groups which are fixed wing, rotary wing and hybrid.

UAVs which have fixed and nonmoving wings are generally called fixed wings. Planes are considered in this group. Staying in air is depends on continously body movements. Thrust are provided by propellers driven by electrical motor or internal combustion engine. Some models have jet engine or electrical fan-jet to reach high rotations. Thrust are applied vertically. Location of propellers in electrical models can be placed at front (a), wings(b) , body (c) and back side (d) as shown in figure-1.

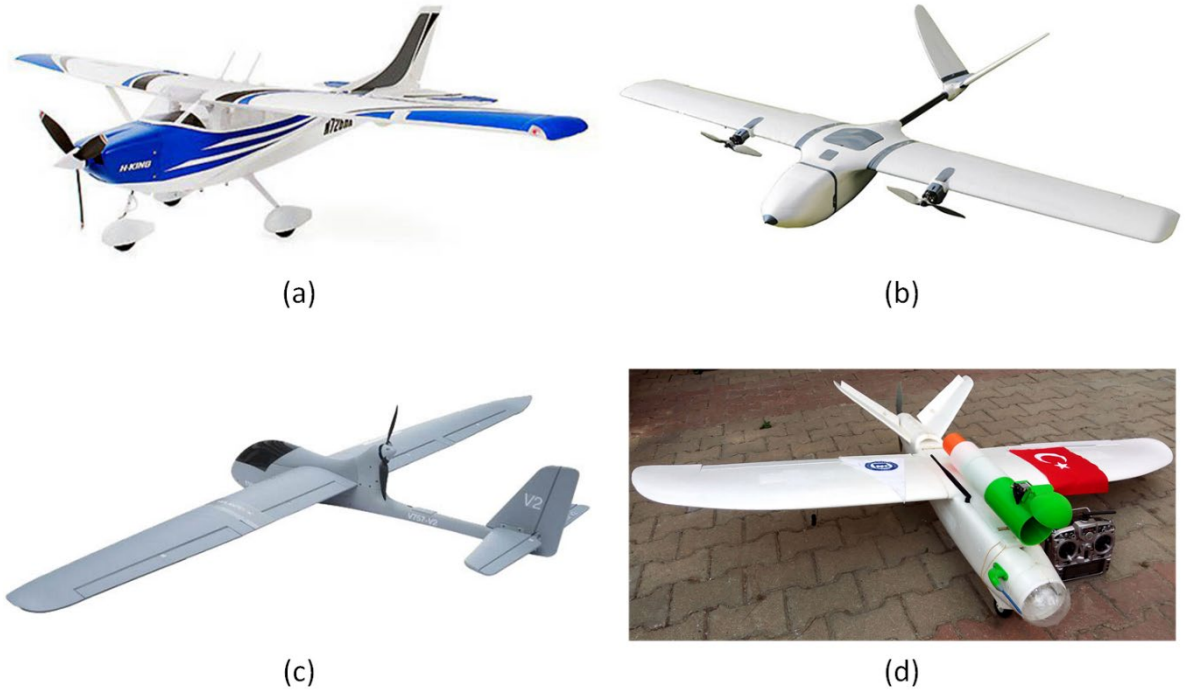

Figure-1: Fixed wings UAV pictures

Most of production and design process of fixed wings are mechanical works. Production cost of these vehicles which has usually single motor is relatively low. Their flight range is quite long, besides wide area is necessary to make them fly , take off and land.

UAVs which have propellers driven by motors placed vertically and keep the body at certain altitute are called rotary wings. These vehicles that have one,two,four,six and eight propellers are named respectively helicopter, tricopter, quadcopter (quadrotor) ,hexacopte and octocopter that all are latin words . Because body is fixed while wings are rotating , it is not necessary to move continously as fixed wings . Thus, rotary wings can do take off or landing at smaller area and their movements in air are more controlled because of their structures. Planning (balance of weight,load, battery) and skills in electronics are more important to produce rotary wings. Production cost of rotary wings is higher beacuse of expensive electronics parts such as motor and driver depens on number of propellers. Their flight range is short. Rotary wings UAVs which have different kind of propellers are shown at figure-2.

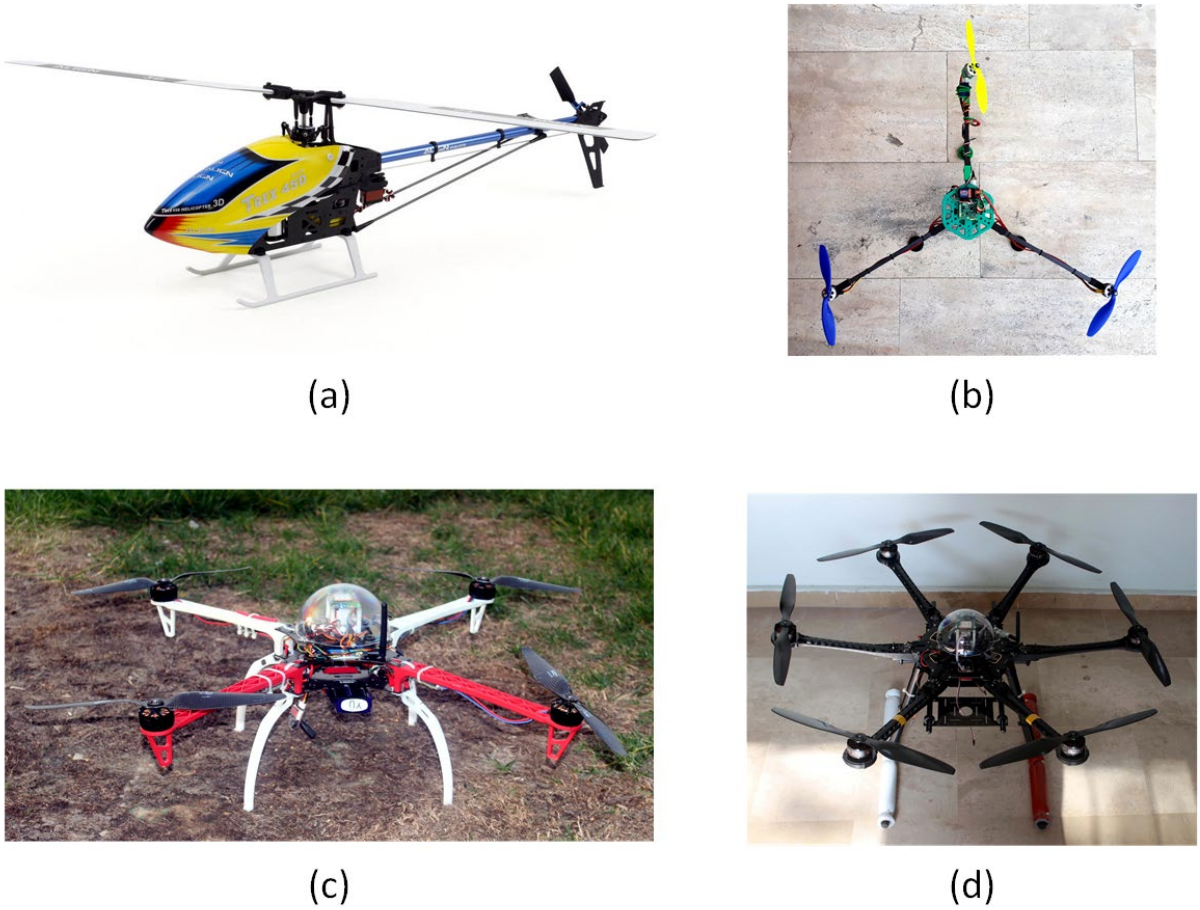

Figure-2. Rotary wings UAV pictures: Helicopter (a),Tricopter (b) , Quadcopter (c) , Hexacopter (d)

Hybrid designs are combination of fixed wing's advantage which is long range and rotary wing's advantage which is take-off / landing at small area. Therefore, it has both rotary wings and fixed wings. There are various hybrid designs and studies in this area are still ongoing. Different kinds of hybrid UAV designs are shown at figure-3.

Figure 3: Hybrid UAV designs produced by differents companies.

In this competition , Mini UAV (racer drone) which is kind of rotary wings either well control in air or need small area to take-off/landing will be raced. Mini UAV seen as a sample at figure 4 is preferred because they have small bodies, low cost maintenance and low possibilites to damage at moment of accidence. This competition will be task-based race given details at the followings as a category of INTERNATIONAL MEB ROBOT CONTEST.

Figure 4: Sample mini UAV picture (UAV MARMARA Yelkovan)

3. MINI DRONE SPECIFICATIONS

3.1. Flight Simulator Software:

Beginners may have idea that fly drone right after buying. Even they prefer cheaper one to have minimum loss in case of accident. However, if there is no any flying experience, first flight big probably ends with an accident and drone becomes unusable. It causes the loss of passion about flying drone which is more important than financial loss.

The most important point for someone who just start flying drone is to control drone by standing a certain place. We can give an example for this issue : A driver sit inside the vehicle so driver's brain directly affected from vehicle's movements. When driver turn the steering right, vehicle turn right. There is no sensing error between driver's brain and physical movement. When using remote controlled toy car, driver is outside of car and stand on fixed place. While the car is moving away from driver, car turns right by right command of driver using remote controller. But, while the car is coming to driver , it happens vice versa. In this case, car turns left by right command of driver using remote controller. Sensing left/right of driver and car's movement always changes depens on car's direction. Drone pilots have same problem. Therefore , orientation trainings are required for beginners. Using simulator is the best and cheapest way to do this.

Figure5. Sample software for flight simulator and it's equipments

3.2. Frame: Commercial bodies which support 3 or 4 motors and made by fiber/ fiber-carbon (220, 250 series, etc.) or special designed bodies made by using 3D printer ,FR4 (printed board) or wooden may be used.(clue: keywords to search in internet "quad frame 250", "racer frame", "tricopter racer frame")

Figure 6. Sample bodies for drone.

3.3. Motor: Brushless DC motors which have 2.000-4.000KV rotation speeds, 11-22 series motor diameters, voltage 2-4S (7,4-14,8V) can be used. (clue: keywords to search in internet "brushless dc 18", "brushless dc 22", "brushless dc racer", "2400KV", "brushless 1104", "brushless 1304", "brushless 1804", "brushless 1808", "brushless 2205" , "brushless 2206")

Figure 7. Sample motors.

3.4. Motor Driver (ESC): Motor drivers (electronic speed controller) which has voltage 2-4S(7,4-14,8V) and able to drive drone's motors current 10-30A and equipped with optocoupler to provide stable speed of motor, and prevent electronic noise caused by suppy voltage can be used. (clue: keywords to search in internet "30A esc opto", "blheli esc", "simon k esc", "micro esc")

Figure 8. Drone motor drivers.

3.5. Flight Controller: 8 bit or 32 bit microcontrollers (compatible with CC3D, PIXRACER, APM, NAZE, Cirus etc.) or special designed flight controllers using MEMs sensors (3 axis gyro, 3 axis accelaretion sensor, 3 axis magnetic compass) maybe used. (clue: keywords to search in internet "pixracer", "x-racer", "naze32", "SP F3", "apm", "SP F4")

Figure 9. sample controllers.

3.6. Power Distribution Board-PDB , Battery Eliminator Circuit-BEC

PDB distributes the current supplied from battery to the drivers. BEC decreases battery voltage (10-14V) and supplies voltage for flight controller and other hardware. Some models have two BECs , one is 5V for flight controller and peripheral circuits , one is 12V for FPV camera system. In addition, there are some models which have sensor (low value resistor) to measure battery current. Some models which are combination of both PDB and BEC are avaliable in the market. Also there are some models which are combination of PDB,BEC and OSD (On Screen display) explained in section-3

(clue: keywords to search in internet "pdb", "bec", "pdb bec" "pdc bec 2 in 1", "pdc bec osd", "pdc bec osd 3 in 1", " current sensor")

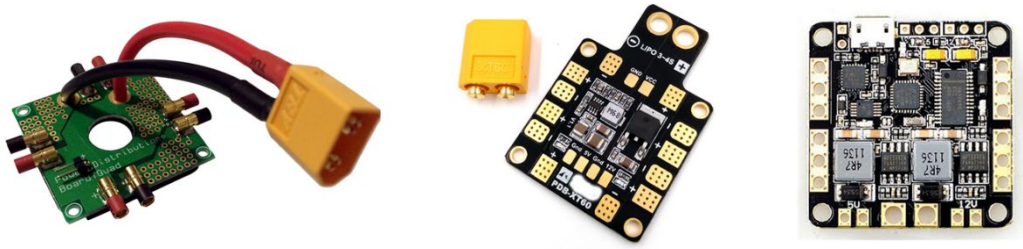

Figure 10: Sample power distributor,power supply pictures

3.7. Remote control: To prevent conflict with other drones, transceivers that have minimum 6 channels , 2.4GHz. should be used. It is adviced that you choose professional models which can work with simulator properly. By purchasing one professional remote control, you can control different kinds of devices with only one single remote control just buying extra RC receiver. Remote control is main device of drone systems , so it is strongly adviced that you choose good brands which can control minimum 16 devices.

Figure 11: sample remote controls

3.8. Flying camera, Screen, First Person View (FPV): First Person View is a video transmit systems which let the pilot feels as he/she was on board. It makes controlling drone easy. FPV set consists of a camera, transmitter, receiver,antenna and LDC screen or goggle. You can buy each equipments seperately. There are some models which are combination of camera and transmitter or screen/goggle and receiver on the market. You should select camera which has receiver, high quality image sensor, low illumination value and SD memory card. FPV is not compulsory in the competition. If you decided to use,you should use the models that can broadcast in 40 channels, using only the band 5.8GHz. and support racing bands (Band R: 5658, 5695, 5732, 5769, 5806, 5843, 5880, 5917) to prevent conflict with other drones. (clue: keywords to search in internet “fpv lcd”, “fpv goggle”, “diversity lcd”, “diversity goggle”,”fpv camera”)

Figure 12:Sample flying camera pictures

Figure 13: Sample headsets, goggle and lcd screens

3.9. On Screen Display - OSD : It is a module to show parameters such as battery voltage, slope of drone etc. on the view of camera like a volume bar appearing on TV screen when you increase TV volume. So user can see all parameters real-time on the screen. It is not compulsory in the competition. (clue: keywords to search in internet “mini osd”, “minim osd”)

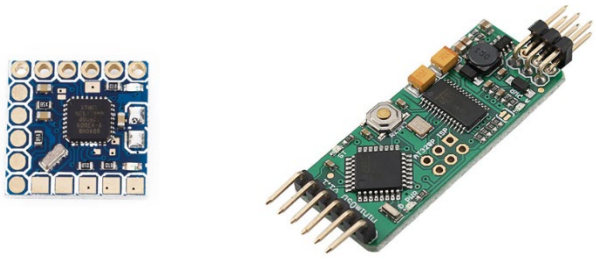

Figure 14:Sample OSD modules pictures

3.10. Propeller: It should has proper size which motor can drive and proper lenght which prevent collision with others wings.

While selecting motor, there are some informations about which size of propellers efficiently work with it. By helping this informations, two or three blade props that have 4-5 inches screw pitch(linear distance when one revolution of prop)(for example: when 6045 written on prop, it means that prop lenght is 6 inch and screw pitch is 4,5inches), 5-7 inches radious can be selected. You shoud buy twin props , one has direction of CW, the other has direction of CCW. Props are most easly fragile equipment, so it is better to buy more. In addition, even you change them with new props , first you should adjust balance just like car’s wheels to prevent shaking. This balance adjusting contributes positively to both battery consumption and motor bearings life.

(clue: keywords to search in internet “5x4.5 prop”, “6045 prop”, “7038 prop” “6045 prop”, “5045 3 blade”)

Figure 15. sample propeller sets.

3.11. **Battery:** It may be Lityum polimer (LiPo), voltage 2-4S (7,4-14,8V), current capacity 45C but no limit in capacity(mAH). You can use battery which has capacity between 1.000mAH and 2.200mAH

3.12. **Battery Alarm (Lipo Alarm):** It is a small electronic module which shows battery cell voltage and warns with voice alarm when battery voltage is lower than 3,7V (clue: keywords to search in internet “lipo alarm”, “mini lipo alarm”, “battery alarm”)

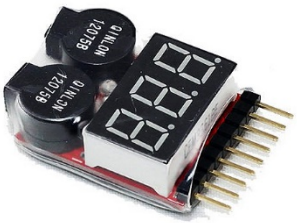

Figure 16. Sample LiPo battery alarm.

3.13. **LiPo Safe Bag:** Fireproof safe bag should be used to prevent any explosion and all batteries should be kept and charged in this bag. (clue: keywords to search in internet “fireproof lipo”, “lipo safe bag”, “lipo guard”)

Figure 10. Sample safe bag.

3.14. **Drone Size:** Distance between diagonal motor axes must be between 180-260mm. Drone must fit inside a 230mm x 230mm square without its propellers. Before the competition, your drone will be checked.

3.15. **Flight weight:** Weight of drone must be between 450 and 1000gr. Include battery and other equipments. Before the competition, your drone will be checked.

3.16. **Mechanic assembly:** Special liquid solutions (locktite etc) must be used to prevent loosening of nuts,bolts and screws during the flight. Before the competition, your drone will be checked.

3.17. **Electric-Electronic Assembly:** Heat shrink tube must be used for connection of cables and connectors, never seen any of electric wire without isolated. When drone drops down or hit to somewhere , cables which are not fixed to drone's body or not isolated may cause a fire. Because of this reason, fixing cables/wires by using heat shrink tubes and cable ties will be examined during techical check before the competition. Drones which have cables not fixed will not be allowed to participate competition. This is a strike rule.

Figure 1. Image showing that judge was fighting with fire because drone crashed in flight zone.

4. FLIGHT ZONE

Organization comittee can change flight configuration in case of necessary (Updated info will be published on web site. Please follow official web site.)

4.1. Competition will be held in an open air field (30x60m)which will be built inside a soccer pitch (45x90m) surrounded with wire mesh . Some photos are shown at figure 19 ,20 .

Figure 19. View from competition area #1.

Figure 20. View from competition area #2.

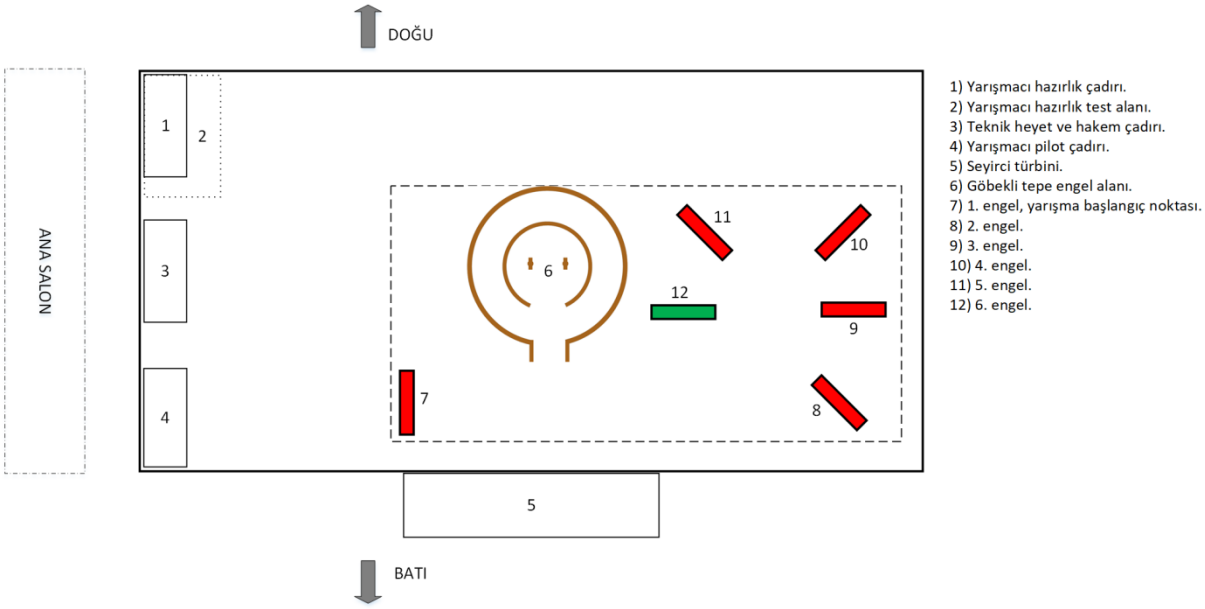

Figure 20. Schematic drawing of competition area

4.3. There will be three tents around competition area: tent for preparation, tent for competitors and tent for technical board

4.4. Competitors will do last modifications , adjusments of their drones inside preparation tent. They will also assemble FPV equipments on mini drones. All electrical facilities and tables etc will be avaliable inside the tent.

4.5. Judges , observers and pilots wait inside competitor tent. There will be a pilot seat for pilots who will use FVP. Observers will stand while race going on. There will be also screens and seats for judges.

4.6. Technical committee will manage organisation from another tent. Check desk for drones, recording equipments will be placed inside this tent.

5. RULES

This rules is subject to change by the competition committee. (Any updates will be published in official web site. Please check it.)

5.1. Teams have to obey the rules and order of judges. Otherwise they will be disqualified.

5.2. Competition committee can decide to repeat the race when it is necessary.

5.3. Teams can object to decisions of judges by written document.

5.4. Each team consists of two students (one pilot and one observer)

5.5. Pilot will control drone by using FPV

5.6. Observer is responsible to place drone on starting area, take it back at the end of flight, to observe drone while flying and to support pilot for a best flight.

5.7. Race is carried on two phases. First phase is qualification race for sorting. Second phase is elimination, quarter-final, semi-final and final races

5.8. First two days , qualification tours will be carried on. Technical comittee may change duration. Each team has maximum three rights to particiate qualification tours in this period

5.9. No extra time will be given to teams that cannot use their three rights
5.10. Best score of teams will be registered as team score.
5.11. Top 32 teams listed according to team score will get right to race in second phase
5.12. each drone will fly alone at qualification tour.
5.13. Drone will take one lap at qualification tour. Lap time will be tour score.
5.14. In second phase, 4 drone will race at the same time.
5.15. Except final , all races will be carried with 4 drones
5.16. Starting positions in all races of second phases will be determined according to previous race time scores of drones. (for example, time scores of drones in second level races will be used to determine their staring position in quarter-final races). In group, drone which got best time in previous race starts 1.position, lowest time score starts 4th position.
5.17. First two teams in each group will race in quarter-final
5.18. First two teams of each group in quarter-final will go to semi-final
5.19. First two teams of each semi-final group will get right to race at final
5.20. Four teams will race at final race.
5.21. At second phase,if all teams in group pass through first obstacle succesfully, race will start. Even if one team cannot pass, start will be repeated.
5.22. At second phase, final race will be performed four times, other races will be performed three times.
5.23. Starting time of each team will be deteched by Lap Timer (an electronic special device) when drone passes from 1.obstacle. When drone arrives to 1.obstacle again, Lap Timer record first lap time, then process goes like that. All lap times will be calculated electronically.
5.24. One judge will be assigned for each team during the racing . Judges will follow racing from screens which shows same video receiving from pilot goggle.Herewith,judge can control and decide every moment and action of racing. If necessary , they will give time penalties. Details about time penaties will be given later. Please follow web site.
5.25. One FPV camera , video transmitter VTX and FPV goggles will be given to each team before racing. After race, all equipments are taken back. More information about how to connect these equipments with drones will be given later. Please follow web site.
5.26. Drones may drop because of crash, hit or bad control . In this case , if drone can take off again, it can continue the race. Time will not be stopped in this case. If it cannot take off, race is over for this drone.
5.27. If judge decides that any action (such as flying very high altitute etc) is unsafety, it is a reason for disqualification
5.28. Entering flight area without permission is forbidden. Competitiors can only enter with judge permission in case of emergency (Drone crash, battery fail etc.). Otherwise , team will be disqualified.
5.29. If team members or their supporters act behaviours which don't respect to the spirit of fair play before, after or during the comptetition, all teams of their institutions in this category gets time penalty.

6. DRONE SPECIFICATIONS

6.1. Distance between diagonal motor axes must be between 180-260mm. Drone must fit inside a 240mm x 240mm square without its propellers. Before the competition, your drone will be checked.
6.2. Weight of drone must be between 500 and 1000gr. Include battery and other equipments. Before the competition, your drone will be checked.

6.3. Teams that couldn't pass technical check can work during qualification period and enter technical check again. After that they can race at qualification tour. But if they cannot complete their failures until end of first phase, they are not accepted.

6.4. Drone propeller should be max. 5 inch.

6.5. Drone battery shoud be max.4S LI-PO (16,8V). There is no limit battery capacity(mAh)

6.6. Video transmitter (25mW) will be provided.

6.7. Drome should be quadcopter (4 motors)

6.8. Commercial or special designed frames can be used but commercial drones or Drone Kits (RTF, ARF etc.) bought completely in market are not allowed. Such drones will be disqualifed.

6.9. Each team must assemble mechanic , electric and electronics parts of drone by own . In addition, they will also install flight software and make settings by themself .Teams will prepare "Drone Production Report " explained all steps of production process of their drones . Each team must dowload and fill the "Drone Production Report" from offical web page of competition. After that it should be uploaded as .pdf format. Teams which didn't upload their reports cannot participate in this competition.

6.10. Batteries should be kept in fireproof safe bag. It will be checked

6.11. Drones won't have autonomous fligh function. Therefore , no GPS modules etc. will be installed.

7. SAFETY PRECAUTIONS

Safety measures for drones which will race in this competition are as the follows. Teams which violate safety rules will be disqualified.

7.1. A switch or button on the remote controller must be set for throttle cut. Before the competition, this button will be checked. If there is no button, team will not be allowed to compete.

7.2. If drone disconnected with remote controller, it will land automatically (radio failsafe). Before the competition, this function will be checked. If there is not, team will not be allowed to compete.

7.3. If drone goes far from flight area and becomes unvisible, pilot will make drone passive/disarm (drone will crash) by order of judge.

7.4. Drones can run by using LiPo or other types of batteries which have high current capacity. These batteries may explode easly because of their unstable chemical structures. It is compulsory that every team keep their batteries in fireproof safety bags. During the competition, if any team detected while keeping or charging the batteries without safety bag, it will be warned and penalty time will be given to this team. Penalty time will be announced later.

7.5. Plugs to connect LiPo or other batteries should be placed on drone so that judge can easily plug in or out. Therefore batteries can be dismounted easily in case of emergency situation. It should be considered while designing drones.

7.6. A practice place will be reserved for teams to able to test their drones. A judge will stay in this practice area. If any team detected while practicing in any other places (such as halls, outside of venue etc.) , it will be warned and penalty point will be given to this team.

8. CONTACT

Please read this guide carefully. If you have any question, use following mail address;

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