



2024 IEEE R5 Conference Student Robotics Competition Rules

Fayetteville, AR

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Revision Information

Version 1.0	Initial
Version 2.0	Added FAQ at end from Discord and updated various sections based on questions.
Version 2.1	Clarified verbiage around buttons, charging stations, and labeling.

Introduction

This document contains the rules of the 2024 R5 Robotics Competition. The competition is open to teams of no more than 5 and no less than 2 undergraduate students who are enrolled in a college or University within the IEEE Region 5 boundaries. The competition encourages a multidisciplinary approach to robot development and recognizes the participation of students who may already be members of SAE, ASME, EEGS, etc. Therefore, only one team member will be required to be a current IEEE Student Member.

Competition Motivation

The objective of the competition is to demonstrate the use of an autonomous robotic system within a confined area to push a button at one end and return to its starting position. Then, the robotic system will perform a series of maneuvers with competitors in the same arena moving from charging station to charging station until a singular robotic system is left in the trial. The initial game field simulates a known task and environment while the competitive time trial presents unknown factors with competitors and power optimization challenges.

Game Field

The Game Field is an area either indoors at the conference center or outdoors on the pavement (weather dependent) that is 8 ft. x 2 ft in dimension with 1 ft walls (all made of plywood) for the preliminary seeding rounds and 8 ft x 8 ft in dimension with 1 ft walls for the elimination rounds. Figure 1 and Figure 2 show an overall view of the field for both the preliminary seeding rounds and the elimination rounds, respectively. These elements will be placed in each Game Field area:

- **Preliminary Seeding Rounds:**
 - **Buttons:** Two large buttons will be at either end of the field with the center of the button 6 inches off the ground. ([Button to be used](#))
 - **Tee Posts:** Wooden “Tee” posts will be placed at intervals in the field depending upon the round and may or may not be moving in later rounds (Movement will be lengthwise and will not affect the size of your robot). The top of the post will consist of a 2 in by 4 in board with the post itself being a 4 in by 4 in board.
- **Elimination Rounds:**
 - **Charging Stations:** The only objects in the field will be labeled charging stations that competitors will maneuver to with predefined paths for each competitor. Each station will be 6 inches off the ground on the wall with clearly marked letter labels in a visible color matching the color in Figure 2 that is associated with the station (e.g., red for A, orange for B, etc.). The stations will be 2 ft from the corners and 4 ft from the other charging station on the same wall.

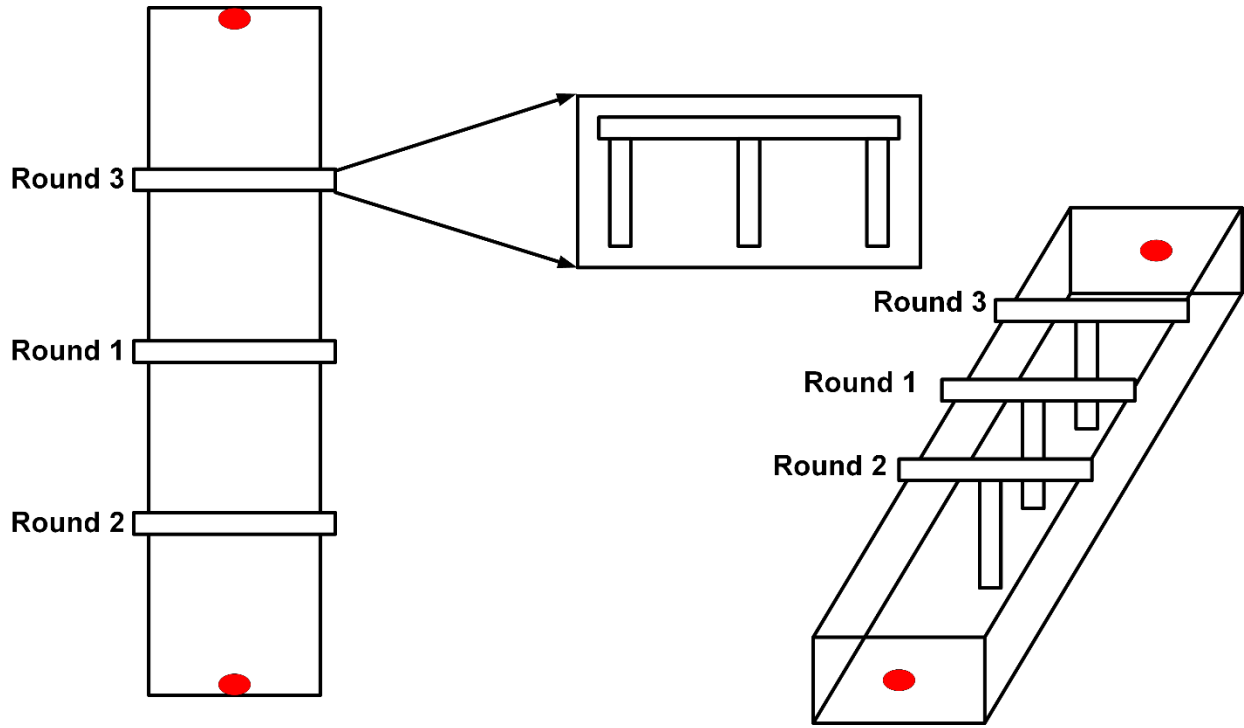


Figure 1. Game Field Layout for Preliminary Seeding Rounds.

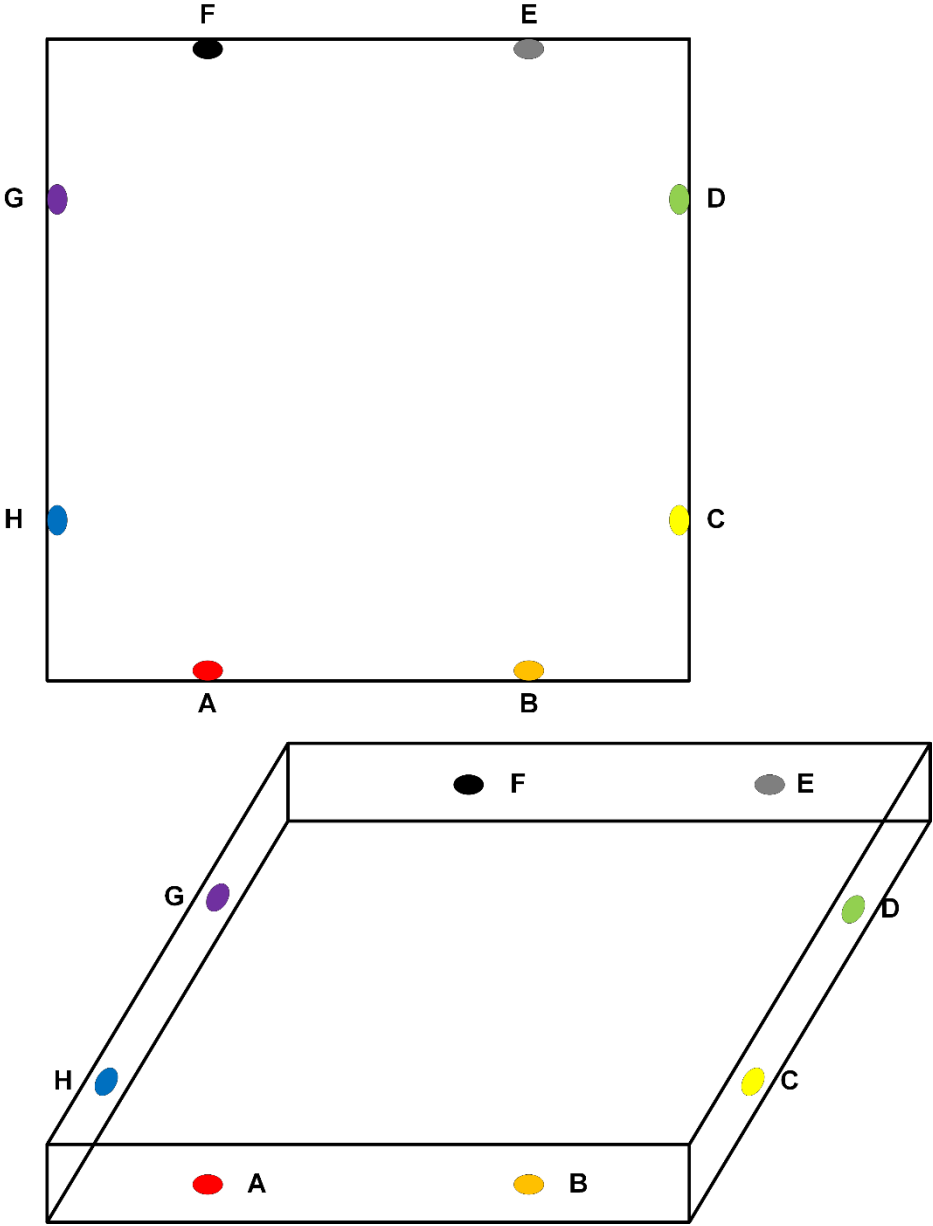


Figure 2. Game Field Layout for Elimination Rounds.

Robot Requirements

- **Construction:** Robots should be built by the student teams and not be purchased as a complete unit.
- **Autonomous Operations:** Required. Robots may not be tethered or controlled wirelessly by the team with the exception of the remote start/kill buttons.
- **Size:** No limits. Must be able to pass through tee posts in seeding rounds.
- **Weight:** No limits. Weight will be an optimization factor for the elimination rounds.
- **Chemicals/Explosives:** Explosives and volatile liquids are not permitted. Chemical batteries are allowed but only if used correctly and with appropriate safety and handling.
- **Capabilities:** Any motorized functionality is acceptable.
- **Supercapacitor:** A supercapacitor must be utilized for the elimination rounds in place of the battery. The supercapacitor must be connected to the receiver end of the charger.
- **Battery/Charger:** The battery for the robot must be ≤ 1500 mAH in capacity and removable. The wireless charger that will be utilized will provide a 5 V output voltage with the current draw dependent upon how close you can get your receiver. The Adafruit 1407 wireless charging transmitter and receiver (<https://www.adafruit.com/product/1407>) will be utilized on the walls of the elimination rounds.
- **Additional Devices:** Multiple vehicles are not allowed, but any additional devices required on the robot for efficient operation are allowable.
- **Bill of Materials:** A Bill of Materials for the robot, including itemized and total cost, is to be submitted by each team by March 31st, 2024.

General Rules

- Only team members are allowed to work on the vehicle, not mentors or supervisors.
- Direct communication with the robot is not allowed once the robot has started moving in the course.
- A remote start button must be utilized and should be declared to the judges prior to the start of any competition rounds.
- The robot must carry any connected devices on its own. The team cannot add or touch the robot once it is in the game field.
- The robot should start each round untethered from any initialization devices.
- Each robot should have a remote-controlled “kill” command to stop all functionality.
- The remote start and kill receivers on the robotic system must be the first device powered by the battery/supercapacitor.
- The supercapacitor is used to provide a limited power source that can quickly be charged in the elimination rounds via the wireless chargers.
- The remote start/kill buttons can be powered with batteries as they will not be physically connected to the robotic system.
- An additional kill switch will be required physically on the robot should the remote kill switch fail.

Gameplay and Order of Operations

Pre-Game Procedure

1. The A/V screen at the Head Judge table will display the order of competition for each game field.
2. Ten (10) minutes prior to the start of a Round, all robots are required to be checked in with the judges table for readiness and rules assessments.
3. Five (5) minutes prior to the start of a Round, teams will check in at the Game Field and play their robot in the START position as designated by the field judge.
4. The public address system will call the start of a Round via the Head Judge.
5. Rotation of competitors will occur approximately every 15 minutes for the preliminary rounds and 30 minutes for the elimination rounds.

Game Play Tasks

See the individual round tasks below for specific tasks.

Preliminary Seeding Rounds (3 for each competitor) (See Figure 1)

1. Place the robot in the START position as designated by the judge.
2. At the call of the Head Judge, start the robot.
3. The robot must pass on the right side of each Tee post without touching the wall or the post within the Game Field.
4. At the opposite end of the START position, the robot will press the red button.
5. After the attempt to press the button, the robot will head back to the starting position on the right side of each Tee post and without touching the wall.
6. The round ends when either the robot presses the button at the start position or 10 minutes has elapsed.

Elimination Rounds (as needed) (See Figure 2)

1. Place the robot in your team's START position as designated by the judge.
2. At the call of the Head Judge, start the robot.
3. The robot must follow the predetermined path to the next charging station. For example, a robot may start at point A then proceed to point D for charging.
4. Each robot is allowed up to 10 seconds to charge at each charging station before proceeding along the designated path.
5. The robots must avoid each other outside of the charging station areas.
6. The round ends when only one robot is left moving or all other competitors have been overtaken on the predetermined path.
7. The predetermined path is: A->D->H->F->B->G->E->C->A
8. "Overtaken" is defined as your robotic system is passed on the predetermined path (as defined in #7 of this list) by a competitor's robotic system. When a judge determines that you have been "overtaken", then your team must hit your remote kill button to stop your robot in place in the field of play.
9. Being "overtaken" can take place at any point in the field of play on the predetermined path. This includes the charging stations. If your robotic system is overtaken on the charging station, then you must hit your remote kill button to stop your robot at the charging station.

Primary Scoring

Preliminary Seeding Rounds

The preliminary seeding rounds will be scored on a lowest accumulated point total being the best (as seen in golf play). Seeding for the elimination rounds will be based on the lowest points accumulated within the three preliminary rounds as well as button press times. Each of the following activities will add a point to your team's score for every instance the activity occurs for each seeding round.

Activity
Hitting the outside wall
Hitting a Tee post
Not pressing the midway button
Not pressing the finish button

Elimination Rounds

The elimination rounds will consist of a tournament style seeding system (think March Madness) with four teams competing in a single Game Field at a time. Every team will follow a predetermined path through each charging station but will be placed on equally spaced segments on the path. There is no scoring system for the elimination rounds. Teams are eliminated by either their robot no longer functioning due to supercapacitor discharge or by their competitors overtaking them on the predetermined path. Once a single competitor is left in the round, the round is over, and the winner will move on to the next round in the tournament until only one robot is left moving.

Scoring Penalties

- **Game Field Damage:** A robot will be disqualified from the round if a robot or team member damages any part of a Game Field. Any Game Field component that requires replacement to continue the competition is considered damage. The Head Judge will make this determination.
- **Obstacle Movement:** A robot will be disqualified from the round if it or a team member moves any of the Game Field elements.

Final Placement and Tie Conditions

- The teams will be seeding based upon their preliminary round scores.
- Ties will be decided based upon times for pushing the finish button, pushing the midway button, and completing the course (returning to the start position but not pushing the button) in that order.
- The final four robots in the final elimination round will compete for final competition placement:
 - Fourth place is awarded to the first robot eliminated in this round.
 - Third place is awarded to the second robot eliminated in this round.
 - Second place is awarded to the third robot eliminated in this round.
 - First place is awarded to the final robot moving in this round.
- Ties for the elimination rounds will be decided on the number of charging stations that a robot visits.

Events and Prizes

- Team registration is required for area game field entry and badges.
- The competition will conclude with an awards banquet on Saturday evening.
- Cash prizes and certificates will be awarded at the banquet.
- Specific award details will be provided on the Robotics Competition page of the Region 5 website.
- The general public may view the competition; however, guests must register and pay to attend the banquet.

Venue

- The 2024 Region 5 Robotics Competition will be held at the Northwest Arkansas Convention Center located at 1420 S 48th St, Springdale, AR 72762.
- Four (4) preliminary round game fields and at least one elimination round game field will be available starting the Friday April 5th, 2024.
- The competition will be held on Saturday April 6th, 2024.
- Detailed schedule information will be posted on the Robotics Competition page of the Region 5 website or onto the Competition Discord Server.
- Wireless internet will be available for teams in the Convention Center on Friday and Saturday.
- Each team will have a working station inside the Convention Center regardless of whether the competition is held inside or outside.

FAQ

Q1: How much force will be required to press the button? What color are the buttons? How large are the buttons? What shape are the buttons? Is there any kind of marking designating where the button is? An example would be a checkboard pattern surrounding it. We need to know how to identify the location of the button with sensors.

A1: The force from the robot driving into the button should be enough to press it. The buttons are going to be red unless supply chain issues arise. They will be about the size of a person's palm at the largest and will be round. There will be no markings around the button.

Q2: In round 1 it says the "T post" will be "Moving" does this mean they will be moving side to side while the robot attempts to navigate the course, or does it mean they will be moved between rounds?

A2: The T-post moving will be longways on the course, so the 8ft length if they are moving at all.

Q3: What is the minimum width between the center of the "T post" and the wall of the corridor? We need to know this so that we can determine the maximum width of our robot.

A3: The rules detail that the width is 2 ft with the post of the T being 4 in by 4 in, so if you do the math that gives you about 10 in on each side but that may not include the thickness of the walls so be prepared for a potentially smaller gap.

Q4: Are there multiple charging coils for each station? If so, if a team is overtaken, and has to remote stop on a pad, is that charging station unusable to the rest of the teams, for remainder of the competition?

A4: There is only one charging coil at each station. Should a robot be overtaken on the coil, that coil is no longer usable.

Q5: Are the charging coils on the walls or the ground?

A5: The coils will be on the walls.

Q6: Size of the game board for the second round?

A6: Unfortunately, I did not put the size of the board on the second round, but it is 8 ft by 8 ft (basically the length of a plywood sheet for ease of layout assembly for teams to practice on).

Q7: With the three preliminary seeding rounds, is your best time taken or an average?

A7: The rules dictate that times for button pushing and completion are used for tie scenarios based on point accumulation in the preliminary seeding rounds.

Q8: Can we assume that the surface the robots will compete on will be made from a sheet of plywood? Or will it be carpet/concrete?

A8: That depends. We haven't decided where the competition will be held (inside vs outside) so you should prepare accordingly.

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Q9: Are we limited to a single supercapacitor for the elimination rounds (i.e. a single 2.7V 300F capacitor)? Or can we put multiple supercapacitors in either series or parallel?

A9: There is no limitation on the supercapacitor since a larger one will take longer to charge. More than likely, the supercaps will be required to be discharged before the start of the elimination rounds.

Q10: What is the penalty for hitting another team's robot during the elimination rounds while trying to overtake it?

A10: If you hit another robot that is in front of you, then they are eliminated. No penalty for hitting them other than you now must track around them to get back on the predetermined path, which will take longer and allow those behind you to catch up.

Q11: I am currently trying to figure out the dimensions of the robot. In the section of the 2x8 game field, it does not specify the distance of the posts. It just says a certain interval. What is the closest the first and last post will be placed?

A11: This will be determined the day of the competition but will be more than 1 foot away from the starting point.

Q12: The rules state that the charging stations will be labeled. Can this system be defined further? Will the labels be on the ground? On the walls?

A12: They will be labeled with the letter of the station for the predetermined path. On the walls next to the chargers, but you should be able to just program what your starting point is and set the predetermined path directly into your robot.

Q13: Do we know specifics about where the chargers are? I.e 2 ft away from the wall, 4 ft away from the other charger on the same wall, etc?

A13: Yes, that is what we are aiming for with the drawing.

Q14: What would be the surface of the arenas if the competition is held outside? What would be the surface of the arenas if the competition is held inside?

A14: Outside – Pavement; Inside – Carpet

Q15: Will the wooden tees be painted, or will they have a finish? If so, will the finish be matte or glossy? What color/finish will the walls be?

A15: None of the wood will be painted, so expect a natural wood color.

Q16: What is the definition of the receiver end of the charger? (Described under Robot Requirements: Supercapacitor)

A16: The charger is a wireless charger, so the receiver end would be the one that is capable of receiving power from the transmitter on the wall.

Q17: Is there any allowance for active and passive components between the charger and supercapacitor?

A17: Charging will be done wirelessly.

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Q18: Can we remove and add components between the seeding rounds and the elimination rounds?

A18: You will need to remove the battery between seeding and elimination rounds. Otherwise, the robot is expected to be the same that performed in the prelim rounds.

Q19: Can we use a solar panel?

A19: No, this would be an unfair advantage in the elimination rounds.

Q20: Can we use an external light source?

A20: Not sure why you would need an external light source, but as long as it operates on the battery/supercap and is mounted to the robot you will be fine.

Q21: Is the cost of our robot going to affect our final scoring?

A21: Cost is not considered in any scoring.

Q22: Is there a max cost for the robot?

A22: No budget requirements.

Q23: Is there a minimum distance requirement for the remote start?

A23: The remote start capability is expected to be on the same device that provides the remote kill capability for your robot. This needs to be wireless and should have about 10-15ft range capability.

Q24: Is there a difference between having a capacitor and having a supercapacitor. What is the official definition of a supercapacitor?

A24: Here is the wiki article on supercaps: <https://en.wikipedia.org/wiki/Supercapacitor> You can use either caps or a supercap, but a supercap will be more effective for your functionality.

Q25: What will be the readiness and rules assessments checklist? (Mentioned in Pre-Game Procedure item 2)

A25: This will be a basic check to make sure that every robot has the required components (or removed specific components for the elimination rounds) prior to the START of the round. (Following all the robot requirements section)

Q26: Is the following a typo? (Mentioned in Pre-Game Procedure item 3)

A26: Yes, it should be place. Will update in the next week or so. Along with inclusions for these questions.

Q27: Is there a quarantine prior to a round? And if so, what is the quarantine time?

A27: No quarantine other than performing the check in with the judge prior to the start.

Q28: How quickly does the robot have to start after the remote start?

A28: Up to you. Time is a tie breaker for the seeding rounds and not moving quickly in the elimination rounds may cost you.

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Q29: How will the button register the press? Will there be any indicator or signal that we pressed the button?

A29: I think the buttons we are looking at using will have a recorded message. I will post a link to what we are expecting to use (barring any logistical concerns) in the updated rules.

Q30: Where is the starting position for the seeding rounds?

A30: You will start next to one of the buttons.

Q31: What score penalties will we have if we end up on the left side of the tees in the seeding rounds? (Seeding Rounds rule 5)

A31: You will receive a point for each missed gate.

Q32: Can you clarify how we will receive the start signal in the elimination rounds if our robot has no power?

A32: The start signal will be said by a judge 10-15 seconds after the wireless chargers are turned on. Your robot is expected to go autonomously at that point.

Q33: How far away from the charger do we have to be to be considered in the charging area? (Mentioned in Elimination Rounds item 5) The rules mention that robots cannot contact each other outside of the charging area, is the collision rule discussed early on the discord only valid in the charging station area.

A33: I use the word “avoid” as you cannot guarantee that a robot isn’t going to contact another when they are autonomous. I don’t want a team to simply program their robot to attack the others rather than follow the predetermined path. This is the point of this rule.

Q34: What is defined as moving or functioning? (Mentioned in Elimination Rounds item 6)

A34: Still has power to follow the predetermined path. If you aren’t moving and someone else is, then you most likely will be overtaken and eliminated.

Q35: What is the definition of being overtaken?

A35: The robot behind you on the predetermined path catches up to you.

Q36: What happens if the remote kill button fails on the robot?

A36: This will be a part of the check in process, but I would also include a kill button on the robot for the judge to intervene if this does happen. (Will update rules to include this.)

Q37: Can the robot discard components while in the field of play?

A37: No, this could be seen as a form of attack by creating obstacles for others.

Q38: How is our scoring affected if the robot hits the wall and remains in contact with it for a prolonged period of time in the seeding rounds?

A38: To discourage teams from simply hitting a wall once and then following it, we will add a point for every 5 seconds you are in contact with the wall.

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Q39: If there are two robots left, who is ahead of who? How do you define hitting a bot in front of you if only two bots are left? What is the definition of the rear of the robot?

A39: Each robot is on the predetermined path. We will be able to tell who is ahead of who based upon the path and relative starting locations on the path. Being overtaken is any contact from the robot behind you on the path.

Q40: In round two, we are not allowed to have a battery. Are we allowed to store energy using mechanical means?

A40: No, all energy must be stored in the supercap/caps and from the wireless chargers.

Q41: Is the Adafruit 1407 wireless charging transmitter on the rules the one that will be used for the competition?

A41: We hope so barring logistical concerns.

Q42: What are the starting positions for each robot in round 2?

A42: Starting positions will be randomized but equal distant from other robots (If you are on A then the next robot you need to overtake would be on H). Hitting a robot before “tagging” the station between would not result in elimination (in this example, the A robot would need to tag station D prior to being able to eliminate the H robot unless this robot tags its next station).

Q43: How close must you get to a charging station before you can proceed to the next?

A43: Let’s say a 6in by 6in square located under the charger. (will update figure)

Q44: If the predetermined path is decided by charging stations, and a robot may have to use its kill switch on a charging station, does the path change?

A44: No, the path stays the same, but the station is no longer viable for charging.

Q45: In the seeding rounds is the “right side” determined by the perspective of the robot? (Mentioned in Preliminary Seeding Round Direction 3)

A45: Yes, the robot should be making left turns only in the seeding rounds.

Q46: Ties in the elimination round are stated to be determined by the number of charging stations a robot visits, is the winner the robot that visits more?

A46: Yes, but this occurrence should be extremely rare.

Q47: What are the exact positions of the charging stations and are they marked in any visual way? Does the color of the dot on the drawing signify and markings in the arena?

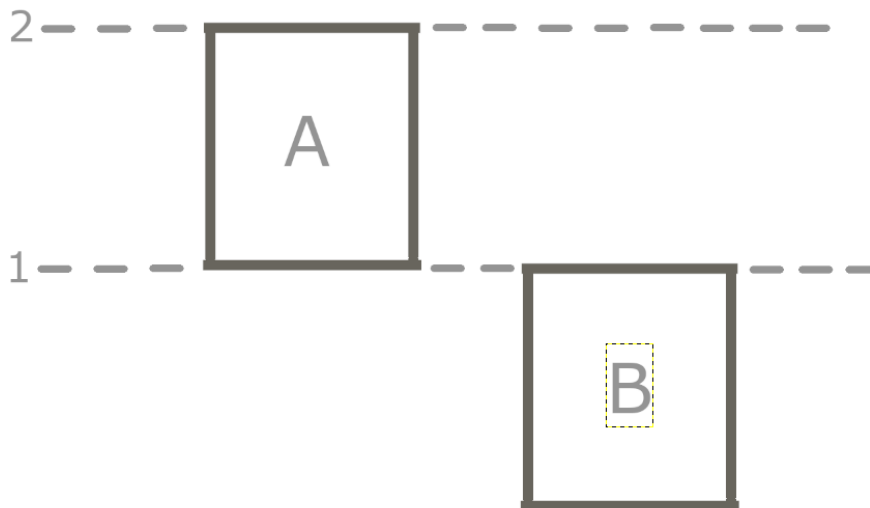
A47: We will try to label them with text or markers on the walls, but the pathway should be same as the figure. The chargers will be 2ft from the corner and 4ft from the other charger on the shared wall.

Q48: To clarify what I was asking in question 22 which of the following situations would be correct:
Robot A is overtaken by Robot B if the front of Robot B crosses line 1.

Robot A is overtaken by Robot B if the rear of Robot B crosses line 1.

Robot A is overtaken by Robot B if the front of Robot B crosses line 2.

Robot A is overtaken by Robot B if the rear of Robot B crosses line 2.



Image

A48: I would say that the third best describes what I am envisioning. Basically, if the robot catches up to you in position, then you are overtaken. But this is only relevant if you are both moving towards a charging station. If robot B comes up and touches the station box on the ground or tags A, then A is overtaken.

Q49: Tee Posts: Wooden “Tee” posts will be placed at intervals in the field depending upon the round and may or may not be moving in later rounds. The top of the post will consist of a 2 in by 4 in board with the post itself being a 4 in by 4 in board.

What does "moving" mean here? Does it mean that the posts are moving horizontally as our robot is trying to navigate to the red button? Or will they just be stationary and be moved to a different position in every round?

A49: Either. Depends upon how easy it is to rig something up to move the posts, but they will only be moving lengthwise (so inline with what the direction the robot should be moving). We may or may not add additional posts to maneuver around in the later seeding rounds.

Q50: Could you specify the exact location and position of the button?

A50: The button will be centered 6in off the ground and 1 foot from the corner in the middle of the short wall.

Q51: Hi, quick question. I understand that the robot should be powered by the supercapacitor in the elimination rounds. I was thinking of isolating the remote kill/start switch to it's own little 9v battery to power the relay and wireless receiver. Would that be in violation of the rules as written? It wouldn't be powering the robot, just the switch keeping it active, but I just wanted some clarification before I move further in the design process.

A51: No, your remote kill/start should be able to live on the supercapacitor in the elimination rounds. It needs to be the first thing powered by the supercapacitor (i.e. direct connection as opposed to microcontroller activation).

Q52: Greetings. I was looking over the rules for the preliminary round of the robotics competition and would like some clarification in regards to the T-posts. In the figure that I have attached, I noticed that the zoomed in view of the set up shows three legs, but I thought the post just has one leg in the middle (hence why it is called a "T-post"). Are these other two "legs" just representing the walls of the enclosure?

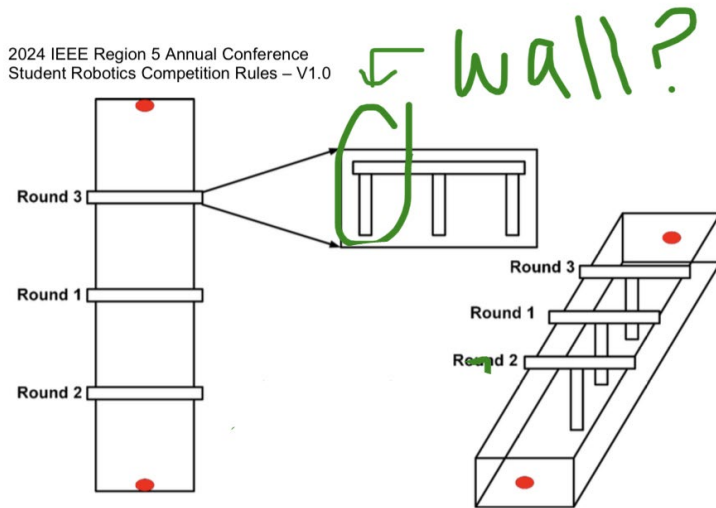


Figure 1. Game Field Layout for Preliminary Seeding Rounds.

A52: Yes, that is correct. It would sit on top of the walls.

Q53: are we limited to use only one supercapacitor or can we use multiple?

A53: That is your design choice.

Q54: is there a Farad limit on the super capacitor?

A54: You can connect multiple supercapacitors in series or parallel to attain a desired capacitance at a desired voltage, we just must pay attention to the cost-benefit (more caps = more weight) I purposely left things open-ended as much as possible for you all to have more design freedom and choose what is important to you.

Q55: I have a question about the elimination round charging stations. Will the charging stations be marked with the colors from the elimination round diagram in the rules document?

A55: That depends on how visible a tape color could be in the various colors as well as availability of diverse colors. We will have the letters taped out in at least a red tape.