ROBOTAXI-FULL SCALE AUTONOMOUS COMPETITION

2024

Content

VERSIONS		
Version	**Date**	**Explanation**
V1.1	16.12.2023	TEKNOFEST 2024 First Version

1. PURPOSE OF THE COMPETITION

Autonomous vehicles are no longer a figment of the imagination as depicted in the science fiction series of the 90s. Today, many technology companies are conducting research and development activities on this subject with large budgets. Autonomous vehicles are already cruising in city traffic in some pilot regions of the USA. Developments in automated driving / autonomous vehicles will continue to accelerate and these concepts will take a serious place in the concept of mobility in 2030 and beyond.

According to the Turkish Statistical Institute's (TÜİK) data for 2022, driver errors account for 86.8% of the causes of traffic accidents. Since autonomous vehicles minimize human error, their contribution to traffic safety is quite high. In addition, factors such as inappropriate route selection and selfish driver behavior, which are of great importance in traffic density, can be eliminated by autonomous vehicles. Therefore, autonomous vehicles will be indispensable elements of the cities of the future.

Robotaksi-Binek Autonomous Vehicle competition is organized to ensure the development of autonomous vehicle technologies in our country as well as to ensure the development of the ecosystem in mobility vehicles, sensor technologies, autonomous control algorithms and artificial intelligence.

In the rest of the competition specifications, the Robotaxi-Robotaxi-Passenger Autonomous Vehicle will be referred to using the name "Robotaxi".

1.1. Competition Categories

The competition will consist of two categories: Unique Vehicle Category and Ready Vehicle Category.

1.1.1. Unique Vehicle Category

This category includes the competing teams that will participate with a vehicle that meets the conditions specified in the Vehicle General Specifications section in section 4.

Teams can participate in this category with donated or previously produced vehicles. However, the team is responsible for the entire structure of the vehicle and its compliance with the specifications.

1.1.2. Ready Vehicle Category

The TEKNOFEST Committee will provide a fully equipped electric vehicle platform with a certain number of drive-by-wire platforms to be used in the competition for teams that only want to make software developments. The fully equipped vehicle platforms, which will be in a certain number, will not be provided on a team basis and will be opened for common use. The fully equipped vehicle is planned to have equipment such as distance sensor, camera, communication system, control card. Teams are required to

develop the necessary algorithm software by processing the data from the necessary sensors in the vehicle.

After the preparation phase of the fully equipped vehicles is completed, the vehicles will be made available to the teams that have passed a certain stage. The usage times of the vehicles will be set with an appointment system and teams will be able to test their software on the vehicles during those times. Technical specifications of the vehicle platform and user manual will be shared with the teams later.

The competition tasks will be the same for both categories and the course will be subject to changes in signs and traffic lights.

1.2. Competition Reporting Process

- ✓ Technical Qualification Form Phase
- ✓ Critical Design Report
- ✓ Vehicle Test Video, Simulation and Presentation
- ✓ Final

1.3. Conditions of Participation

1.3.1. Team

Since the design and development of autonomous vehicles involves different disciplines, participants must participate in the competition as a team.

High school, university students and graduates can participate in teams. Participation as a private sector is not allowed.

✦ Teams do not have to be school (university/high school) clubs.

✦ Teams can be formed from a single school or as a mixed team with one or more high school/higher education students.

✦ Teams;

O The Ready Vehicle category should consist of a minimum of 3 and a maximum of 25 people.

(Numbers do not include consultants)

O The Unique Vehicle category should consist of at least 5 and at most 25 people.

(Numbers do not include consultants)

The number of team members who can take part in the final will be announced later.

1.3.2. Application

✦ Applications to the competition are received separately in the Uniqe Vehicle and Ready Vehicle Categories.

✦ Applicant teams can only register for one of the categories.

✦ A member of a team cannot be a member of another team within the Robotaxi Competition.

✦ Each team that will apply through the Unique Vehicle category can participate in the competition with only one vehicle.

1.3.3.3. Education Level-Advisor

✦ High school level teams are required to have an advisor.

✦ The finalist teams are required to upload their approved student documents, and for the advisors, the approved document showing that they are faculty members/assistants, research assistants or teachers to the area to be opened on the CMS platform.

Undergraduate, graduate students and graduate level teams do not have to have an advisor, they can take a lecturer/member or research assistant as an advisor.

✦ The highest level of education among the members of the team determines the education level of the team.

✦ They have to submit the assignment letter of the advisor to be taken from the relevant education / training institutions in writing to the TEKNOFEST Committee. (This document must be given within the change of advisor.)

✦ In case of a change of advisor, they must notify the relevant TEKNOFEST Committee in writing.

✦ Each team **can have** only one advisor.

✦ An advisor can only advise one team.

✦ The role of the advisor in the team is to provide the academic support needed in the project and to guide the team members to find solutions to their problems.

1.3.4. Other

✦ Teams that have been finalists in previous years must have developed their projects/vehicles/autonomous software and indicate in their reports that they have participated in the competition before.

✦ The applications of the teams that do not meet the above conditions will be deemed invalid.

✦ Applications will be made through the official website of the Aviation, Space and Technology Festival TEKNOFEST Technology Competitions (www.teknofest.org). No application will be accepted after this date **(29.02.2024)**.

2. CONTEST TASK

The Robotaxi will operate on a track that reflects a full-scale urban traffic situation. The vehicle's task is to travel an urban route starting from a fixed point (BN: starting point) and ending at an end/stop point (DN: end/stop point), similar to a typical urban taxi.

During this journey, the Robotaxi will stop at the first available stop sign (YA: passenger pick-up point), pick up the passenger and continue its journey. Robotaxi will drop off the picked passenger at a marked point on its route (YB: passenger drop-off/pick-up point). The robotaxi will obey traffic rules throughout the journey and will stop at the end point. Robotaxi will have successfully completed its mission by parking in an empty space that can be parked in accordance with the rules in the parking lots at the end of the end point.

2.1 Track

Robotaxi will operate on a full-scale track. The competition track is shown in Figure 1.

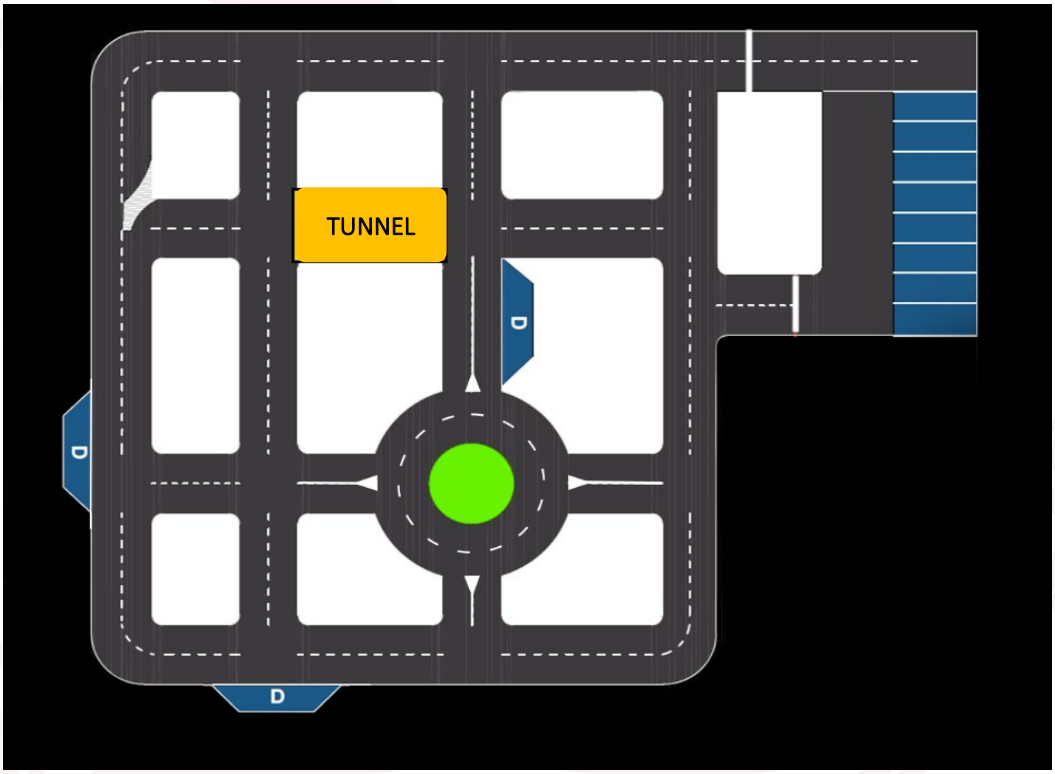


Figure 1 Map Boundaries of Robotaxi-Full Scale Autonomous Vehicle Competition

The vehicle will be expected to move within the lane as in normal traffic. The starting point of the course will be marked with a straight line perpendicular to the course of the road. The end point will similarly be marked with a straight line perpendicular to the road.

There will also be many traffic signs on the course. Typically there will be directional signs, no-turn signs, pedestrian crossing signs, traffic lights and stop signs.

The path that Robotaxi will follow will be determined by lane markings. There will be barriers for safety purposes so as not to touch these lanes and not to interfere with the viewing of the imaging devices. There will be no sidewalk or similar elevation before the barriers. The height of the barriers is expected to be between 50cm and 100cm. Barriers will only be placed around the competition course for security purposes.

Robotaxi parking area is arranged in such a way that the vehicle can park vertically. The entrances of the parking lots will be open. The other three sides will be marked with straight and uninterrupted white lines. There will be the barriers mentioned above around the parking lot.

2.2. Traffic Signs

Various traffic signs will be used throughout the autonomous vehicle track and vehicles will be expected to obey these signs. All signs will comply with the General Directorate of Highways Traffic Signs standards.

These standards are available at the link below.
https://www.kgm.gov.tr/SiteCollectionDocuments/KGMdocuments/Trafik/IsaretlerElKitabi/TrafikIsaretleriElKitabi2015.pdf

Some examples of traffic signs to be used are shown below:

Figure 2 Examples of traffic signs

It should be noted that other traffic signs in accordance with highway standards, not mentioned above, may also be used in the competition.

The location of traffic signs next to the road is shown in the figure below.

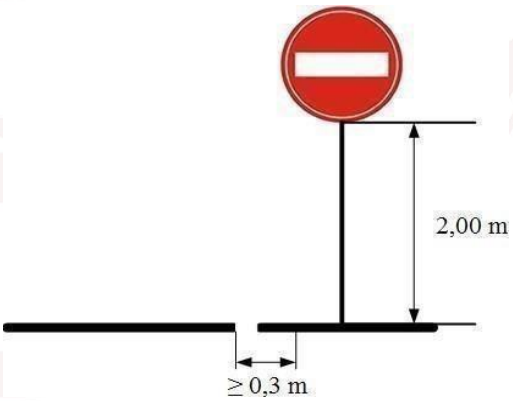


Figure 3 Location of traffic signs

Parking and stop signs are shown in the next figure.

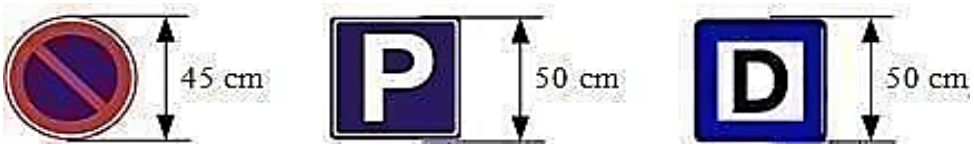


Figure 4 No Parking (left) Parking Lot (Center), Stop (right)

In addition, the starting point will be single line white and uninterrupted. The stopping point will also be like the starting point.

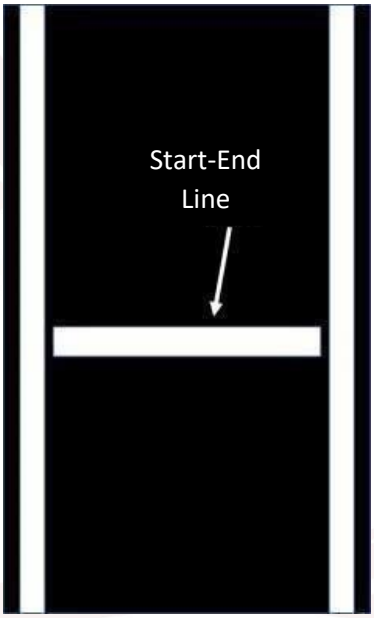


Figure 5 Start and end points

The passenger pick-up point (YA) will be the stop sign shown in Figure 4. The same sign will be used as passenger drop-off sign.

The traffic light dimensions to be used are shown below

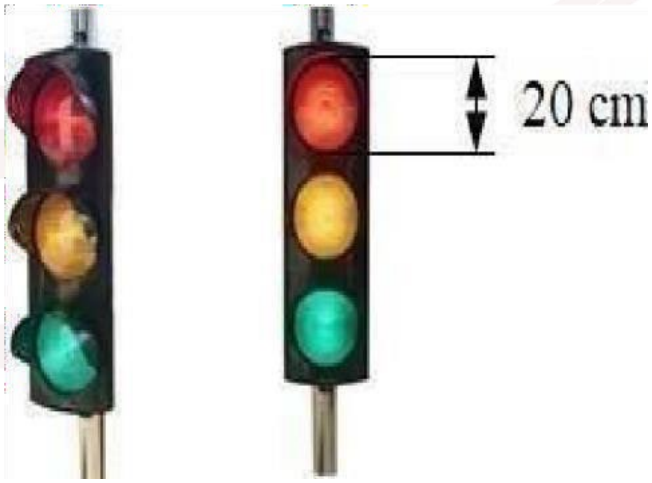


Figure 6 Traffic Light

The measurements of the parking area are shown in the figure below. The color and

thickness of the parking lot line shall be similar to the regular parking lot lines traffic.

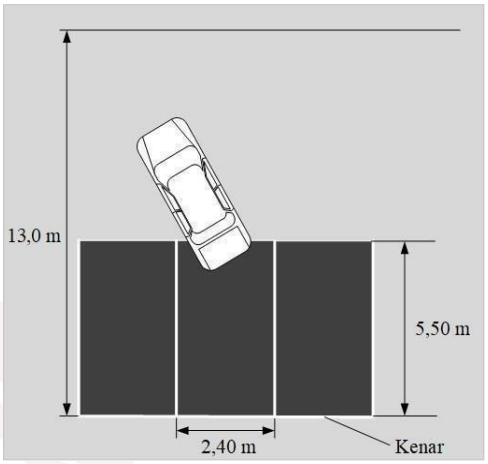


Figure 7 Parking Lot

2.3. Barriers

Plastic road barriers, traffic cones of different sizes and moving objects can be used as obstacles in the competition. Sample obstacle images are given below. Vehicles are expected to avoid the obstacle by changing lanes or moving to other areas within the lane depending on the location of the obstacle.

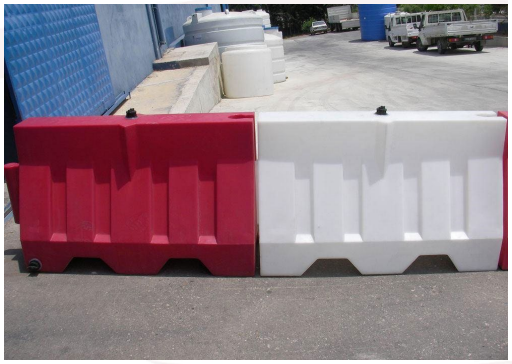


Figure 8 - Road Barrier and Traffic Cone

2.4. Task

Robotaxi will perform a typical mission in the city. This mission will start with the vehicle moving from the starting point and will end with it parking after reaching the end point.

The number of attempts to complete the task for each participating vehicle will be determined by the committee of judges in the final according to the number of teams. The time to complete the task is 15 minutes. The order of the first attempt will be determined by lot. A single draw will be made before the start of the races. The order of the draw will be taken as the basis for the trial rights and competition time.

Once the teams have their software ready, they will determine by lot which two of the three stops they can use, the positions of the obstacles and the parking spaces in the parking lot before starting the competition.

The vehicle to perform the task will be brought to the starting point by the team. After the vehicle is started, there will be no one on the track except the emergency stop pilot from the team. The vehicle will proceed completely alone on the track. (If the TEKNOFEST Competitions committee deems it necessary, it may have people on the track to follow or record the vehicle, so as not to affect the competition).

The started vehicle must start the mission within 60 seconds at the latest. Within 60 seconds, the vehicle that cannot start the mission will be deemed unsuccessful in that trial/event.

After the vehicle moves, it will continue on its way by obeying traffic rules. The traveling vehicle will stop at the first passenger pick-up sign it sees. In order for the vehicle to pick up passengers successfully, it must stop within the area shown in Figure 8. The vehicle will wait at least 30 seconds for passenger pick-up. Vehicles that move without waiting for 30 seconds and vehicles that wait for more than 90 seconds will be considered unsuccessful in the passenger pick-up task.

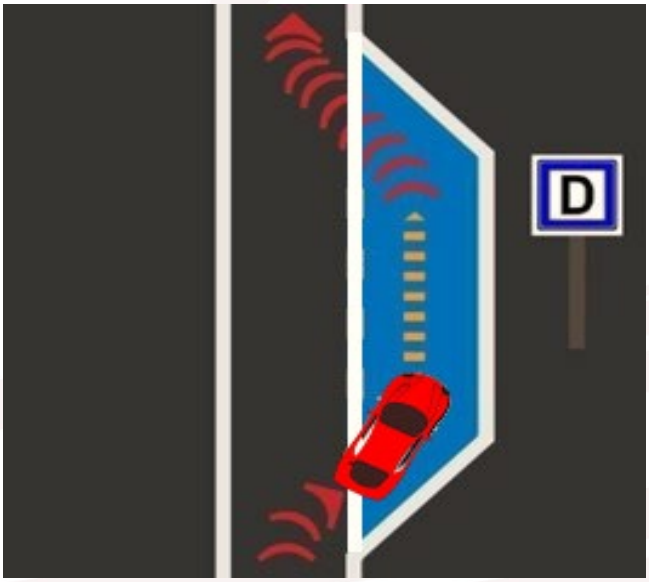


Figure 10 - The process of stopping at a bus stop

2.4.1. Passenger Pickup

Passenger pick-up will take place at a stop in a pocket on the main road. It is illustrated in Figure 8 above. The vehicle must signal in the direction of the direction when entering the pocket. After that, the vehicle will follow the traffic rules as it continues its journey. The vehicles will need to decide which route to follow for the rest of the task to get to the end point. This decision can be influenced by the length of the route and the condition of the signs on the road. Vehicles that move without waiting for 30 seconds and vehicles that wait for more than 90 seconds will fail the passenger pick-up task.

2.4.2. Passenger Drop Off

The traveling vehicle will drop off passengers when it sees the stop sign for the 2nd time. In order for the vehicle to successfully drop off passengers, it must stop within the area shown in Figure 8. The vehicle shall wait at least 30 seconds for passenger drop off. Vehicles that move without waiting for 30 seconds and vehicles that wait for more than 90 seconds will be considered unsuccessful in the passenger drop-off task.

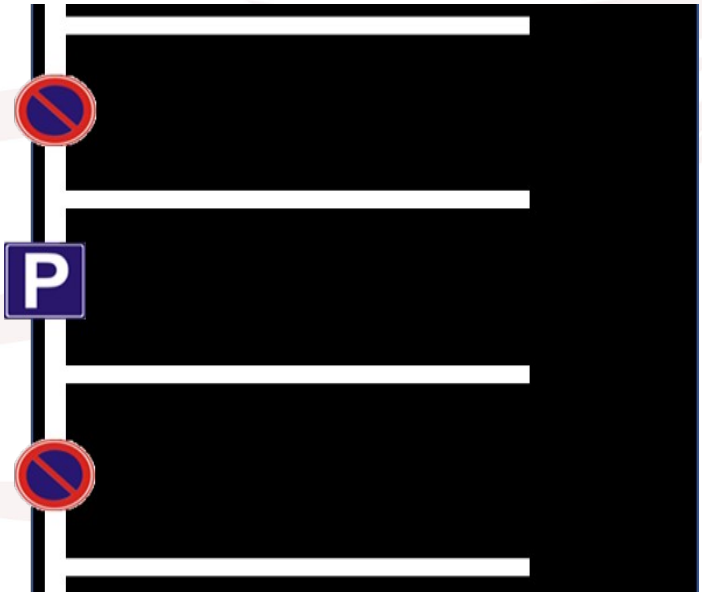
2.4.3. End Point

The vehicle will have completed the route when it reaches the finish point (when the front of the vehicle reaches the start of the finish line). This time will be measured. The team that fails to reach the finish point within the maximum time will be considered unsuccessful for that event.

2.4.4.4. Park Construction

After the end point, the vehicle will autonomously drive to the parking lot and park in the parking lot according to the rules. Successful parking is when the vehicle parks and stops without violating any traffic rules and staying within the lanes. The wheels of the correctly parked vehicle do not touch the lanes bordering the parking space. A vehicle that parks correctly within 3 minutes after reaching the end point will be considered successful in the parking task. If 3 minutes are exceeded, the parking task will be invalidated. The parking area will have a capacity of at least 3 vehicles. Some of them will be marked as no parking. Parking spaces marked as parkable may be occupied by vehicle(s) previously positioned by the competition or by various obstacles preventing parking. Parking and no parking signs are shown in the figure below.

Figure 11 - Parking and no parking signs



This sign will be placed at the end of the parking lots. This placement is shown in the figure below.

Figure 12 - Parking signs.

Two of the 3 parking spaces are marked as unparkable. The other one is marked as parkable. These signs will be placed 2m above the ground.

Robotaxi can choose a parking lot according to the rules with no parking bans and park. Parking and no parking areas may be different for each team during the competition.

Penalty points will be applied for traffic rule violations while driving. Penalty points are explained in table-4 of chapter 6.

The vehicle will be monitored with external cameras from the top throughout the race and violations will be recorded. The course referees will monitor the offending vehicle instantaneously and follow whether the sub-tasks are successful or not.

2.4.5. Task Restrictions, Requirements and Permissions

2.4.5.1. Restrictions

✦ Robotaxi must complete the track task within 15 minutes. If the task/track cannot be completed within the specified time, the vehicle is stopped on the track and the task is terminated.

There are lane narrowings on the track. The vehicle must change lanes according to the rules.

✦ The vehicle must signal when changing lanes.

2.4.5.2. Requirements

Our competitors who will compete in the Ready Vehicle Category must bring their own monitor, keyboard and mouse for each team to use the vehicle during the test and competition process.

2.4.5.3. Permits

In both categories, mapping technology used in today's autonomous vehicle technology will be allowed. Teams are expected to dynamically perform path planning (such as traffic lights, dynamic obstacles, closed stop areas, closed parking lot area).

2.5. Data Package

Competitors are required to record information such as GPS coordinates of the robotaxi vehicle, sign reading information, orientation information, obstacle avoidance information, stop duty information, etc. in real time while using their final rights. Data package examples and detailed information will be shared later in the Robotaxi-Passenger Autonomous Vehicle Competition Communication Package file.

Teams are required to create these files, the data package files of the teams that have successfully completed their task will be checked at the end of the competition. Otherwise, the teams' tasks will be considered unsuccessful.

3. Competition Reports and Presentations

Within the scope of the competition, two reports, namely Technical Qualification Form and Critical Design Report, will be requested from the teams. In addition, teams may

be asked to make a presentation at the end of the competition in line with the decision to be taken by the referee committee at the final time. Teams that successfully complete the Critical Design Report process will be asked to make a Vehicle Test Video, Simulation and Presentation.

These reports and presentations will be included in the evaluation if requested by the review committee.

3.1. Technical Qualification Form

Each team applying to the Robotaxi competition is obliged to prepare the technical qualification form by the deadline specified in the competition calendar and upload it to the relevant field in the CMS by the advisor and team captain. Teams that do not submit the form by the specified deadline will be deemed unsuccessful and will not have the right to participate in the competition.

The form must be uploaded on the day specified in the calendar: 22:00 on the day specified in the calendar. The TEKNOFEST Competitions Committee has the right to make changes in the calendar and hours.

Teams applying to the Robotaxi competition will prepare the technical qualification form in accordance with the Technical Qualification Form Template. Teams that do not include the information requested in the form template in their reports will be eliminated.

The technical qualification forms of the teams applying to the Robotaxi competition will be evaluated by the Robotaxi Competition Advisory Board and Referees in accordance with the "Technical Qualification Form Template". As a result of the evaluations, the teams that will be accepted to the next stage will be determined, and the teams that will not be accepted to the competition will be eliminated. Technical Qualification form evaluation results will be announced to the teams on the date specified in the competition calendar.

The Technical Qualification Form Template will be published on the competition website (teknofest.org).

3.2. Critical Design Report

Teams that have successfully completed the Technical Qualification Form process are obliged to prepare their critical design reports by the deadline specified in the competition calendar and upload them to the relevant area in the QMS by the advisor and team captain. Teams that do not submit their reports by the deadline will be deemed unsuccessful and will not be entitled to participate in the competition.

The report must be uploaded on the day specified in the calendar: 17:00 on the day specified in the calendar. The TEKNOFEST Competitions Committee has the right to make changes in the calendar and hours.

Teams applying to the Robotaxi competition will prepare their critical design reports in accordance with the Critical Design Report Template. Teams that do not include the information requested in the report template will be deemed unsuccessful.

The critical design reports of the teams participating in the Robotaksi competition will be evaluated and scored by the Robotaksi Competition Advisory Board and Referees in accordance with the "Critical Design Report Template". As a result of the evaluations, the teams that will be accepted to the competition will be determined and the teams that will not be accepted to the competition will be eliminated. The evaluation results of the critical design reports will be announced to the teams on the date specified in the competition calendar.

Teams above the barrage score to be determined according to the results of the Critical Design Report will continue the competition and financial support will be given to the number of teams determined by the Competition Advisory Board and the Referee Committee. Other teams above the barrage score will continue the process without financial support.

The Critical Design Report Template will be published on the competition website (teknofest.org).

3.3. Vehicle Test Video - Simulation - Presentation

The Vehicle Test Video is an uninterrupted video that demonstrates that the vehicle that will participate in the competition can operate safely, move autonomously, and move in the desired direction. The video content includes two sub-videos. The first sub-video takes the driver's seat and steering wheel in full frame. The second sub-video fully frames the vehicle and its movement from outside the vehicle. Both videos must be shot at the same time. The Vehicle Test Video should show that the vehicle can autonomously travel 20 meters along the road and stop when it encounters an obstacle. It should be shown that the vehicle can move from one point to another point on a straight road since the vehicle starts moving autonomously. The resolution of the video must be at least 720p and the total duration must be at least 2-3 minutes and at most 5 minutes. In order to participate in the competition, the video must be submitted by the date specified in the competition calendar.

The simulation will be carried out in any simulation environment that meets all the conditions specified in this specification and will be presented verbally to the evaluation board.

The aim of the simulation is to demonstrate the skills required for the realization of the tasks in the TEKNOFEST Robotaxi competition by the teams in a simulation environment.

For simulation qualifications, teams are free to choose the simulation environment. All simulation environments such as Gazebo, Unity, Unreal Engine, LGSVL/Simulator, Matlab etc. can be used. The algorithms and software to be developed in the simulation environment are expected to be adapted and used in the real vehicle (in case the teams are accepted to the competition). The vehicle and equipment (sensors such as LIDAR, RADAR, Camera, GPS) to be defined in the simulation environment must be compatible with the vehicle design submitted by the teams in the critical design report. Sensors that will not be used on the vehicle envisaged in the critical design report should not be used in the simulation.

All teams model the race course (including the vehicle for the unique vehicle) in the simulation program of their choice, within the framework of the Robotaxi race rules described in detail in this specification. The track to be created in the simulation environment must be suitable for performing the race tasks. Therefore, the track in the simulation environment should include at least the track given in Figure 1. The simulation should include algorithms for moving in lanes, route generation, obstacle avoidance in lanes, and planning movement by changing lanes on dual carriageways. All teams model the vehicle and autonomy sensors in their chosen simulation program in accordance with the Robotaxi specifications (physical characteristics) detailed in this specification. All teams complete the simulation by developing algorithms and software that will fulfill the Robotaxi Vehicle Competition tasks detailed in this specification in the simulation program of their choice. The team is expected to fulfill the criteria determined in the competition as a result of the simulation using the modeled vehicle and algorithms.

Teams will be evaluated on the criteria of environment modeling, vehicle modeling, autonomous driving, sensor modeling, obstacle avoidance, and mission execution in simulation.

In addition, the teams will be asked to present the simulation environment they have designed, the vehicle, the execution of their tasks in the simulation environment and the vehicle test video to the referee committee.

The teams that successfully complete this process and qualify for the finals will be announced on the date specified in the competition calendar.

4. Vehicle General Specifications

Teams that will compete in the Unique Vehicle category must meet the specifications specified in this section. General specifications for the Ready Vehicle will be shared later.

4.1. Physical Properties

Vehicles are expected to be passenger cars suitable for urban driving. For this purpose, vehicles (within the specified dimensions) are required to have at least 4 wheels (for a driver approximately 1.70 m tall and weighing 70 kg).

Vehicles must use electricity as fuel and electric motors in their propulsion systems. No other system other than this can be used within the scope of the competition.

4.1.1. Vehicle Dimensions

- The height of the vehicle must be at least 100 cm and less than 1.25 times the vehicle width (100 cm < vehicle height < vehicle width x 1.25 (150-225cm)).
- The distance between opposite wheels must be more than half the width of the vehicle.
- The vehicle width must not be less than 120 cm and not more than 180 cm (119 cm < vehicle width < 181 cm).
- Vehicle length must be at least 200 cm, maximum 425 cm.
- The clearance of the front wheels must be at least 100 cm and the clearance of the rear wheels at least 80 cm.

- The distance between the front and rear wheels must be at least 130 cm. The ground clearance of the vehicle must be at least 45 mm.
- There is no lower limit on vehicle weight, vehicles with doors and other components damaged in the wind that the Advisory Board and the Arbitration Committee deem unsafe (see 4.3) will be excluded for safety violations.
- Vehicles that cannot meet the required dimensions during technical controls will not be allowed to be modified by adding or removing materials on the vehicle body.

4.1.2. Vehicle Body

The vehicle body must be fixed in such a way that all mechanical and electrical parts are enclosed. When the vehicle is viewed from the front, rear and top, all parts must be completely inside the body, the wheels may protrude outside the shell (e.g. Formula cars). The shell must not touch the road, wheel or any other component. Where brake cables, pipes, hoses, electrical cables and electrical equipment must be mounted outside the vehicle, they must be protected from the risk of damage such as stone impact, corrosion, mechanical failure. All components to be mounted inside the vehicle shell must be protected from risks such as combustion and short circuit. The body of the vehicle must not have sharp and sharp protrusions that may damage the track during the race.

During technical controls, all elements that may pose a risk to the track or other vehicles will be checked.

4.1.3. Weight

There is no lower limit on vehicle weight. However, if the vehicle does not comply with the safety equipment, it may be disqualified from the race by the Advisory Committee and the Referee Committee.

4.1.4. Wheels

The wheel to be used in vehicles must consist of hub, rim and tire. It is compulsory to use pneumatic tires on the wheels. It is forbidden to heat the tires by any means or to subject them to chemical treatment. There is no restriction on the rim size of the wheels and the material from which they are made. The wheel width must be at least 70 mm.

4.2. Sensor / Detection System

The geometry of the road (lanes) and the recognition of obstacles can be done through a camera or other sensors. One or more sensors can be used to detect the position of the vehicle and its surroundings and help perform the given autonomous task.

The sensor must be securely mounted on the vehicle. Its area must not exceed the envelope defining the surface of the vehicle. Horizontally, this area is limited to the outer edges of the 4 wheels and the front and rear end points. Vertically, it may exceed the height of the vehicle, excluding the sensor, by a maximum of 30 cm.

There will be a "Sudden Brake Task" at a point determined on the competition course. Within the scope of this task, it will be asked to stop without crashing during the movement against pedestrians and similar situations that may unexpectedly

come/jump on the road in urban traffic. Vehicles that cannot fulfill the braking task will not be eligible to compete.

4.3. Security Hardware

Vehicles participating in the race must include safety measures that will not jeopardize the safety of life and property. Some general rules are listed in this section. The Advisory Committee and the Referee Committee have the authority to update this list by announcement if necessary. The Committee of Advisory and Referees may identify vehicles that may pose a risk before or during the race and exclude them from the competition.

Your vehicle must have brake, right and left turn signal lights. The diameter of the reflection surface of these lights cannot be smaller than 7cm and the amount of light cannot be less than 500 lumens.

There are no restrictions on the choice of motor and motor drive. The battery pack must be placed inside the vehicle and protected from short circuits and leakage by means of a protection container. The battery protection container must be securely fixed to a solid point on the floor of the vehicle. The fixing must be done in such a way that the fixing bracket and fixing points cannot be moved even in the event of an accident. The Battery Management System (BMS) is the electronic system that ensures that the rechargeable battery cells and pack operate within safe operating limits and its use is mandatory. For this purpose, the BMS should monitor the voltage, current, temperature, state of charge (SOC), state of charge (SOC), life estimation (SOH) of each battery cell and pack and take the necessary safety measures when the safe operating limits are exceeded. The BMS should also include a passive or active balancing system to eliminate voltage imbalances that may occur in the battery cells.

In terms of Electrical Safety; All vehicles must comply with the rules laid down by national authorities for the standardization and use of low-voltage electrical equipment. All parts of the electrical equipment must be protected with at least IP 44 type protection (dust and splash-proof), although IP 55 type protection is recommended. Any electrical connection between energy generating equipment and energy consuming units must be interrupted by at least one non-sparking circuit breaker (overhead emergency cut-off switch/emergency stop). It is sufficient to have one emergency button (See Figure 13-a, b, c).

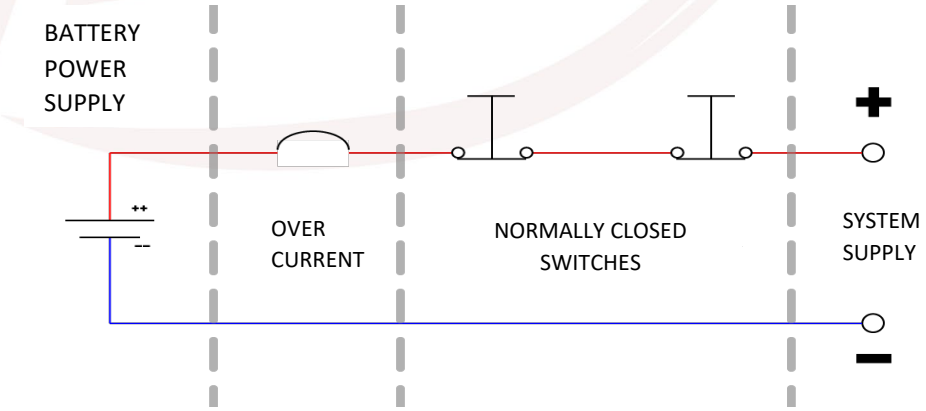


Figure 13-a. Sample de-energizing circuit with high current emergency de-energizing switch

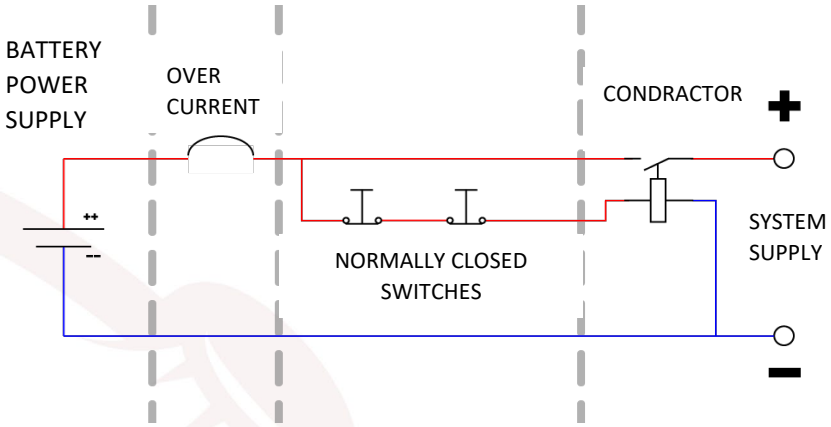


Figure 13-b. Sample de-energizing circuit with weak current emergency de-energizing switch

Figure 13-c. Examples of emergency de-energizing switches

The emergency cut-off switch must be in a place that can be easily accessed from outside when necessary. In the technical controls, after the other controls of the vehicle are completed, the functional operation of the emergency stop button will be tested by pressing it while the vehicle is running and moving.

All electrical cables in the vehicle must be protected by an overcurrent circuit breaker (fuse, etc.) of a value appropriate to the diameter of each conductor. Overcurrent breakers cannot replace the circuit breaker (emergency stop button) in any way. Cables must be in suitable cable sheaths and bare cables must not be used. Cable bundles must be properly clamped. In addition, the value of the maximum RMS current carried by the cables used in the vehicle must not exceed 5 times the cross-section of the cable used in mm2 unit. (For example, the maximum current that can pass through the 16mm2 cable used in the vehicle should be 80A RMS).

The braking performance of the vehicle will be checked by braking. At the rear of the vehicle, a stop lamp that can be seen from a distance of at least 25 meters in the daytime, gives a red light and will be activated in case of full or half pressing the brake. In technical controls, it will be checked whether the stop lamps can be easily seen from a distance of 25 meters.

4.3.1. Brake

Your brake assembly, which is the stopping system of your vehicle, must be strictly mechanical. An electrical stop will not be allowed.

4.3.2. Remote Emergency Response System (UMS)

The autonomous vehicle must have a UMS. The UMS should have two functions:

IAS-1: The vehicle must make an emergency stop when the remote emergency stop button is pressed.

UMS-2: When the Go button is pressed, the vehicle must start its mission. This button will replace the start flag in other races.

The on-board UMS circuit will be connected directly to the vehicle with a cable. In technical controls, UMS-1 and UMS-2 functions will be tested to be working.

4.3.3. Control System

All movement of the vehicle (road following, braking and steering maneuvers) will be performed by the on-board control system or computer. This control will be provided by electromechanical systems. It must be demonstrable in technical controls that the software that realizes the control algorithms works correctly.

(When software is shown, it should be shown in Intermediate and High level languages for easy understanding of the functions).

4.3.4. Wireless Communication System

The start of the mission is given to the vehicle via remote wireless communication. This system must also fulfill the emergency shutdown function.

The team is responsible for demonstrating that wireless communication does not interfere with the autonomous driving of the vehicle during the mission. Any changes to the vehicle (changing parameters, updating software, sending commands, etc.) via wireless or any other type of communication during the mission will not be allowed.

It is strictly forbidden to communicate with the vehicle in any way other than the systems mentioned above. The vehicle will never be controlled remotely.

Technical controls of autonomous vehicles will be carried out according to the following points:

It will be checked whether the vehicle complies with the rules regarding communication.

Participants have to prove that their vehicles can perform the autonomous mission. This will be checked by the Advisory Board and the Committe of Judges through the competition evaluation report and presentation.

4.3.5. Assembly and Cabling Elements

The autonomous in-vehicle drivetrain must be structurally and chemically suitable for its task and environmentally reliable. For this, various considerations must be taken into account during Assembly and Cabling.

4.3.5.1. Assembly

✦ Silicone etc. adhesive cannot be used for fixing parts that have a certain force or that will be subjected to force in the process and that may experience rupture / dislocation as a result of these forces. (There is no harm in using it in simple bonding).

✦ Fastening/connection of sections in critical areas must be done with suitable fastening equipment (bolts, rivets, etc.).

✦ For screw connections, make sure that the nut is fully tightened.

✦ No part should move abnormally when the car is ready.

Unsuitable connection equipment may not be used.

✦ Electronic components cannot be mounted on two potential moving parts.

4.3.5.2. Cabling

✦ Cables should be selected according to the task.

✦ Cables touching hot areas must be insulated from heat.

✦ Protect the cable from punctures, cuts and chipping.

✦ Precautions should be taken to prevent damage to the cable in cases such as pushing and pulling (the copper inside the plastic may break, the plastic may break, come out of the connectors or break the connector, etc.).

✦ Cable bundles must not be kept loose. Bundling devices such as cable socks should be used.

✦ Cables must be labeled. (To save time and prevent possible accidents during the competition).

✦ Power cables must be properly selected, laid inside the vehicle, protected and insulated.

The color selection of the cables should be as standardized as possible.

✦ When selecting the color of the power cables, (+, plus) line Red (-, minus) line Black color should be used.

✦ When using cable ties, care must be taken to ensure that the cable is not exceeded and precautions must be taken.

✦ Power drivetrains must not be transferred directly, connectors must be used (direct soldering from board to board, etc.).

✦ Data and signal cables must be easy to understand.

✦ Areas where arcing is likely to occur must be designed against combustion.

✦ No active conductors must be exposed in a ready vehicle.

✦ Cables, cable harnesses and any equipment transmitting must not touch a moving surface (wheel, etc.).

5. SUPPORTS AND REWARDS

5.1. Supports

5.1.1. Unique Vehicle Category

✦ Teams that advance to the next stage as a result of critical design results will be eligible for support. It is not required to participate in the competition for the first time for support. Individuals can only take part in one team.

✦ A ranking is made among the teams that pass the first stage according to the points they receive. In the ranking, the number of teams determined by the competition committee will be provided with support in the amounts to be determined.

✦ The upper limit of project support is 80.000 TRY.

✦ In order for financial support to be paid, Team Responsible must fill and sign the Letter of Commitment, stating that all the responsibilities and rules of the competition have been accepted, and submit the document to the official during the registration in the competition area.

✦ The team captain must request the Letter of Consent of the parent/guardian for all members under the age of 18 and delivered in the race area.

5.1.2. Ready Vehicle Category

According to the results of the Critical Design Report, a certain number of fully equipped drive by wire vehicle platforms will be provided to the teams that qualify for the next stage, which they can work on through an appointment system before the competition and use in a certain order during the competition. The relevant vehicle platforms are planned to be ready by May 2024. This date may be moved to a later date depending on the conditions of the day or some technical processes. It is planned that the ready vehicles will be located in the Informatics Valley area and the teams will work on the vehicle platform and make preparations for the competition with the appointment system.

5.2. Awards and Rules

Teams that successfully complete their tasks will be eligible for the prize ranking.

The prizes in the table below indicate the total amount to be given to the teams that are entitled to receive awards, no individual awards will be made. First, second and third place prizes will be divided equally according to the total number of team members (excluding the advisor) and teams participating from abroad will be paid to the Team Responsible in cash in the competition areas or TEKNOFEST area. Team advisors who are entitled to receive an award cannot benefit from the first, second and third prize amounts below, and the awards to be given to the advisors are also specified in the table below.

Degree	Unique Vehicle Category	Ready Vehicle Category	Advisor
First	200.000 ₺	150.000 ₺	9.000₺
Second	150.000 ₺	120.000 ₺	7.500₺
Third	120.000 ₺	100.000 ₺	6.000₺

Table 2 - Awards

Teams that do not meet the minimum requirements for the award, but are eligible for an honorable mention according to the award criteria below, will be awarded an honorable mention at a rate deemed appropriate by the Advisory Board.

Most Original Software Award: The software is evaluated by the Competition Evaluation Board together with the report stages. They will determine the team with the most original software by voting method by considering the evaluation criteria in terms of the functionality, reliability, domestic and nationality of the original domestic software product, infrastructure and system architecture compatible with the current high technology, and the effect of increasing our national competitiveness within the scope of the national technology move. The specified award is for prestige purposes and does not have a financial equivalent.

Best Design Award: Competitor teams that successfully accomplish the first stop mission in the unique vehicle category will be evaluated for this award. The specified award is for prestige purposes and has no financial equivalent.

Best Video Award: Teams that best explain the contest preparation process and the final process with the video they shot will be evaluated within the scope of this award. This award is for prestige purposes and does not have a financial equivalent.

5.2.1. Minimum Merit Criteria for Award Ranking

In order for a team to be deemed successful and receive an award, the competing team must meet all the conditions set out below;

- ✦ Proper passenger boarding
- ✦ Proper passenger drop-off
- ✦ Reaching the parking lot
- ✦ Parking according to the rules
- ✦ Following the right route

Teams that fulfill their tasks will be considered successful.

When ranking the teams that fulfill all the tasks, firstly the score is taken into consideration. If the scores are equal, the time to complete the course is taken into consideration. The first three places of the competition are determined among the teams that fulfill the award criteria. If there are not enough teams that meet the award criteria to fill the first three places or if no team meets the award criteria, the vacant places are filled by the teams that meet at least one of the following criteria in order of

points. These teams will receive an honorable mention award as specified in the Awards and Rules section instead of the competition prize.

Mansion Mention Criteria:

✦ Performing at least one of the tasks of picking up or dropping off passengers in accordance with the rules

✦ Following the correct route to the parking lot

When ranking the teams for the honorable mention award, if the scores are equal, the time it takes for the vehicles to complete the above-mentioned mansion mention tasks is taken into consideration. The team that completes the task in less time is ranked higher. For example;

If only 2 of the 20 teams participating in the competition fulfill the award criteria, these teams will be ranked first and second according to the points they receive. Since there are no teams that fulfill the award criteria for third place, only the teams that fulfill the honorable mention award criteria are considered. The team with the highest score among these teams will be ranked third. Even if this team's score is higher than the first and second place teams, it is ranked behind these teams because it does not meet the criteria. The first and second place teams that fulfill the criteria receive the announced first and second prizes of the competition, while only the third team that fulfills the honorable mention criterion receives an honorable mention.

6. EVALUATION

The following rules are applied to determine the winning team.

✦ Robotaxis are scored separately for each given task (see Table 3).

✦ The Robotaxi with the highest score wins the competition.

✦ In case of a score tie, the Robotaxi that finishes the task in the shortest time wins the competition.

✦ In the event of a tie, these teams are given one more competition with the same rules.

✦ In the event of a tie under the above conditions, the Advisory Board and the Committee of Judges will divide the prizes.

During the final evaluation, the calculation will be made according to the table below.

Scoring Type	Scoring Percentage
Critical Design Report	% 15
Vehicle Test Video Simulation-Presentation Phase	% 15
Final Evaluation	% 70

Table 3 - Scoring Percentages

Task Type	Score
Start of Vehicle Movement	200
Passenger Pickup in accordance with the Rules	500
Passenger Drop-Off in accordance with the Rules	500
Act in accordance with the rules (Lane Following **(500),** Traffic Lights **(250),** Obstacle Crossing **(250))**	1000
Parking According to the Rules	500
Following the Correct Route (No Reverse Direction Violation)	500
Tunnel Access	750
Completing Section 1 of the Runway	100
Completing Section 2 of the Runway	200
Reaching the Parking Lot	300
First Traffic Rule Violation	-50
Second Traffic Rule Violation	-100
For Each Violation After the Second Traffic Rule Violation	-200

Table 4 - Final Evaluation Criteria

The final evaluation will be carried out by dividing the track into three sections. The criterion of proper behavior will be evaluated separately for each section.

Section 1 of the track is the section leading up to the first stop mission.

Section 2 of the runway is the section behind the traffic light near the second stop duty area.

Section 3 of the track is the section up to the park entrance area.

The team will earn points when the robotaxi reaches these areas, even if it does not perform tasks.

If Robotaxi remains stationary for more than 3 minutes or exceeds the 15 minutes given to reach the end point, it loses the right it is using and is considered unsuccessful. Failed attempts are not taken into any evaluation.

7. COMPETITION

Robotaxi competition activities to be held within the scope of TEKNOFEST 2024 consist of two main parts: pre-competition activities and activities to be carried out during the competition.

Teams applying to the competition in the Robotaxi category will perform technical qualification form submission, critical design report submission and vehicle test video-simulation-presentation activities before the competition. During the competition; technical controls and execution of the competitions will be carried out.

The activities carried out will be subject to evaluation by the Robotaxi Competition Advisory Board and Referees. As a result of the evaluations; the teams to be accepted to the competition, the teams to receive support, the teams to participate in the competition and the teams entitled to receive awards will be determined.

Teams that do not fulfill the issues specified in the competition activities will be deemed unsuccessful; they will not be entitled to be accepted to the competition, receive support, participate in the competition or receive awards.

During the competition period, teams will be monitored by the team in charge of the Competition Committee on technical issues such as autonomy and automatic control systems, and mentoring support will be provided. In addition, in order for the teams to develop better, information sharing and development meetings can be organized by providing training on topics such as control and simulation systems, autonomy, sensor systems, etc. at the facilities to be organized by the Competition Committee and/or over the internet (online).

7.1. Activities to be carried out before the Competition

Pre-competition activities describe the activities that teams will carry out before the final.

- Technical Qualification Form Submission
- Submission of Critical Design Report
- Vehicle Test Video-Simulation-Presentation

7.1.1. Ready Vehicle Category Vehicle Training

Within the scope of the Ready Vehicle category, competitors will be given trainings about the vehicle on dates to be announced later. If deemed necessary by the Competition Advisory Board and the Referee Committee, an evaluation will be made after these trainings to measure the competence of the teams in this regard.

7.2. Activities to be carried out during the Competition

Activities during the competition describe the activities that teams will perform during the active time of the competition.

Robotaxi Competition Advisory Board Members and Referees will hold a meeting with all team managers who are eligible to compete before the activities. In this meeting; information will be given about the rules to be followed during the competitions, safe behavior procedures and emergencies.

The team managers who will attend the meeting will ensure that all members of their team are informed of all the rules and procedures explained during the meeting and that they are followed. In case of any contrary situation or any violation is detected, the relevant team may be deemed unsuccessful or eliminated. The authority in this regard belongs to the Robotaxi Competition Advisory Board Members and Referees.

Teams are required to submit their objections or suggestions regarding the order in writing to the Robotaxi Competition Advisory Board Members and referees before the technical controls begin. Objections and suggestions made after the technical controls have started will not be evaluated. The authority to decide on this issue belongs to the Robotaxi Competition Advisory Board Members and referees.

The authority to decide on the situations that occur during the competitions belongs to the Robotaxi Competition Advisory Board Members and Referees.

7.2.1. Technical Controls

The vehicles of the teams that qualify to compete in the Robotaxi Competition will undergo technical controls before the competition. Technical controls will be carried out by the Referees under the auspices of the Robotaxi Competition Advisory Board Members.

Each team will have the technical controls of the vehicles they will compete in the order determined. Team members are obliged to follow the technical control order. A team that has not carried out technical controls will not be able to compete in any way and will not be able to claim any rights related to the competition.

Technical controls include checking the compliance of the vehicles that the teams will compete with the specifications and the brake test of the vehicle. These controls will be carried out in the area determined by the Robotaxi Competition Referees and 2 team members. After the brake test to be carried out in a 20 - 30 meter flat area, they will be eligible to compete on the track.

In the braking test, the vehicle will be asked to move autonomously and stop when it encounters an obstacle.

Vehicles that fail to fulfill this condition will not be able to participate in the race.

The time allotted to the teams for the brake test will be determined by the referee committee according to the number of teams before the technical controls, teams that fail to pass the brake test in all the allotted time will be deemed unsuccessful and will not be included in the race.

A team that enters the technical controls and is found negative or inadequate as a result of the technical controls will not be able to compete in any way and will not be able to claim any rights related to the competition. Robotaxi Competition Advisory Board Members and Referees are authorized in this regard.

7.2.2. Competitions

Robotaxi Competition will be held on the prepared track. Each team will compete in the designated order. Team members are obliged to follow the competition order.

The competition involves the vehicles performing the specified task within the track. The competition will be held in the designated area with the Robotaxi Competition Referees and 2 team members. Teams will be given rights to complete the course. The amount of these "rights" will be communicated to the teams on the day of the competition. The vehicles will start the competition from the beginning of the course for each team.

Teams are entitled to a total of 2 "starts" in each heat. 2 unsuccessful "start" attempts will invalidate that heat ("success is when the car starts on any of the 2 starts").

Changes will be made to the traffic signs and obstacles on the track before each right. Once the teams have their software ready, they will draw lots to determine which stops will be closed, the position of the obstacles and the parking areas.

The evaluation during the competition will be done by the Robotaxi Competition Judges as stated in the scoring heading.

7.2.3. Competition Report and Presentation

All teams that are eligible to compete in the Robotaxi Competition, after the completion of the races on the track; If the advisory board deems it appropriate; they will prepare a competition report and present the report they have prepared. The competition teams will make their presentations one by one in the order determined. A time will be set for the presentation of each team, and within this period, they will present their reports in a place where the Robotaxi Competition Advisory Board and Referees are present and participation is not limited.

Teams competing in the Robotaxi Competition will prepare their competition reports in accordance with the Competition Report Template. Teams that do not include the information requested in the report template will be deemed unsuccessful.

The presentations to be made by the teams will consist of a presentation of the work by the team members and a question and answer session. It will not be accepted for a person who is not a team member to make a presentation or to participate directly or indirectly in the presentation.

Explanations made outside the deadlines set for the presentation will not be evaluated by the Robotaxi Competition Advisory Board and Referees. The times determined for the competition presentations will be notified to the teams in the meeting held by the Robotaxi Competition Advisory Board and Referees with the team managers.

7.2.4. Evaluation

Robotaxi Competition Advisory Board and Referees are authorized for all evaluations to be made before and during the competitions.

8. COMPETITION CALENDAR

The schedule and activity details of the Robotaxi competition to be held within the scope of TEKNOFEST 2023, which will be organized in May, are given in Table 5.

EXPLANATION	HISTORY
UNIQUE VEHICLE CATEGORY	
Competition Application Deadline	29.02.2024
Technical Qualification Form Deadline	18.03.2024 22:00
Announcement of Technical Qualification Form Results	25.03.2024
CDR Deadline	22.04.2024 17:00
Announcement of CDR Results	21.05.2024
Vehicle Test Video Deadline	1.07.2024
Simulation Presentations	4-7.07.2024
Announcement of Finalists	12.07.2024
Test Period*	AUGUST 2024
Robotaxi Competition Final Dates	AUGUST 2024
READY VEHICLE CATEGORY	
Competition Application Deadline	29.02.2024
Technical Qualification Form Deadline	18.03.2024 22:00
Announcement of Technical Qualification Form Results	25.03.2024
CDR Deadline	22.04.2024 17:00
Announcement of CDR Results	13.05.2024
Ready Vehicle Camp Start Date	18.05.2024
Ready Vehicle Camp End Date	30.06.2024
Simulation Presentations	4-7.07.2024
Announcement of Finalists	12.07.2024
Test Period*	AUGUST 2024
Robotaxi Competition Final Dates	AUGUST 2024

Table 5 - Competition Calendars

** The deadline for the delivery of the support to be provided within the scope of the Robotaxi competition and the schedule of the test period before the final will be announced later.*

The Advisory Board may organize question and answer meetings and training programs before or after the specified report stages. The relevant teams will be notified by the Competition Committee during this competition period.

Report submission must be uploaded via the CMS system within the day and time specified in the calendar. The appeal process is notified to the teams by the TEKNOFEST competitions committee via e-mail sent after the results are announced.

The TEKNOFEST Competitions Committee has the right to make changes in the calendar and hours.

TEKNOFEST committee and advisory board reserves the right to make changes regarding the dates when deemed necessary.

9. GENERAL RULES

Click here to access the General Rules booklet which is valid for the competition.

10. CODE OF ETHICS

Click here to access the General Rules booklet which is valid for the competition.

Statement of Responsibility

T3 Foundation and TEKNOFEST are in no way responsible for any product delivered by the competitors or for any injury or damage caused by the competitor. T3 Foundation and organization officials are not responsible for any damages caused by the competitors to 3rd parties. T3 Foundation and TEKNOFEST are not responsible for ensuring that the teams prepare and implement their systems within the framework of the laws of the Republic of Turkey.

Technology Team Foundation of Turkey reserves the right to make any changes in this specification.

7th YEAR

#MİLLİ TEKNOLOJİ HAMLESİ