

2018 4-H Robotics Engineering Challenge

The 4-H Robotics Challenge provides an opportunity for 4-H members interested in science, engineering and technology to participate in a hands on, team based activity of building robots.

Game Manual

1.0 Teams

1.1 Teams will consist of 2 to 4 Junior, Intermediate or Senior 4-H members . Teams of mixed age groups are allowed, but the oldest member on a team establishes the age group applicable to the team. Please note that any team who wishes to compete for the National 4-H Engineering Challenge trip must be made up entirely of Senior (14 years old before January 1, 2018) 4-H members. While Junior and Intermediate team members may compete on a Senior team at the State Fair, they do not qualify for the National Trip. Mixed teams of Intermediate and Senior 4-H members also will not qualify for the National Trip. The top ranked team made up of entirely Senior 4-H members will earn the opportunity to represent Maryland at the National 4-H Engineering Challenge.

1.2 The team must have an adult coach who has completed the Maryland 4-H UME Volunteer training.

1.3 Senior teams and team members who have previously won the State contest may not compete in the 2018 contest.

2.0 Robot Design- This section provides rules and requirements for the design and construction of your robot. The robot is a remotely operated vehicle designed for the game.

2.1 Robots can be constructed from materials and/or from any robotic platform of the teams' choosing as long as all other rules are met¹.

2.2 Motors- A robot may utilize no more than 10 motors or servos.

2.3 Batteries- The robot shall be powered by non-spillable batteries. The battery voltage shall not exceed 12 volts and the total battery capacity of the batteries used on the robot shall not exceed 6000 mAh.

¹ The intent is to allow teams to compete using a robot assembled from hardware from a commercially available robotics platform, a robot built from materials purchased from a variety of local sources (hardware stores, electronics stores), or a hybrid of hardware from more than one robotics platform and/or additional materials purchased at local sources.

2.4 Radio Control- Robots must use radio control for tele-operated operation. No tethered operations will be allowed on the field. Teams may use any radio control system as long as it has been approved by the superintendent for use. To gain approval, the team must submit a completed copy of the documentation contained in Annex 1. The VEX Robotics V.5 crystal-based radios, the VEX Robotics VEXnet radios, the LEGO Bluetooth radios, VEX IQ radios and the TERIX (FTC) Samantha Radio are already approved for use. Teams do not need to submit approval requests for these radio systems. New radio systems must be shown to be compatible with these existing radios in order to gain approval for use.

2.5 Microprocessor- Any microprocessor may be used in the design. It is the responsibility of the team to ensure their microprocessor is compatible with the batteries, motors and radio control system that they have selected.

3.0 Robot Inspection - Each robot will be required to be inspected by an inspector during the registration time. This inspection will ensure that the robot rules are met. If the robot does not pass inspection the team will be allowed to modify the robot and have it be re-inspected, but may not compete until the robot passes inspection.

3.1 Robot Size- The robot in its starting configuration must fit inside of an 18" X 18" X 18" sizing box without touching any side of the sizing box. A sizing tool will be used during inspection to determine if the robot meets the size requirement. Once the match starts the robot may unfold to any size. The sizing tool may also be used at the field by the referees to verify starting size. Robots that cannot meet this requirement will be disqualified from the match.

3.2 Robot Weight- The robot may weigh no more than 20 pounds with batteries installed. A scale may be used at inspection to ensure the robot meets this requirement. Any changes that add parts after inspection will require that the robot be re-weighed.

4.0 Robot Control- An official field clock will be provided, however each team must provide their own means to start and stop their robot in the autonomous and tele-operated portions of the game. Start and stop commands will be given by the referee based on the official field clock. Teams who violate the stop command will be given a verbal warning on the first occurrence, and will be disqualified from the match for any subsequent occurrence.

4.1 Autonomous Period Operation

4.1.1 Teams should utilize or design autonomous software to begin autonomous operation with minimum interaction with the robot. A designated member will be allowed to press a button on the robot at the beginning of the autonomous period if required. No manipulation of the robot or part of the robot is allowed when starting the autonomous program.

4.1.2 The autonomous program shall automatically terminate or be terminated by computer or control electronics from the side of the field at the time the referee gives the "stop" indication. The robot will be left in the position it stopped in at the end of the 30 second autonomous period. Any game pieces scored after the 30 second autonomous period will not be counted and will be returned to the playing field.

4.2 Tele-Operated Period Operation

4.2.1 Each robot must be controlled through wireless controllers. Two team members designated as the drivers may control the robot. One additional team member may be at the field for support. No team members or adults may coach from sidelines or spectator seating.

4.2.2 Teams should design their tele-operated software to start the tele-operated period of the game with minimal interaction of the robot. A designated member will be allowed to press a button on the robot at the beginning of the tele-operated period if required.

4.2.3 Once the Autonomous or Tele-Operated periods begin, no member of the team will be allowed to touch or in any way manipulate a robot or game piece. If a member touches or manipulates the robot or a game piece, the team will be disqualified for that match.

5.0 The Game

5.1 The Field

5.1.1 The field will be a standard 12' X 12' Vex/FIRST Tech Challenge field. The general field perimeter specifications can be found at:

<https://content.vexrobotics.com/docs/278-1501-Build-Instructions-20170629.pdf>

5.1.2 The floor of the field will be covered with standard foam Vex/First Tech Challenge foam floor tiles. Note that the field tiles are installed with the unfinished side up.

5.1.3 Scoring elements:

- 32 standard tennis balls (2.7" in diameter)
- 6 plastic softballs that measure 12 inches in circumference (e.g. <https://www.amazon.com/dp/B01N2212KU/?encoding=UTF8?coliid=I2ETLVL2U5CEQ5&colid=39AS13Q00QJKX&psc=1>)
- 1 foam soccer ball measuring 7.5 inches in diameter (e.g. <https://www.amazon.com/dp/B0073ATK18/?encoding=UTF8?coliid=I5HCQSN15VXMQ&colid=39AS13Q00QJKX&psc=1>)

5.1.4 Field diagrams, technical drawings, and videos will be available as separate documents and/or links to an external web site(s).

5.1.5 The tennis ball corral, will be located in the center of the field. It will be:

1. A rectangle constructed of 0.5 inch PVC pipe
2. will have a perimeter measurement of 48 inches by 24 inches.
3. Will be attached to the field walls by 0.5 inch PVC pipe that extends from the side of the corral to the walls of the field
4. will be located in the center of the field
5. At the beginning of the match, a total of 30 tennis balls will be placed in the corral. Spacing will be random. That is no attempt will be made to arrange the tennis balls other than to place them in the corral.
6. The entire corral will be considered neutral (i.e. not red, not blue). Robots may enter the corral from any point around the perimeter, and at any time during the match.

5.1.6 The tennis ball goal will:

1. Have interior dimensions of 15 inches by 15 inches
2. Have exterior dimensions of 16.5 inches by 16.5 inches
3. Have a perimeter constructed of 1x 4 x N pine stock (actual thickness: 0.75 inches, actual height: 3.5 inches)
4. Have a solid floor constructed with plywood that is at least 0.25 inches thick. Thicker material may be used.
5. Have an interior height of 1.5 inches
6. The front of the goal will be placed directly on the ground. This means that the top face of the floor will be 2 inches off of the floor.
7. At the rear of the goal, the top face of the goal's floor will measure 8 inches off of the floor (i.e. elevated 6 inches), which will set the floor of the goal at an angle of approximately 22.5 degrees.
8. The area under the goal should be enclosed to prevent games elements from easily becoming trapped underneath it

5.1.7 The plastic softball goal will:

1. Have a top face with dimensions of 15 inches by 15 inches
2. Have a top face constructed of plywood that is no more than 0.5 inches thick. Thinner material may be used as long as the face of the goal does not flex when completed
3. At the front of the goal, the top face will be raised 2 inches off the ground
4. At the rear of the goal, the top face of the goal's floor will measure 8 inches off of the floor (i.e. elevated 6 inches), which will set the floor of the goal at an angle of approximately 22.5 degrees.
5. There will **not** be a raised perimeter around the top face of this goal.
6. 9 round holes will be cut into the top in a grid, giving it the appearance of a tic-tac-toe board.
7. The holes will have a diameter of 3.5 inches
8. The location of the center of each of these holes can be found in the technical drawings for the field elements
9. The area under the goal should be enclosed to prevent games elements from easily becoming trapped underneath it

5.1.8 A Low goal in each color's corner will be created by connecting a 0.50 inch PVC pipe from the front of the tennis ball goal to the front of the plastic softball goal

5.1.9 The parking ramp will:

1. Have two rails constructed of 1x 4 pine stock (actual thickness: 0.75 inches, actual width: 3.5 inches)

2. Each rail will measure 24 inches in length
3. The bottom of the parking ramp's rails will rest on the floor
4. The top of the parking ramp's rails will measure 10 inches off the floor, giving the ramp an angle of ~22.5 degrees
5. The rails will measure 12 inches on center (or 15.5 inches from outside edge to outside edge, and 9 inches from inside edge to inside edge)
6. Will have a parking zone measuring 24 inches by 24 inches marked in tape at the base of the ramp. The parking zone will also include the ramp itself and the tile on which the ramp sits.

5.1.10 Preloads and Match Loads

1. A preload must be put into play before the autonomous period of any match begins
2. A match load may be put into play only after the autonomous period of a match has begun
3. Each team will received 1 tennis ball as a preload
4. Each team will received 3 plastic softballs that can be used as preloads and/or match loads

5.1.11 a deck of 7 laminated cards will be printed to be used by teams before each match to select the pattern they must match when scoring plastic softballs in order to receive the multiplying bonus. Templates for these cards can be found in the technical drawings.

5.1.12 Each team must start the match on color tile matching their robot's assignment for that match.

5.2 The Challenge

5.2.1 Competitors may score points in the following ways:

1. Score more points than your opponent during the 30 second autonomous period to obtain the 20 pt bonus
2. Score as many tennis balls as possible in the low goal or angled goal area
3. Place plastic softballs in the softball goal in a manner that matches the pattern on the card the team selected prior to each match. The more softballs properly placed, the higher the bonus multiplier for the tennis

balls

4. Park on the ramp without possession of the soccer ball
5. Possess the soccer ball at the end of the match
6. Possess the soccer ball at the end of the match AND park on the ramp
7. Collect as many points as possible for the Engineering Notebook

5.2.2 At the beginning of each match, each team will randomly select one of 4 possible patterns for scoring the plastic softballs that must be matched in order for the softballs to be considered “properly scored”. See Appendix 2 for the possible patterns.

5.2.3 Tennis balls scored in the low goal area on the floor between the angled tennis ball goal and the softball goal will be worth 1 point each. These points are not multiplied.

5.2.4 Tennis balls scored in the angled tennis ball goal will be worth 2 points each, but their value may be multiplied per the following:

1. If one (1) plastic softball is properly scored, each tennis ball scored in the angled goal will be worth 3 points each
2. If two (2) plastic softballs are properly scored, each tennis ball scored in the angled goal will be worth 5 points each
3. If three (3) plastic softballs are properly scored, each tennis ball scored in the angled goal will be worth 10 points each

5.2.5 At the conclusion of the match, teams may earn one of two parking bonuses.

1. A 20 point parking bonus will be awarded if a robot:
 - a. Is in contact with no other field element other than their own parking ramp but
 - b. any part of the robot is in contact with the ramp below the bonus line (i.e. 6 inches from the base of the ramp)
2. A 50 point parking bonus will be awarded if a robot:
 - a. Is in contact with no other field element other than their own parking ramp and
 - b. no part of the robot is in contact with the ramp below the bonus line (i.e. 6 inches from the base of the ramp)

5.2.6 With 1 minute (60 seconds) remaining in a match, a referee will place the foam soccer ball in play within the tennis ball corral in the center of the field. The scoring for this soccer ball will be as follows:

1. The soccer ball will not affect scoring if
 - a. It is inside of the corral
 - b. is simultaneously contact with any robot AND another field element
2. A team will incur a 20 point penalty at the conclusion of the match if:
 - a. the soccer ball is on the same side of the field as their starting tile
 - b. and is outside of the corral
 - c. and is not touching any part of either robot
3. At the conclusion of the match, a team will be awarded 20 points if:
 - a. their robot is in full possession of the soccer ball. Possession means the soccer ball must be controlled by a robot and must not be in contact with any field element
 - b. their robot is not parked above the bonus line on the ramp
4. At the conclusion of the match, a team will be awarded 100 points if:
 - a. their robot is in full possession of the soccer ball
 - b. and no part of the robot is in contact with any field element other than the rails of the ramp
 - c. and no part of the robot is in contact with the rails of the ramp below the bonus line
5. No robot may come into contact with their opponent's parking zone during the last 60 seconds of a match. Any infraction of this rule will result in a disqualification from the match for the violating robot.

5.2.7 Each team will be given 1 tennis ball as a match preload.

1. This preload can only be placed on/in the robot and must not touch the field tiles or field walls or any other field element
2. The preload does not need to be used
3. The preload may not be introduced to the field once the autonomous period has started.

5.2.7 Each team will be given 3 plastic softballs, which can be used as either preloads or match loads.

1. When introduced in the field of play, the softballs must be placed on the starting tile for that team. These cannot be placed in/on the robot directly.
2. While a softball is on the starting tile, the opposing robot cannot touch either the softball or the starting tile
3. If the softball is no longer in contact with the starting tile it will be considered "neutral", and either team may possess it

5.2.8 Descoring is not allowed from any goal. Teams that intentionally descore any element by any means will be disqualified from that match and will receive zero points.

5.2.9 The Autonomous Bonus of 20 points is awarded to the autonomous period winner. The Autonomous Period winner is the team that has scored the most points during the autonomous period.

5.2.10 Tennis balls will be considered scored if

1. Any part of the ball is inside the imaginary vertical boundary of the goal's boundaries (i.e. tennis balls _can_ be stacked)
2. no part of the goal's owner's robot is in contact with the ball
3. Any ball in contact with the robot will be removed from the goal before final scoring commences

5.2.11 No game element may be intentionally ejected from the field area. The first offense will result in a warning. A repeated offense during a match will result in disqualification for that match.

5.2.12 If a tennis ball leaves the field accidentally, it will not be returned to the field of play.

5.2.13 If a plastic softball leaves the field of play for any reason, it will be returned to the possession of the team who originally possessed it who may then treat it as a valid match load, may be put in play again.

5.2.14 If the soccer ball leaves the field of play, the ball will not be returned to the field, and regardless of the intent, the team that took the action that resulted in the ejection of the ball will incur a 20 point penalty.

6.0 Official Questions about the Game- If you have questions about the game, e-mail them to Willie Lantz at wlantz@umd.edu or Tim Krispin at tim.krispin@gmail.com

7.0 The Tournament

7.1 Matches- Matches will be 2 minutes and 30 seconds in length. The first 30 seconds will be the autonomous period. The remaining two minutes will form the operator control part of the match.

7.2 Ranking- A team will earn two points for each Match win and one point for a Match Tie. Teams will be ranked using the total of points earned for Match Wins and Ties, plus the points earned for their Engineering Journal as discussed under Section 8.0. In the event that two teams are tied in rankings, they will play an additional match to break the tie.

8.0 Engineering Journal and Judge Interview

8.1 The engineering journal will be used to document the teams design process in building the robot from design concepts to finished product. Team members should document your work in the journal each time your team meets to work on the robot. Record your obstacles, lessons learned and successes of your designs. Place information in the journal about testing procedures and results of tests. Any format may be used for the journal.

8.2 The Engineering Journal will be presented and evaluated during a Judge Interview. An interview will last 10 to 20 minutes. The team should be prepared to present their design, team activities and other items of interest, but also allow time for the judges to ask questions during the interview period.

8.3 Judges will judge each team's presentation on a scale of 0-100 points, per the following:

- 10 %: quality of display elements
- 40%: quality of presentation
- 50%: quality of documentation/Engineering Journal

8.3.1 The Judge Interview will be worth as much as the maximum possible match points that a team can earn in match play, per 7.2. For example, if each team plays 5 matches, there is a potential for a team who wins every match to earn 10 Points. In this case, that maximum score that can be earned for the Engineering Journal is 10 points.

8.4 Each team's Judge Interview Score will be added to their Total Match Points for a final ranking score. Ties will be broken by tiebreaker matches.

9.0 Field Construction Drawings and Videos

9.1 Field Construction Drawings will be posted to the University of Maryland 4-H Robotics Website as a separate document. Links to field construction videos will be posted as well.

Appendix 1 Radio Approval

Radio Manufacturer: _____

Radio Model Number: _____

Radio Manufacturer technical point of Contact Name: _____

Radio Manufacturer technical point of Contact Phone Number: _____

Radio Manufacturer technical point of Contact Email: _____

Frequency range(s) of Radio System: _____

Does the system use any of the following technologies?

Bluetooth

802.11B/G

802.11 A/N

Is the radio frequency setting adjustable?

Yes

Manual

No

Automatic

NOTES:

- The goal of this requirement is to ensure all competitors can operate without concern over interference caused by other robot radio links. All efforts will be made to allow new hardware. The intent is not to discourage use of new hardware.
- The team may be required to submit a radio system for compatibility testing against the already approved devices. The equipment will be returned once testing is complete.
- It the responsibility of the proposing team to provide all requested information, additional information and hardware for testing. The team may also be required to provide an equipment operator at the time of compatibility testing.
- Approval is not guaranteed. Inability to obtain necessary information (on his form or additional), lack of hardware for testing and/or suspected incompatibility with already approved radio systems will result in rejection of the hardware for use in the State Fair contest.

Appendix 2
Plastic Softball Goal Scoring Cards

