



REPUBLIC OF TURKIYE
MINISTRY OF NATIONAL EDUCATION
The General Directorate
of Technical and Vocational Education

15th INTERNATIONAL MoNE ROBOT CONTEST

**UNMANNED AERIAL VEHICLES
(MINI DRONE) CATEGORY RULES**

INTERNATIONAL
MoNE
ROBOT
CONTEST

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 enery, 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.

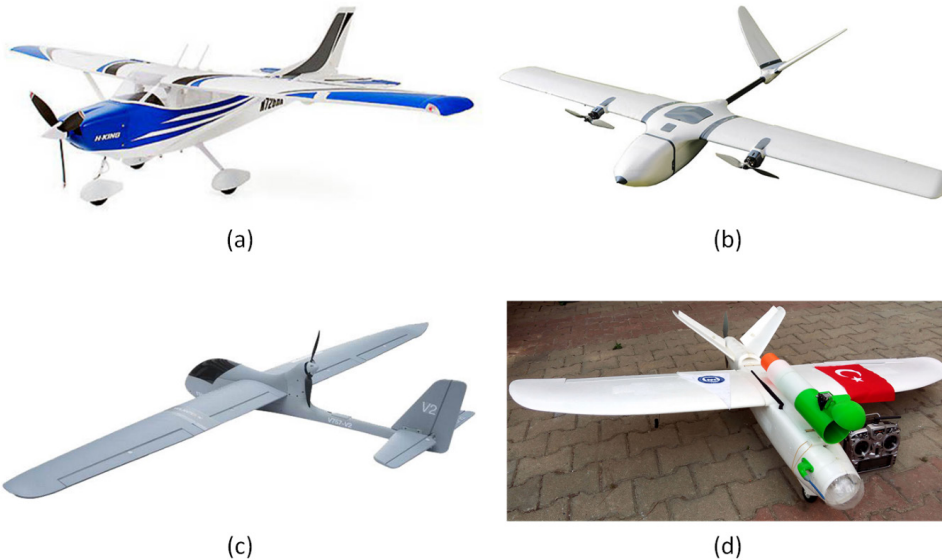


Figure-1: Fixed wings UAV pictures

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 altitude are called rotary wings. These vehicles that have one,two,four,six and eight propellers are named respectively helicopter, tricopter, quadcopter (quadrotor) ,hexacopter and octocopter that all are latin words . Because body is fixed while wings are rotating , it is not necessary to move continuously 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 because of expensive electronics parts such as motor and driver depends on number of propellers. Their flight range is short. Rotary wings UAVs which have different kind of propellers are shown at figure-2.

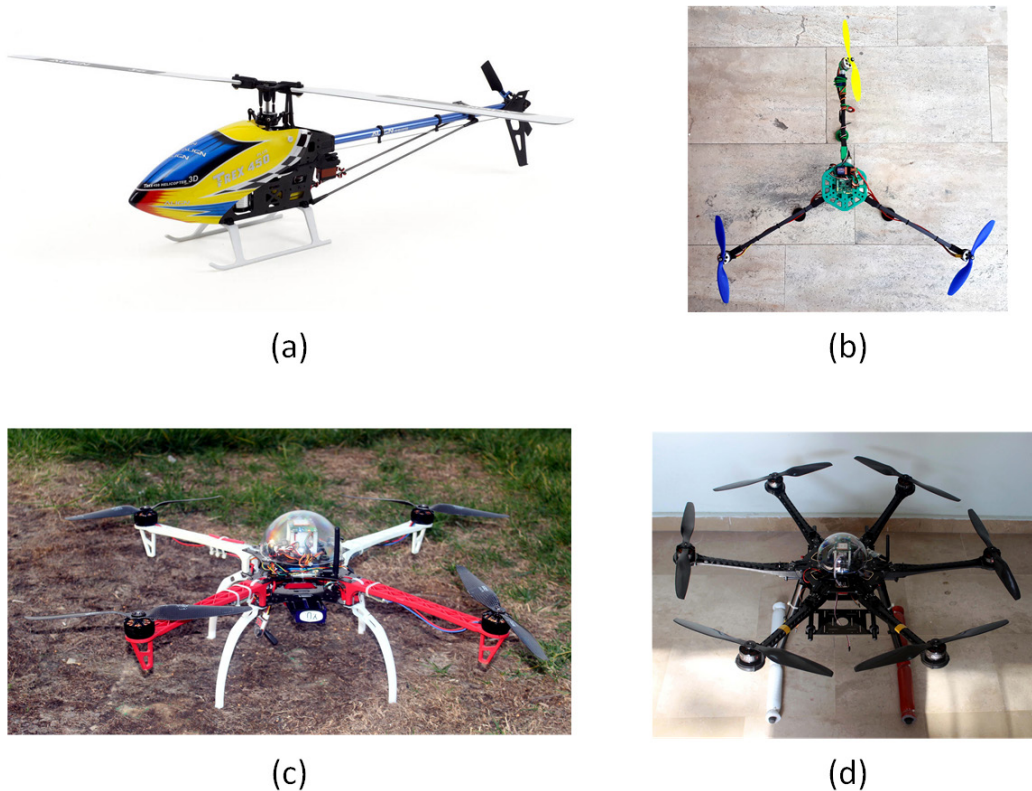


Figure-2. Rotary wings UAV pictures: Helicopter (a),Tricopter (b) , Quadcopter (c) , Hexacopter (d)

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 different 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 possibilities to damage at moment of accident. 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 depends 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 supply 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 available 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”)

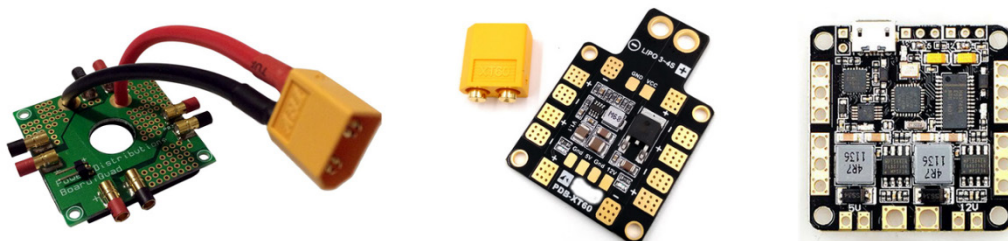


Figure 10: Sample power distributor,power supply pictures

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 advised 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”)

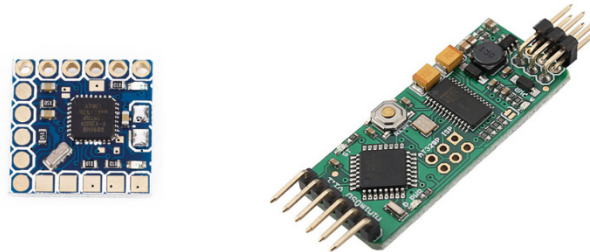


Figure 14:Sample OSD modules pictures

3.10. Propeller: It should has proper size which motor can drive and proper length 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 length is 6 inch and screw pitch is 4,5inches), 5-7 inches radius can be selected. You should buy twin props , one has direction of CW, the other has direction of CCW. Props are most easily 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”)

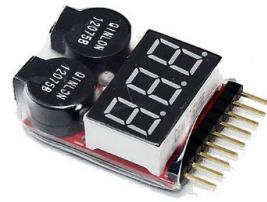


Figure 16. Sample LiPo battery alarm.

- 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. 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.
- 3.15. 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 technical check before the competition. The team that does not comply with even one of these rules will not compete.



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



4. FLIGHT ZONE

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

- 4.1. The competition will be held in the gymnastics hall within the Naim Süleymanoğlu Sports Complex on a track measuring 35 x 23 metres. Sample pictures of the competition venue are shown in Figure 19, Figure 20, Figure 21 and Figure 22.



Figure 19



Figure 20



Figure 21

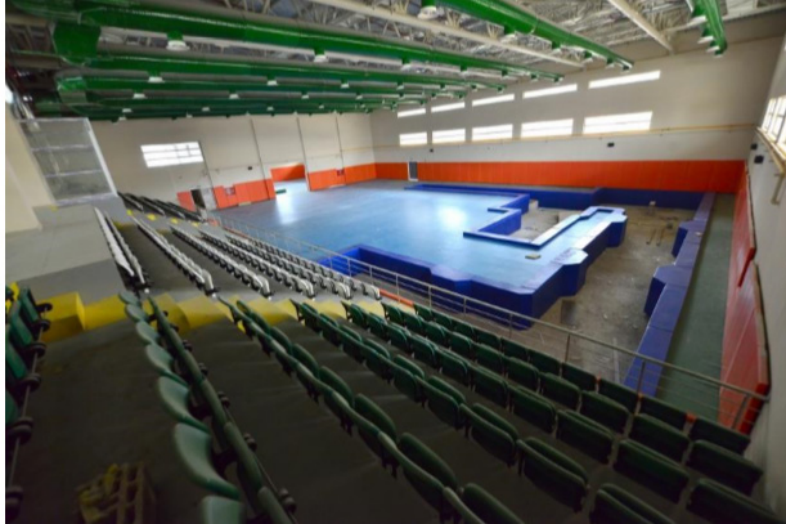


Figure 22

4.2. It is foreseen that the settlement in the competition area will be as shown in Figure 23

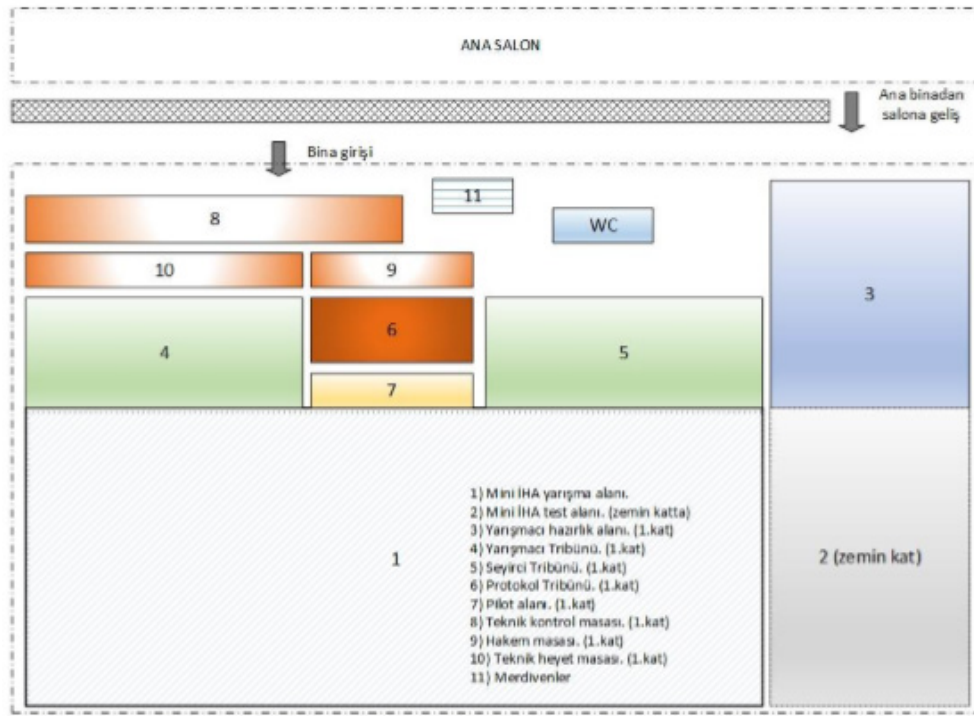


Figure 23

4.3. The competition environment is planned to be semi-dark. For this reason, the obstacles to be used on the track consist of illuminated geometric shapes. Sample obstacles are envisaged to be as shown in Figure 24. In addition, sample images of the competition environment can be accessed by searching the keywords "neon led drone race" on platforms that offer video content on the internet.



Figure 24 Sample barriers made by Neon-leds

- 4.4. Genel yerleşim planında Şekil 23'te görülmekte olan 3 numaralı alanda yarışmacılar, Mini İHA'ları üzerindeki son değişiklik, ekleme, kontrol ve düzenlemeleri yapabileceklerdir. Ayrıca bataryalarını şarj edebilmek için 3 numaralı alanda 220VAC priz imkanı olacaktır. Yarışmacılar, isterlerse sıraya girmek kaydıyla yerleşim planındaki 2 numaralı test alanını uçuş testlerini yapmak için kullanabileceklerdir. (Teknik sebeplerle yarışmacı hazırlık alanı, ana salon içerisinde farklı bir odaya taşınabilir.)

5. RULES

This rules is subject to change by the competition committee. (Any updates will be published in official web site. <http://robot.meb.gov.tr> Please check the version number of cover page in this document no body.)

- 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 the application guide.
- 5.4. Each team consists of two students (one pilot and one observer)
- 5.5. Pilot will control drone by using FPV or watching LCD screen. Competition committee will not provide camera/screen and 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 as shown figure 25. 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 committee may change duration. Each team has maximum two test rights to participate qualification tours in this period. (According to participation number, competition committee may change test numbers)
- 5.9. No extra time will be given to teams that cannot use their two rights.
- 5.10. The order of participation of the teams in the qualifying rounds will be determined by the draw to be organised before the competition. Competitors who do not come to the technical control tent even though they are called with an announcement will lose their turn and will be placed in the last row. Teams that have completed their first qualifying



round and want to use the second one will be added to the end of the list determined according to the result of the draw.

- 5.11. Best score of teams will be registered as team score.
- 5.12. Top 32 teams listed according to team score will get right to race in second phase
- 5.13. Considering the number of competitors, teams will compete alone or in pairs in the qualifying rounds Drone will take one lap at qualification tour. Lap time will be tour score.
- 5.14. In the qualifying round, teams will take two laps on the track. The time to complete two laps will be considered as the qualifying lap time. (The number of laps can be changed by the race committee.)
- 5.15. In all races in the second stage, four Mini UAVs will compete together in the competition area at the same time.
- 5.16. In all races in the second stage, except for the final race, groups of 4 will be determined by lot.
- 5.17. 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 starting position in quarter-final races). In group, drone which got best time in previous race starts 1.position, lowest time score starts 4th position.

1. STAGE (FIRST 2 DAYS)

PHASE 1 :QUALIFYING RACES

All teams race in this phase.
Race order is determined by lot
Each team takes two laps of the track alone or in two teams
The time at the end of two laps is registered as the "phase 1- lap time".
Each team has maximum two rights to lap in this phase

2.STAGE (NEXT 2 DAYS)

PHASE 2: ELIMINATION RACES

-Top 32 teams in phase1 join to elimination race
-Teams takes two laps of the track in group of four
-Group number $32/4 = 8$
-Teams in each group are determined by lot
-Start positions of teams in group are determined according to result of qualifying races

PHASE 3: QUARTER FINAL RACES

-Best two teams in each group in phase2 (total $2 \times 8 = 16$) join to quarter final race
-Teams takes two laps of the track in group of four
-Group number $16/4 = 4$
-Teams in each group are determined by lot
-Start positions of teams in group are determined according to time result of phase2

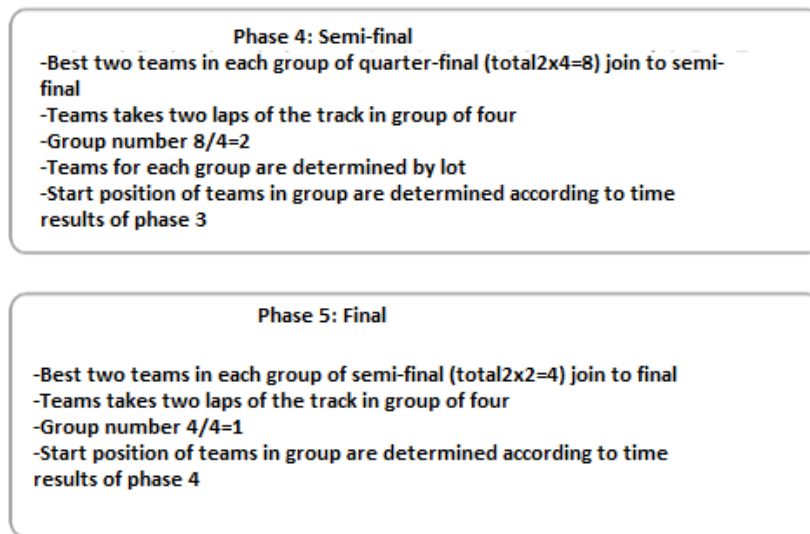


Figure 25 Competition Plan

- 5.18.** First two teams of each group in the second phase will race in quarter-final
- 5.19.** First two teams of each group in quarter-final will go to semi-final
- 5.20.** First two teams of each semi-final group will get right to race at final
- 5.21.** Four teams will race at final race.
- 5.22.** At the start of all races, the judges will check whether the competitors' image transmission systems are working on the correct channel and at the correct power. Afterwards, the initial start-up (ARM) control of the Mini UAV will be performed and it will be checked whether the remote controls are working or not. Teams that have problems with the image transmission system or ARM control will be given a short technical break to correct their problems. The length of this time will be determined by the referees.

At the end of this time, the teams that continue to have technical problems will lose their place and will be moved to the back of the queue and will be considered to have used their first right. In all races in the second stage, the teams that cannot solve the problem within the technical break given will be eliminated from the competition and the remaining teams will compete.

- 5.23.** Starting time of each team will be detected 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.

Technically, the LAP Timer starts the timer by using the signals of the image transmitters on the Mini UAVs. In some cases, the LAP Timer does not detect the first passes of the Mini UAVs. In such cases, since the timer does not start, the race must be restarted. In order to overcome this unavoidable failure due to technical reasons, the perception of the first pass of all competing UAVs through the first obstacle by the LAP Timer will be checked by the referees. In the event that the passage of even one competitor is not detected, the referee will restart the race.

- 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. These images will



also be recorded with a DVR device. Herewith, judge can check and decide every moment and action of racing. Thus, the referee will check whether the competitor passes the obstacles in the correct order, whether he/she skips obstacles in between, and whether he/she complies with the race rules. Accordingly, a time penalty will be given to the competitor when necessary.

- 5.25.** Each team will compete with its own video transmitter (VTX) and goggles. The VTX modules to be used by the teams must support the standard 48-channel analogue race band. Their broadcast power must be set to 25mW. Only a single analogue VTX broadcast will be made over the mini UAV. Teams found to be broadcasting more than one VTX will cancel the other VTX modules within the short time given by the referees. In this case, the team may be eliminated from the competition according to the decision of the referee.
- 5.26.** Each competitor will be allocated a broadcast channel by the referees before the competition. Competitors will bring their own VTX modules and FPV goggles to the channel determined by the referees. In the final checks before the competition, a special measuring device will be used to measure whether the Mini UAV is broadcasting more than one VTX, the VTX broadcast power and channel. Competitors who have not acted in accordance with the rules must bring their Mini UAVs into compliance with the rules. Otherwise, at the discretion of the referee, the team will be eliminated from the competition.
- 5.27.** Mini UAVs that collide with each other during the race, hit an obstacle or fall to the ground as a result of individual error, or whose image transmission system is damaged, will be able to continue the race from where they left off if they can take off. The time they stay on the ground will be included in the race time and the competition time will not be stopped for the team. For Mini UAVs that cannot take off for whatever reason, the race will be deemed to be over.
- 5.28.** If judge decides that any action were unsafety (such as flying very high altitute etc) is unsafety, it is a reason for disqualification
- 5.29.** Entering flight area without permission is forbidden. Competitors can only enter with judge permission in case of emergency (Drone crash, battery fail etc.). Otherwise , team will be disqualified.
- 5.30.** In case of ungentlemanly behaviour and cheering, if it is possible to identify the school of the person or persons committing the act, all teams of the school in this category will be penalised 20 seconds each
- 5.31.** Teams that are detected by the referees to have skipped the obstacles on the course during the race or to have passed the obstacles in the wrong order are penalised 10 seconds for each mistake. The maximum number of obstacles that can be skipped (penalised) accidentally or intentionally in a stage is 5, and skipping more than 5 obstacles is a reason for exclusion from the competition.
- 5.32.** Since the competition will be held in semi-darkness, Mini UAVs must be visible to pilots and spectators. In order to ensure visibility in the dark environment, Mini UAVs must have remarkable LED lighting on them. Teams without conspicuous LED lighting will not be allowed to compete.



6. DRONE SPECIFICATIONS

- 6.1.** Distance between diagonal motor axes must be between 180-270mm. 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 min 4 inch , max. 5 inch.
- 6.5.** The mini UAV will be equipped with a single VTX module capable of broadcasting in the analogue race band and supporting 25mW broadcast power. Teams will provide their own VTX modules, FPV goggles or LCD screens. As in previous years, "pilotage camera and image transmission system PKGA" will not be provided by the competition committee.
- 6.6.** In order to be seen by other pilots and spectators doing FPV, the Mini UAV will be illuminated with remarkable LEDs. The number, colour and pattern of LEDs to be used can be selected as desired. However, the lighting must be in quantity and quality to ensure that the Mini UAV is recognised in a dim environment.
- 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 disqualified
- 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 ARm/Disarm function. 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 invisible, 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 easily 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 dismantled 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. If necessary, at the discretion of the referees, the UAV and its team will be excluded from the competition.

8. CONTACT

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

iha.robotyarismasi@meb.gov.tr

9. COVID PANDEMIC RULES INSIDE THE FIELD DURING THE COMPETITION

- a. Follow hygiene rules
- b. Keep social distance