

# **Makerspace Friendlies 2026**

**Two-Day Robotics Competition Rule Book**

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# **1. Introduction**

The Makerspace Friendlies 2026 is a two-day robotics competition that challenges participants to build a robot, compete in different tasks on each day.

## **1.1. Day 1**

Day 1 features a full autonomous robot that must follow a predefined line path and uses computer vision to identify and collect plastic balls. This tests the robot's sensor integration, mechanical design, and autonomy. Participants are allowed to retrieve their robot back to the starting point during the exploration and shortest return path phase. Participants who successfully achieve the self-returning system will be awarded bonus points. Each ball collected will contribute to the team's scoring and will also be used as extra "bullets" in the second day's competition.

## **1.2. Day 2**

Day 2 involves a human-operated robot, designed to shoot balls into an upright hoop. Each team will be given 5 balls by default, whilst those teams that managed to secure the bonus balls from Day 1 will have extra shots in Day 2's game. The robot can use any mechanical or electromechanical launching mechanism to aim and fire the balls into one of three hoops. Scores will depend on shooting accuracy, the difficulty of goals, time, etc.

## **2. Participant Eligibility**

### **2.1. Makers Association Membership**

All participants must be verified members of a recognised Makers association affiliated with an institute of higher education in Singapore. This is to ensure fairness and affiliation across all teams.

### **2.2. Team Formations**

Each team shall consist of 4-6 members. Students may form cross-faculty or cross-major teams within the same university. Participants who registered alone will be grouped by the organising committee according to availability.

### **2.3. Number of Teams**

The number of participating teams is capped at **10** for logistical and tournament management reasons. Priority may be given on a first-come, first-served basis or through internal qualifiers if necessary.

## **3. Robot Specifications**

### **3.1. Assembly**

Rapidfire Rover has to be designed and built by the respective teams from scratch.

### **3.2. Dimensions**

The width and length of the robot must not exceed 18cm x 18cm. The height of the robot will be restricted to 30cm.

### **3.3. Day 1 - Autonomous Collection Robot**

#### **3.3.1. Autonomy and Power Source**

The line following robot must be autonomous. "Autonomous" is defined as: operating without any human assistance after being deployed, following a pre-laid path using line sensors. Once reaching a dead end, an onboard camera will stream real-time video to the laptop to detect and collect balls placed in random positions.

#### **3.3.2. Ball Collection Constraints**

Balls must be collected using safe mechanical or suction-based methods. Robots can choose to store the balls inside or outside their chassis, provided that they manage to bring the balls to the end zone. The robot must not damage or deform the balls during the collection process.

### **3.4. Day 2 - Human-Controlled Shooter Robot**

#### **3.4.1. Control and Operation**

On Day 2, participants can manually control the robot using any wireless connection (wireless controller or computer interface). Each robot must have a clear start and end signal before and after the run.

#### **3.4.2. Ball Launching Constraints**

Any shooting mechanism can be used, including spring-loaded, rotating shooter wheels, pneumatic systems, or custom-made launchers, as long as they are safe, non-explosive, and do not require ignitable materials. This shooting mechanism can be in a detachable design, only installed in the Day 2 event.

### **3.5. Method of Traversal**

All attachments must fit within the maze and arena walls and must not damage or mark the floor or arena structure. The robots should not jump, stick, fly, climb, scratch, cut, burn, mark, damage, or destroy the maze and arena.

### **3.6. Power Source**

The robot must be powered by electric sources (batteries, solar cells, etc.). Internal combustion, flammable fuel, or unsafe mechanisms are strictly prohibited.

### **3.7. Other Feature Constraints**

The robots must not have any features that are intended to damage the arena, goals, balls, other teams' robots, or players.

### **3.8. Judging**

The referee reserves the right to request an assessment at any time during the competition for judging purposes.

### **3.9. Breaching of Rules**

Violation of robot specifications will lead to either:

- Point deductions
- Disqualification from one or both days
- Ineligibility for prizes.

Decisions are at the discretion of the head referee and organising committee.

## 4. Robot Building

### 4.1. Materials

#### 4.1.1. Starter Kit

A starter kit will be provided to each team as a starting point. The list of components can be checked in this [📄 Team Budget Template](#) .

#### 4.1.2. Extra Budget

An extra S\$70 will be provided to each team to enhance and customise their robots by choosing their components to buy. Participants must follow the guidance for claiming in [9.1] before buying anything.

#### 4.1.3. Raspberry Pi Kit Bonus

If participants succeed in PID and solve the testing map, they will be given an offer to use a Raspberry Pi through a “Level up” kit, which has the following terms and conditions:

- The first 5 teams to achieve line following in the test maze can level up their kit, provided they still have S\$30 unused funding.
- To claim the kit, S\$30 of the team’s extra budget will be deducted.
- After the competition, all Raspberry Pi kits must be unplugged and returned to Garage@EEE.
- If the RasPi is damaged by the team, they will receive a S\$50 penalty.

#### 4.1.4. Upper Limit of the Robot’s Cost

Every team must make sure their robot costs below S\$250 otherwise a penalty will be given accordingly for ensuring the fairness of the game.



## **5. Maze Specifications**

### **5.1. Maze Dimensions**

The maze measures a total of 3.66m x 4.88m and is composed of 24.4cm x 24.4cm unit squares arranged to form a 14 x 19 grid. The walls of each unit of the maze are 10cm high and 5mm thick. An outer wall fully encloses the entire maze.

### **5.2. Maze Colouration**

The maze is made of wood, finished with non-gloss paint. The floor is black and the maze walls are unpainted with plain plywood texture.

### **5.3. Maze Walls**

All maze walls are constructed without any overhanging structures. Walls rise vertically from the base surface.

### **5.4. Start Zone**

The start zone is a unit square located at a corner of the maze at coordinate A19. The start zone is bounded on three sides by walls. The start line is located between the first and second unit squares. As the robot exits the start zone (signified by crossing the start line), the run timer starts.

### **5.5. End Zone / Destination**

The end zone is a square in the maze such that a wall-hugging mouse will not be able to find it. The end zone is a white square of 25cm x 25cm at the end of the track within the free-track zone. It can be located anywhere inside this zone (see *Section 5.10*). As the robot enters the end zone (signified by stopping within the unit square), the run timer ends.

### **5.6. Lattice Points**

Lattice points are the small square posts at the four corners of each unit square for wall support. The maze is assembled so that there is at least one wall at each lattice point.

### **5.7. Multiple Paths**

The maze will include at least three viable paths, which may differ in length and complexity and may contain branches, dead-ends, and intersections.

### **5.8. Checkpoints**

Each path may contain a different number of checkpoints. The top edges of the bounding walls of the checkpoint unit squares will be marked and painted red for clear identification.

### **5.9. Following Line**

The line to be followed by the robot is white and has a uniform width of 2cm. Each unit square in the maze may contain one of several track configurations:

- Straight line
- Left or right turn
- T-junction
- Crossroad

Turns are implemented as 90-degree angles in the maze, except in the free-track zone. The following lines will be present throughout the maze, except that they will terminate at the unit squares where balls are placed.

Due to the modular construction of the maze, the following lines will be a 3D-printed structure with a slightly raised profile of 1mm height relative to the flat base. Participants are advised to ensure their robots have adequate ground clearance to navigate the maze without obstruction. Minor connection gaps may be present at the connection parts between the lines.

### 5.10. Free-Track Zone

The free-track zone is a special section of the maze where there are no maze wall structures, and only the white line track is present on a black background. This area is designed solely to test the robot's line-following capabilities through multiple intricate track patterns.

The free-track zone spans 7 x 9 unit squares and is bounded by coordinates H19, N19, H11, and N11 (see *Appendix 1*). It has only a single entrance gateway, and the end zone is located within this area.

**Note:** Checkpoints are set in the free-track zone. This is the only section where participants are permitted to place or reset their robot at the previous checkpoints if necessary (e.g., for recovery or re-alignment purposes) throughout the whole run. However, doing so may result in time penalties or loss of performance points.

The track patterns within this free-track zone include, but are not limited to:

- Zig-Zag
- Curved paths (semi-circles or S-curves)
- Sharp angled turns
- Intersections
- Road split
- Dead-ends

The dimensions of the track design in the free-track zone are shown in *Appendix 2*.

### **5.11. Ball Collection Position**

A total of 7 balls will be placed within the maze. These balls are intended to be detected using Computer Vision and captured by the robot during the exploration phase. The balls will be removed during the final run phase.

These balls will be located only at the dead-end locations. Among these, “hidden balls” which offer greater rewards if captured, will be positioned several unit squares away from the normal balls at the line termination point, increasing the difficulty of capturing them (see *Appendix 1*). Balls will not be placed in the free-track zone.

### **5.12. Maze Fabrication Inconsistencies**

Do not assume the walls have consistent texture and colour, or that the floor is consistently black, or that the following lines are consistently white. Fading may occur and parts from different mazes may be used. Do not assume the floor provides a given amount of friction. It is simply painted plywood and may be quite slick. The maze floor may be constructed using multiple sheets of plywood. Therefore, there may be a seam between the two sheets on which any low-hanging parts of the robot may snag. Overall, all maze dimensions are subject to a  $\pm 5\%$  fabrication tolerance.

## **6. Arena Specifications**

### **6.1. Arena Measurements**

The arena dimensions are set at 3 meters by 3 meters, with 4 sets of loading bays & goals with 4 colours and two shared rotating goals.

The walls of the arena are 20 cm high and 0.5cm thick (with 5% tolerance).

The arena will be constructed using plywood materials; It will not be smooth, as there may be seams between 2 sheets of wood when joined together, and gaps and bumps may be present.

### **6.2. Arena Color**

The walls of the maze will be standard wood color, and the floors of the arena will be coloured black.

### **6.3. Goals Type**

Each team has one colour-coded goal. Shared middle black goals are present for bonus points.

### **6.4. Arena Layout**

The arena contains:

- Four loading bays (LB1–LB4)
- Four coloured goals (G1–G4) at the arena's edges
- Two shared middle rotating black goals (G5, G6) for bonus scoring

Obstacles to encourage navigation and ball strategy.

Refer to (*Appendix 4*)

### **6.5. Starting Point**

The starting points shall be constrained to the loading bay of the arena and be bounded at the corners of the arena. All players shall place their rovers at their respective loading bay indicated by their team colour. Contestants may begin once the timer starts running.

### **6.6. Loading Bay**

Once players have run out of balls and need to reload, it can be done either autonomously or manually. Autonomous reloading can be done at any part of the arena, whilst manual reloading can only be done at the loading bay. Failure to obey this rule will be penalised.

### **6.7. Goals**

In order to score points, players can choose to shoot their balls through their respective hoops at the opposite end of the arena or into a free-for-all shared goal placed at the middle

of the arena, which will award higher marks. Interception or disturbing other teams' rovers is allowed.

## **6.8. Number of Balls**

Each team will be given 8 balls by default in each match and may use bonus balls secured on Day 1 in any matches (can only use once). 5 of the default balls and bonus balls will be randomly placed in the arena, and 3 of the default balls will be placed in respective loading bays by judges before the start of the matches. If the teams decide to use bonus balls in the match, they will need to inform the judges before the matches start. Each team's ball count post-Day 1 will be recorded by referees.

## 7. Tournament guidelines

### 7.1. Matchlist

The organising committee will release the run schedules for each team **at least three days before the competition day**. The matchlist will be posted on the official competition Instagram account

### 7.2. Pre-tournament checks

All Rovers will be checked during registration to ensure that the robot is within the maximum size limits and that no components on the robot are showing visible signs of damage.

#### 7.2.1. Visible Signs of Damage

Visible signs of damage are inclusive, but not limited to the following:

- Bulging batteries
- Frayed electrical wiring
- Cracked chassis/PCB boards/wheels
- Leakage from motors/electrical components

### 7.3. Pre-tournament Check-up

Participants are to place their Rover at the starting line within **5 minutes** when it is their turn to run the maze. Failure to do so may result in disqualification by the head referee.

### 7.4. Tournament Proceedings

#### 7.4.1. No Shows

If a team fails to place their robots at the starting point within **10 minutes** after being called to compete, the head referee will call the team's name three times. If there is still no response, the team will be deemed a no-show.

#### 7.4.2. Run Time

##### 7.4.2.1. Day 1 - Maze

The maze will be open for **1 hour** for testing. During this period, judges will call each team, one by one, for a robot check-up. Each team will then be given a total of **10 minutes** to complete their run:

- **7 minutes** for exploration and ball-catching.
- **3 minutes** for the final run.

All teams are expected to operate their robots autonomously. Depending on the situation, if more than three teams are unable to perform autonomous line-following, a **50% score deduction** may be applied to teams that use manual control.

## 7.4.2.2. Day 2 - Arena

### 7.4.2.2.1. Competition Stages

The competition consists of four stages:

- **Stage 1 – Heats:**

10 teams (A–J) compete across 5 heats. Teams earn points based on their performance in each heat.

- **Stage 2 – Top 6 Selection:**

The top 6 teams with the highest total points advance. These are divided into two groups:

Group 1: Seeds 1, 4, 6

Group 2: Seeds 2, 3, 5

- **Stage 3 – Semi-Finals:**

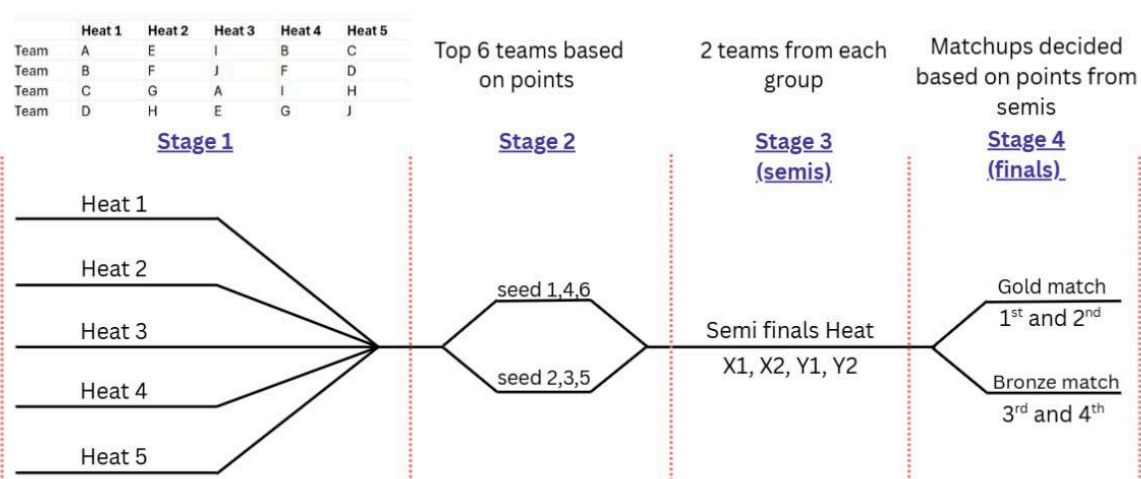
The top 2 teams from each group advance and compete in a semi-final heat (X1, X2 from Group 1; Y1, Y2 from Group 2). From the semi-final, the top 2 teams will advance to the Stage 4 Gold Match, and the other 2 teams will advance to the Stage 4 Bronze Match.

- **Stage 4 – Finals:**

Final placements are decided based on semi-final points:

Gold Match: 1st vs 2nd

Bronze Match: 3rd vs 4th



### 7.4.2.2.2. Team Colours

Teams are assigned red, blue, green, or yellow. Balls and goals match team colours.

#### **7.4.2.2.3. Match Rule**

- **Duration**

Matches last 5 minutes. All four teams play simultaneously.

- **Ball Picking**

Robots may collect free balls or reload manually at loading bays.

- **Ball Shooting**

Teams may shoot their own balls or opponents' balls into their goal. Shared black goals offer higher points.

#### **7.4.2.2.4. Balls or Robots Out of Arena**

Out-of-bounds balls will be placed by the judges into the arena in random places. Robots out of the arena must restart from their loading bay.

#### **7.4.2.2.5. Tie-Breakers**

In the final match of each stage, if a tie occurs between teams competing for advancement, the match shall be extended by one additional minute. Before the additional time begins, all existing balls in the arena will be cleared, and each team will be provided with 5 new balls. Goals scored during the additional time will not be counted in the final marks, but only for the purpose of determining the advancing team(s).

### **7.4.3. Adjustments Within the Given Time Slot**

The following adjustments are permitted within the given 10 minutes.

- Change codes or algorithms
- Replace depleted batteries
- Move and tweak sensors
- Adjust speed
- Fix and restore the mouse

All interactions with the robot will be monitored closely by the referee.

### **7.4.4. Seamless Traversal**

Time taken will not be counted once the Rover enters the endpoint. The Rover are given the opportunity to explore an alternative path when travelling back to the starting point. If any Rover is able to do so, a bonus 10 points will be awarded.

### **7.4.5. Weight Alterations**

Participants are not allowed to alter the weights of their Rover by removing any part of their robots (Eg, removing bulky sensors or replacing batteries with lighter ones).



#### **7.4.6. Interactions with the Robot**

All interactions with the Rover after the containment phase shall be facilitated by any referee at the scene. Any unsupervised interactions with the Rover will result in disqualification.

#### **7.4.7. Spectatorship Access**

Teams are allowed to spectate the competition and wait for their turns. However, they are not allowed to communicate with the competing teams in any form. Violations will be managed by the head referee accordingly.

#### **7.4.8. Sportsmanship**

All teams/spectators are to exhibit sportsmanlike behaviour at all times. For any anti-sportsmanship behaviour, the referee reserved the right to prohibit the participants or their team from continuing the competition.

#### **7.4.9. Request for Timeout**

A team can request a 5-minute timeout after the team completes at least one run, if another team is waiting for their play. The 15-minute timer will stop and will resume once the team returns to continue their run. However, a timeout is subject to a case-by-case basis and is determined by the judges.

### **7.5. Post-Tournament**

#### **7.5.1. Exiting**

Teams are to clean up and exit the competition zone immediately after their turn to allow the next team to proceed. Nothing shall be left in the maze after their turn is done. Discompliance would be subjected to a penalty determined by the referee.

#### **7.5.2. Clearing**

Referees are to ensure that the competition zone is obstacle-free before allowing the next team to proceed with their competition.

#### **7.5.3. Results**

Teams shall report any disagreements with their timing to the head referee table immediately after their turn. Any disagreement after will not be entertained. The head referee reserved the right to declare the competition outcome.

## 8. Scoring and Final Result

### 8.1. Day 1 - Maze Scoring

Components	Maximum Score	Description
Checkpoint	50 points	Each checkpoint crossed during the final run earns 10 points, with a maximum of 5 checkpoints.
Run time	50 points	<p>1st: 50 points</p> <p>2nd: 40 points</p> <p>3rd: 30 points</p> <p>Remaining teams that solve the maze: 20 points</p> <p>Teams that fail to solve the maze: 0 points</p> <p><b>Run time starts</b> as the robot exits the start zone (signified by crossing the start line)</p> <p><b>Run time ends</b> as the robot enters the end zone (signified by stopping within the unit square)</p>
Balls Detection	20 points	<p>Each detected ball (signalled by an LED or a buzzer) will be awarded 5 points.</p> <p>Each False Positive detection signal will be deducted by -5 points in this category.</p>
Size of the mouse	20 points	<p>1st (smallest): 20 points</p> <p>2nd: 15 points</p> <p>3rd: 10 points</p> <p>Teams meeting requirements: 5 points <i>See section (3.2)</i></p> <p>Teams with robots exceeding the required dimensions are penalised with -5 points additionally. <i>See section (3.2)</i></p>

Bonus 1	30 points	If the robot can find an alternative path back to the starting point.
Bonus 2	30 points	If the robot can solve the maze without hardcoding.

## 8.2. Day 2 - Arena Scoring

Components	Maximum Score	Description
Ranking	80 points	1st: 80 points 2nd: 60 points 3rd: 50 points 4th: 40 points 5th & 6th: 30 points Remaining teams that score at least once: 20 points
Size of the mouse	20 points	1st (smallest): 20 points 2nd: 15 points 3rd: 10 points Teams meeting requirements: 5 points <i>See section (3.2)</i> Teams with robots exceeding the required dimensions are penalised with -5 points additionally. <i>See section (3.2)</i>
Bonus 1	30 points	If the robot can pick up and load the ball directly in the arena without any manual assistance.
Bonus 2	50 points	If the robot can execute all the tasks autonomously without human control throughout the matches.
Bonus 3	20 points	Most scoring in a single match (match in any stage).

### **8.3. Final Result**


Scores from both days will be combined to determine the final ranking and winner.

## **9. Prizes**

A total of four prizes will be awarded to participants:

- Top 3 Teams: The top three prizes will be awarded to the teams that accumulate the highest scores based on the grading criteria in *Section 8*.
- Aesthetic Award: A prize will be given to one team, determined by a vote, for the most aesthetic mouse design.
- Newcomer Award: A prize will be given to the best performing freshman team; the team must consist of at least three 1st year students.

## 10. Guideline for Claiming

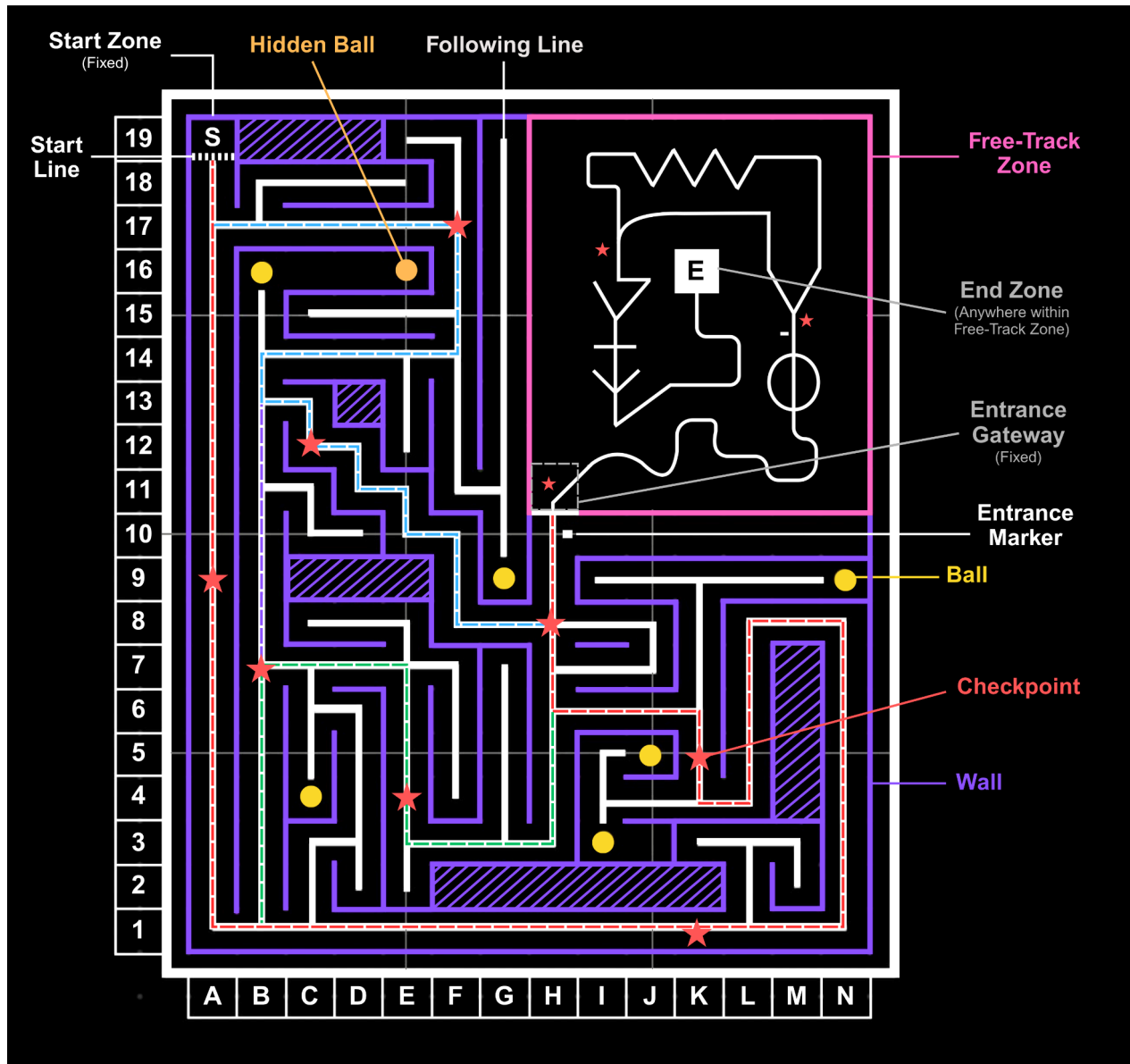
 Guideline of Claiming

## 11. Organising Committee Guidelines

- Committee members shall not disclose any information about the maze layout prior to the discussed release date.
- All other inside information shall not be disclosed outside of the organising committee.
- Organising committee members and judges are to remain unbiased towards all teams, irrespective of their academic institute and ethnicity.
- Any discompliance will be dealt with accordingly. Any committee members found to violate the guidelines will be barred from the organising committee for at least 5 years.

## 12. Appendices

### 12.1. Appendix 1. Maze Example

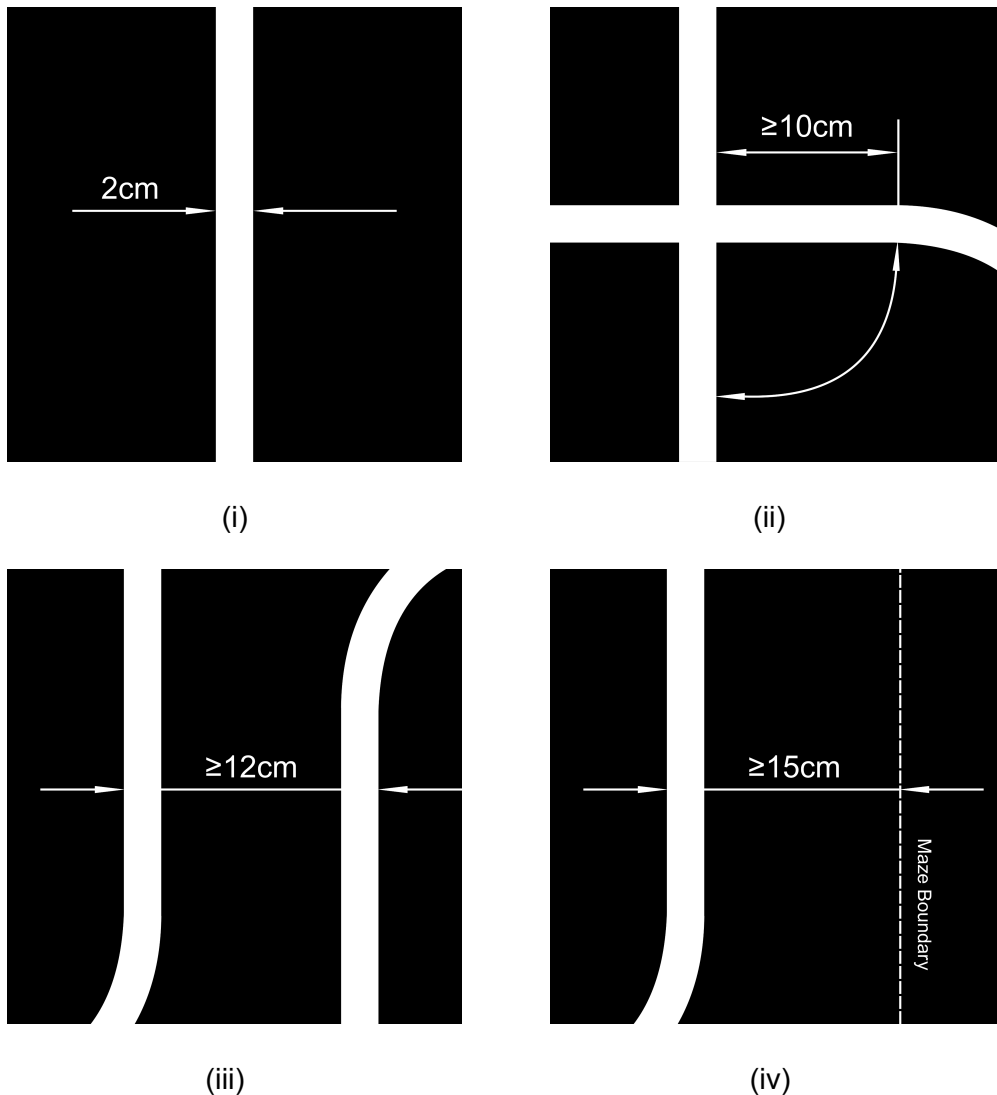


Remarks:

- The illustration is for example purposes only. The final competition maze layout, placement of balls, free-track zone design, etc., may differ from what is depicted.
- The **start zone** is located at the A19 corner.
- The **end zone** is a white square at the end of the track within the free-track zone. It can be located anywhere inside this zone.
- The **free-track zone** spans 7 x 9 unit squares, bounded by coordinates H19, N19, H11, and N11. It has only one **entrance gateway** at H11.

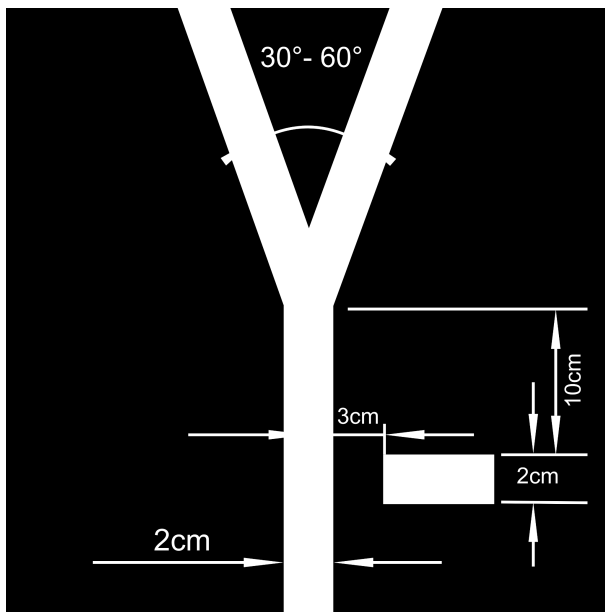
- There are at least 3 viable **paths** from the start zone to the end zone.
- The **following lines** terminate at the unit squares where balls are placed. “Hidden balls” (e.g., coordinate E16) are positioned several unit squares away from the normal ball placement points.

## 12.2. *Appendix 2. Dimensions of Track in Free-Track Zone*



- (i) The track is white on a black background with a uniform width of **2cm**.
- (ii) Before the curve, there is at least a **10cm** uninterrupted section of straight track.
- (iii) The minimum perpendicular distance between any two adjacent tracks is **12cm**.
- (iv) The minimum perpendicular distance between the track and the outer maze boundary is **15cm**.

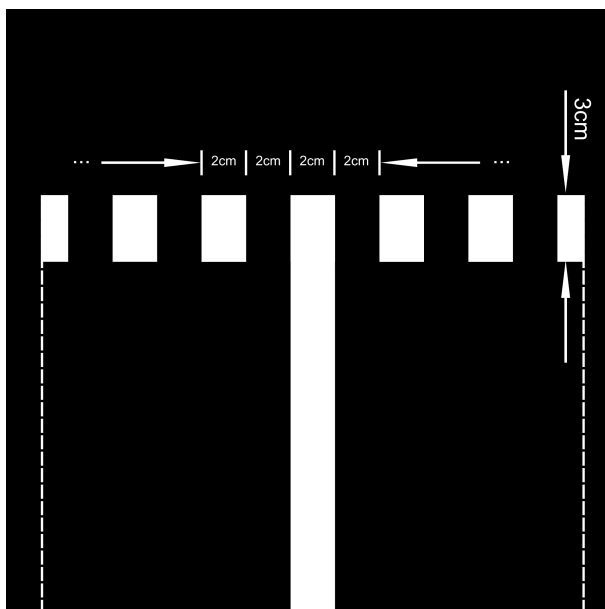
### Road Split and Marker in Free-Track Zone:



At road splits, the angle between diverging paths ranges from  $30^\circ$  to  $60^\circ$ . A marker is placed at either side of the track before the road splits as an indicator of a better path.

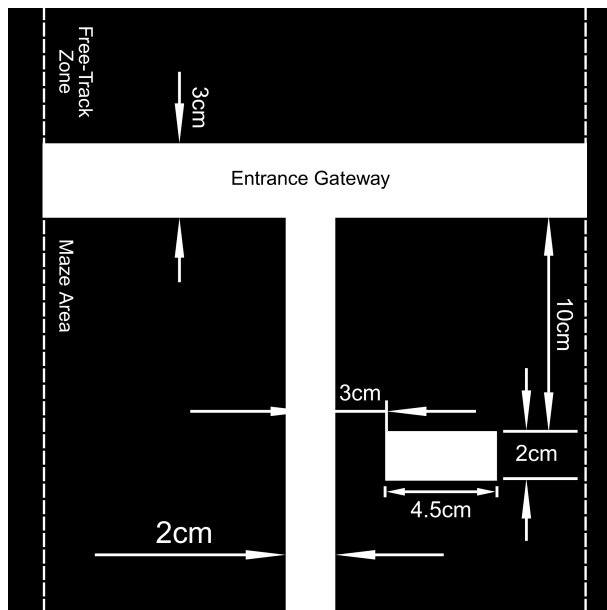
## 12.3. *Appendix 3. Dimensions of Start Line, Entrance Gateway, and End Zone*

### Start Line:



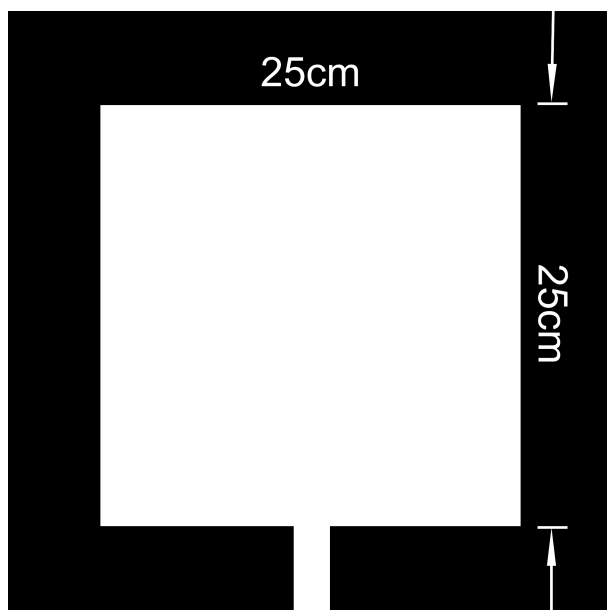


### Entrance Gateway:



There will be a marker at the final unit square before the entrance gateway of the free-track zone. The dimension of the marker is shown above.

### End Zone:



The end zone is a white square of 25cm x 25cm at the end of the track within the free-track zone.

## 12.4. Appendix 4. Arena Layout

