# ROBOFEST - GUJARAT 4.0

***Engineering the Future!***

**Guidelines for Final Objectives**
**for**
**Proof of Concept (PoC) / Prototype at Grand Finale**

**Category-wise instructions**

Investing in Science: Investing in the Future!

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# ROBOFEST - GUJARAT 4.0
## Engineering the Future!

**Guidelines for Final Objectives**
**for**
**Proof of Concept (PoC) / Prototype at Grand Finale**

## 1. Submarine or underwater Robot:

1. Outdoor pool at Science City, Ahmedabad will be provided. The pool will be made available to the teams 2 days prior to either PoC event or Grand Finale for trials. Teams interested for trials at site need to write to GUJCOST well in advance.

2. Five objects will be kept at different locations at the bottom of the pool. All objects will be barcoded and fixed at the bottom of the pool. Those will be placed at a depth of 4 to 4.5 ft.

3. The participants will be given a day or two in advance to test their prototypes.

4. The underwater bot should be able to map all the barcoded objects.

5. The bot is expected to stay underwater for 5 minutes at least.

6. Underwater bot batteries should be properly charged and sealed. No external power shall be given to the bot while in outdoor pool, during competitions.

7. Ideally, underwater bot should be totally autonomous. The teams who can demonstrate fully autonomous navigation of the bot will be given better weightage in evaluation. Nonetheless, underwater bots can also be shown operated by controlling the same through joystick or on-shore laptop.

8. Teams will be given 2 additional chances to re-operate the underwater bot in case the bot gets out of control for some reason and it reaches directly the bottom of the pool. However, the final operation of the bot must demonstrate the items listed at sl. nos. 2,4 & 5.

9. The marking will be done based on:
   i. Time taken to map all of the barcoded objects. If the bot fails to map all the objects, time will be noted for 'partial' completion of the map.
   ii. Ability to be underwater for 5 minutes at a depth not less than 4ft.
   iii. Overall design features
   iv. Extent of indigenous development
   v. Instrumentation & Electronics, communication of hardware and software / programming.

NOTE: After selection of the Proof of Concept model, during 'Grand Finale' the participants will be given a task of finding the barcoded objects placed in a specific geometric pattern. The said objects will be placed approximately 1.5 ft distance apart. The details of the said pattern will not be available to the teams before the Grand Finale event.

## 2. Fun Robotics: Maze Solving Robot

1. The overall size of the maze will be 5ftx5ft.The breadth of the maize shall be12 inches.
2. The maze will have right and left-hand loops.
3. The height of the maze will be 6 inches.
4. The surface will be smooth and made of polished wood.
5. No Wi-Fi module will be allowed inside the maze.
6. One practice maize will be available one or two days before the competition date.
7. Robot should start after pressing the 'ON' button.
8. Arduino RP2040 Nano$^{R}$ /other similar controller hardware is allowed for the teams who are using it
9. The maze will have some bend paths.
10. There will be a space of approx. 6-8 inches for the bot to enter as well as exit the maze.
11. The maze design for the 'Grand Finale' will consist of either of the problems, stated below (along with other usual features vide sl.nos 1,2,3,5,7,8, 9 & 10):

    I] *Problem 1*: There will be TWO non-identical MAZES. These mazes will be connected through a straight channel of ~ 100 mm in length. After exiting the first maze, the bot must traverse this channel and enter into the second maze. Then the bot has to solve the second maze and finally come out of the second maze successfully.

    II] *Problem 2*: There will be one 'Mother' maze and two identical 'Daughter' mazes (of smaller dimensions). The 'daughter' mazes will be placed on either side of a straight channel (~ 100 mm length). The bot must independently decide which 'daughter' maze to enter. Naturally, the bot can't enter both the 'daughter' mazes simultaneously. The bot has to come out successfully from the 'daughter' maze that has been selected on its 'own'.

12. Use of any external single-board-computer (SBC) / PC/ laptop/ tablet or any compatible electronic devices in the neighborhood that can be connected via Wi-Fi to the bot is restricted.
13. There won't be any time limit to find out the shortest path or for that instance, the optimal path. The ultimate objective for the team will be to 'solve' the maze, i.e. come out of it successfully. The team that can do this task with MINIMUM TIME will be the winner!
14. There will be one single color for the maze walls and floor. White (light shade /white) color has been decided by the GUJCOST.
15. The evaluation will be carried out based on the total time taken to solve either of these two maze designs.

16. The marking will be done based on the time taken by the bot to solve the maze and reach to the end point. However, in an extra-ordinary case, if the committee finds that the computation is taking too long (~ 30 minutes) because of hardware issues of the team, then GUJCOST will have the right to 'cancel' the trial by the team at that time. That team may be given another chance if logistic support is available and decided by the committee.

17. The committee and GUJCOST will have the authority for the final decision in case of any extra-ordinary/unusual/unexpected situation, pertaining to situations like bot getting stuck to the wall, extra-long time taken by the bot to solve the maze or any other hardware issues.

18. The end goal of the tournament will be to solve the maze in quickest possible time. If two or more teams can solve the maze in exactly the same time, then for tie-breaking, committee will consider other features, like i] design of the bot; ii] compactness of the electronic circuitry or iii] number of fouls that the bot comes across in the traversed path for whatsoever reasons.

## 3. Two Wheeled Self-Balancing Robot

1. Indoor area of 200 – 300-meter path, oval in shape will be provided.

2. The robot has to move on smooth regular floor surface made of polished wood.

3. The robot should be able to carry a load of 1 kg (liquid filled in an open container) over a minimum distance of 200 meter without spillage. The water must be filled more than 50% of the container's height (i.e., more than half-filled case).The team can select the dimensions of the container.

4. The team can select the container, made up of any suitable material with dimensions commensurate to the design of the robot.

5. Multiple switches can be used.

6. The bot should be battery operated.

7. The bot must intelligently select which line to follow based on a command given to reach the final destination.

8. The track ('line') will be provided for guiding the robot. Naturally, the robot which will be able to follow the track perfectly (100% without any deviation) will be the winner!

9. No sample picture of the environment can be provided. However, the actual 'field' will be made available by GUJCOST two days prior to the PoC / Grand Finale event.

10. The marking will be done on the basis of completing the challenge, stability of the robot, fulfilling the design requirements, no spillage, maintaining the path without deviation, hardware integration and minimum time taken to cover up the distance of ~200-300 m (along the major axis of the oval-shaped area).

11. The participants should be ready to deal with the challenges which may include putting two containers side by side, be able to enter and exit a room on the way (only during Grand Finale).

12. The winner robot will be selected on the following criteria (inclusive of tie-breaking, if needed):
    i. Completing the challenge, i.e. load balance & locomotion
    ii. Minimum time taken to complete the challenge without liquid spillage
    iii. Design, i.e. innovative idea & Complexity of the design
    iv. Aesthetics, i.e. Look and feel of the robot

## 4. Rover Robot

1. Robot should be able to travel in an outdoor field, having boulders of different shapes & sizes, various obstructions, e.g. short fence, tree-branch, plastic bottles etc. The rover robot has to go up & down over a slope of 45° and it should be able to take short turnings.

2. Artificial grass surface will be available at the test-site, along with natural field-surface. The robot has to move over the surface with artificial grass as well as natural field surface.

3. Slope of 45° will be created with foam sheet. Foam sheet has been chosen for easy fabrication with rapid production (less time) and GUJCOST will ensure a high-grade foam sheet with considerable compressive strength. Nonetheless, arrangements will be made to replace the original sheet with another foam sheet in case some rupture /tear happens. Teams will be given extra time if such an eventuality occurs.

4. An ideal OUTDOOR field will be created for the test (PoC and Grand Finale). There will be THREE obstacles in totality in the entire path of the rover and those will be of different fixed size & shape. The shape of those obstacles will be either spherical / near-spherical or cuboid (box) or mixed. However, exact shape of the obstacle will remain confidential.

5. Apart from these obstacles, there will be 3 more obstructions, as stated in '1' above. The ability to take turn around an obstacle and / or obstruction will be examined only in the Grand Finale. The exact type & shape of such obstruction will remain confidential.

6. The approximate size of the obstacles ('boulders') will be100 mm diameter spherical or near-spherical shape or 100 mm side cuboid. Unfortunately, no additional information or picture of the obstacles and the track can be provided.

7. Start point and end point will be approximately 200 m away. The rover should be able to take different short turns en-route in order to bypass the obstructions / obstacles. The robot should be able to take full U-Turn at the end of the traverse.

8. There won't be any U-turns in-between the entire path of ~200m.The rover should be able to take a U-turn after completing the full stretch (of ~200m) only.

9. The teams have to measure the GPS co-ordinates in the field. GUJCOST will make the 'field' available two days prior to the PoC / Grand Finale.

10. Marking will be done on the basis of parameters like design (mechanical & controller), strength of the parts, autonomous navigation, smoothness of the obstacle avoidance, moving on some boulders, grass and slope, turnings, time taken to cross the path.

11. During Grand Finale, the rover will be expected to traverse a wide range of surface including a natural rocky surface with synthetic grass and crossing crater-like surfaces. The size of the craters and semi-cuboidal rock will be approximately between 1 ft to 2 ft (diameter / side).

12. Both autonomous control and semi-autonomous control via joystick or laptop will be accepted. However, due credit will be given to those teams who can show the locomotion of the rover with fully autonomous control.

## 5. Hexapod Robot

1. The field area (indoor or outdoor) will be provided which includes obstacles, stairs and turnings.

2. The hexapod has to traverse along the path distance of ~200m.

3. The hexapod must climb up and down 2 ‘obstacles’, in the form of stairs that are 6-inch-high. 4 ft broad stairs will be provided. The robot needs to take a turn during the motion over a path.

4. Each stair is of 6-inch height and 4 ft. wide. So, the team can consider 4 ft. as the TOTAL WIDTH of the stair. Second ascent of the stair will be immediately after the first. In other words, hexapod must climb TWO STAIRS together (at a time without pause).
5. The descent of the hexapod over the stairs can be at an orthogonal direction to that of ascent. In other words, strairs for climbing down can be at 90 degrees with the stairs for climbing up. The hexapod should be able to take appropriate turn to adjust with such descent.

6. Any additional features of the Hexapod will be considered under ‘Design’ which will be an important marking scheme.

7. Marking will be done on the basis of parameters like design, strength of the parts, smoothness of the obstacle avoidance, stair climbing and descending operation, turning at given location and time taken to cross the path.

8. Both autonomous control and semi-autonomous control via joystick or laptop will be accepted. However, due credit will be given to those teams who can show the locomotion of the hexapod with fully autonomous control.

9. Teams will be given 2 additional chances to re-operate the hexapod in case the bot gets out of control for some reason due to entanglement of the legs while turning. However, the final operation of the hexapod must demonstrate the items listed at sl. nos. 2,3,4 & 5.

## 6. Swarm Robot

1. The LEADER and the FOLLOWERS of the Swarm Robot must be identified and known to the examiners prior to the testing.

2. The Swarm Robots must be able to form at least 3 different shapes (viz. circle, square & triangle) in air (at least 10ft. from the ground). The swarms should begin the formation with a straight line and then it should carry out the other two shapes one-by-one. Finally, it should be able to go back to the straight line formation again.

3. The Swarm Robots should be able to pick plastic balls of a given colour and be able to retain the grasp at least 5 ft. above the ground. Three different balls with varying size, weight & colour will be provided (weight of the balls:~200 gm; size: ~ 75mm max. diameter).

4. The Swarm Robots should fly to a given destination and drop the ball in a cart.

5. The competition will be held outdoor at a suitable time (forenoon/ afternoon/ early evening) so as to have a clear view of the flight of the aerial bots and the formation in air.

6. Marking will be made on the basis of
   (i) ability to make unique shapes, over & above the three geometric shapes listed
   (ii) number of bots used in the swarm

7. The team must have minimum 3 drones to be used for swarm formation.

8. The Swarm Robot must be able to retain the GEOMETRIC SHAPE, stated above, in air for at least 3 minutes.

9. The teams may be given a challenge to make a particular shape (other than circle, square & triangle) during Grand Finale.

## 7. Application-based Robot

**Final guidelines for this category will be published only after selection of the successful teams at PoC level.**

# General Instructions related to electronics for all categories

1. Participants are advised to design, fabricate and utilize their own PCBs to reliably connect sensors, motors and other components. During the evaluation, more weightage will be given to the team that has utilized customized PCB.

2. Customized PCB must have "ROBOFEST 4.0" printed clearly on either side of the board. PCBs can be fabricated using standard FR-4 material. Flexibility in the choice of material for specialized ROBOT applications is permitted based on the design requirements. Design traces and pads should be made such that they can handle the expected current load. Ensure the trace width is sufficient for power lines to prevent overheating and potential failure during the Grand Finale demonstration. All components and connectors must be securely soldered to the PCB.

3. There are no strict limitations on the size and shape of the PCB; however, it should be designed to fit within the overall dimensions of the robot.

4. Design your microcontroller circuit to control the ROBOT using commercially available microcontroller chips like 51 families, AVR, ARM, PIC MSP430 etc. All sensors, motors, and power supplies must be connected to the main PCB using robust connectors to withstand typical robotic motion, vibrations, jerks and interaction with outside disturbances.

5. Include a power management circuit on the PCB to handle different voltages and currents required by various components safely and efficiently.

6. Please provide a complete schematic diagram of the circuit and layout of the PCB, including all components and their connections. Also, please provide a detailed list of all components used and their specifications. User manual for assembly of the ROBOT is to be prepared with perfection and professionalism so that a new person can do assembly of the ROBOT with proper connections. The PCB Design and Gerber files should be submitted to GUJCOST.

7. After selection in the PoC round participants are required to avoid the use of ready-made boards such as Arduino, Raspberry Pi, etc. during the Grand Finale. Instead of that, teams are highly encouraged to design, fabricate, and utilize their own PCBs to connect sensors, motors, and other components reliably. During the evaluation, more weightage will be given to the team that has utilized customized PCB.