

## 2019 Illinois 4-H Robotics Challenge: STEMbot 3/8/19 Update

*“Creativity is the Secret Sauce to Science, Technology, Engineering, and Math”*  
- Ainissa Ramirez, Science Evangelist

This year’s challenge revolves around one of the largest and fastest growing professional sectors in the world...STEM! With major organizations estimating that between 2018 and 2028, the number of STEM jobs will increase by 13% as opposed to 9% for non-STEM jobs, it is critical that youth begin to build the skills and knowledge needed to occupy these positions. Additionally, the US will need an additional 1,000,000+ STEM professionals over the next 10 years than we are currently projected to produce. For these reasons, each task this year will revolve around STEM related fields and concepts, and will help illuminate some of the work that STEM professionals do.

This year’s competition will take place at the **McLean County Fairgrounds** in Bloomington, IL on **Saturday, May 11, 2019**. Team registration will open February 1, 2019 and will close March 31, 2019. There will be a \$20 Entry fee per team assessed at the time of registration.

Register Here:

<https://web.extension.illinois.edu/registration/default.cfm?RegistrationID=19382>

**This year, the competition will consist of three parts including a newly formatted Teamwork Judging section which *replaces last year’s Project Judging section*.**

### Content

Teams will compete in three events: 1) Table Performance Judging, 2) Technical Judging, and 3) Teamwork Judging. Due to the size of the event, Technical and Teamwork judging will be a single 30 minute combined judging session with Teamwork and Technical judges observing both.

#### ***I. Table Performance Judging, Three Rounds (10 minutes each)-35% of total score***

Teams will have until May 11, 2019 to design and program a robot that is able to complete as much of the STEMbot Challenge as possible. This challenge covers information contained in the 4-H Robotics Platforms curriculum. It is not expected that teams will achieve perfect scores in the Performance Judging, but rather that team members design a robot and program that reflects their current level of learning. The challenge is designed to be open-ended and includes a lot of room for creativity.

The rules for the Performance Judging are as follows:

1. Team members at the performance table will have approximately 10 minutes to position their mat and prepare their robot for tournament play.
2. Teams can use the setup time to run several practice runs before the performance run. The performance run will start at the time indicated on the schedule. Teams may use the time after the previous team clears the table until their performance time to practice – this should be a minimum of 10 minutes. Judges will alternate between the A and B Tables.
4. While the robot is in action, the team members must not touch the performance table or robot. Any touches will result in a touch penalty of 10% with 5 maximum touches.
5. Each team will have three rounds of performance judging, with time in between to make adjustments. The best score of the three rounds will be used.

A note on variability: Remember that lighting and sound may differ at the competition from the conditions in which you tested your STEMbot program. Consider covering your light and color sensors from surrounding light, and be prepared to make on-site adjustments as needed. Please note that any materials can be used to modify the robot; materials do not have to be made using LEGO® elements.

## ***II. Technical Judging, 10 minutes- 45% of total score***

A team may provide a demonstration of the robot and its program to the judges. Teams will be allowed to bring their field into the judging room, however robot tables will not be provided so the field will need to be set up on the floor. If your team decides to do a presentation, it should be at the beginning of the session. Only team members are allowed in the judging room, no coaches, parents or siblings. This requirement is primarily a space issue – up to six teams will be in each judging room.

The judges will wish to view your team's robot and ask you about its design. **YOUR TEAM SHOULD BRING CODE DOCUMENTATION FOR YOUR STEMBOT.** See the video at this link for tips on printing programs for an NXT robot (very similar for EV3 Robots). <https://uofi.box.com/CommentingCode>

The team members should answer the judges' questions. For the robot design judging, points will be awarded based on assessment of the teams' technical understanding and not on the performance of their robot.

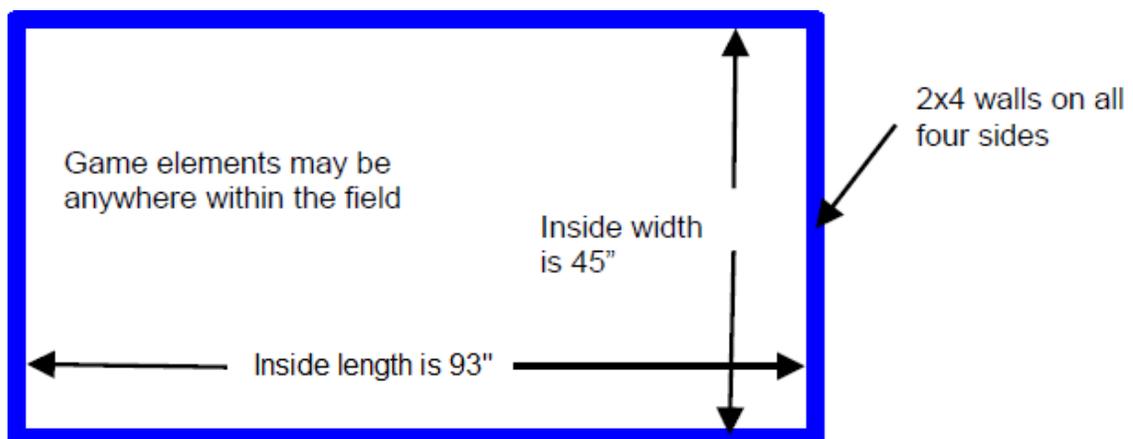
## ***III. Teamwork Judging, 10 minutes- 20% of total score***

This year, Teamwork judging will replace last year's Project judging. This portion of the competition will challenge each team to work together for a common goal. The goal will not be announced until the actual judging session for your team. This section will force you and your teammates to adapt to something new, and effectively communicate as a

team. This section is designed to assess your team's ability to work together and stay level headed as you work through a difficult task.

### General Rules:

1. Teams must consist of at least three youth with a maximum of ten youth aged 8-18. To Participate youth MUST BE AN ENROLLED MEMBER OF 4-H PRIOR TO THE EVENT.
2. Any commercially available or homemade robot may be used and any material may be used in the construction of the robot and field. This is also your opportunity to be creative in designing your field and robot.
3. The playing field is a standard FIRST® LEGO® League (FLL®) table constructed using a 4'x8' sheet of plywood with 2x4 walls, resulting in a 45" x 93" playing surface. Alternatively, teams can practice and design without a table, however at the competition event, robots must be able to run on a field with walls. It is suggested that teams that are practicing without a table use boxes, 2x4s or a wall to simulate the competition table walls to be sure robots stay within the bounds of the field. A playing area can be made on a floor using two 2x4s 96" long and two pieces 45" long - basically a table without the plywood.



4. While you may use up to two STEMbots to complete many of the tasks, only one STEMbot may be scoring at a time. This means that only one STEMbot can be performing a task that yields points at a time (unless specifically noted). At the competition there will only be one judge with one set of eyes on your playing field. STEMbot 2 can be moving into position to begin a task while STEMbot 1 is working on a task, but STEMbot 2 cannot begin the task until STEMbot 1 has completed its task. For your points to be considered, each action must be done in succession (not necessarily in order). This means that you do not have to do task 1 then task 2, but rather can complete each task in whatever order you want. However, you must complete each task in full before doing work on the next task. This is true of

all tasks except those that require both STEMbots to be synchronized/ tasks in which both STEMbots are performing an activity.

5. The robots will have 3 minutes to complete their programmed tasks. Once the robot(s) and timer have started, human team members cannot touch any robots or anything on the field. Depending on time available, teams may have one or two practice runs at the table before the “real” run. No remote control will be allowed.
6. Teams will incur a technical penalty each time they contact the robot or directly influence its path. Each technical penalty removes 10% of a team’s score, with a maximum of 5 penalties.
7. All STEMbots must start the table run touching a wall at least 6” horizontally from the first task. Items must begin 12” horizontally from the target as measured by the distance from the robot on the table, to the base of the target item on the table. This is measured in 2-Dimensions on the mat.
8. You may only use one programmable brick per robot.
9. When transporting, taking, placing and/or delivering objects from one location to another, as long as there are NO GUIDERAILS, it is okay to use completely flat ramps, slides, bridges, etc. as conduits to complete the mission. Anything designed to keep the object in/on the conduit is not allowed, and will cause that run to not be included in final score. **Inform the judges if you think you may be violating this rule BEFORE your official run.** As in FLL, the robot DOES NOT need to be in contact with the object for the entire task, as long as the robot initiates the task.
10. Each target or drop-off location must be separate and distinct. No one location may have dual purposes (e.g. the biohazard container may not also be the computer scrapyards). All destinations must be defined by a 2D outline (unless using a 3D destination) on the mat and must be labeled.
11. Items must be delivered or transported individually.
12. With the exception of #5, items do not need to physically look like what they represent but must be clearly labeled for the judge (e.g. Lego brick cube labeled broken glass).
13. **ALL 3D objects Delivery locations (e.g. Waste Bin) MUST be no less than 1" tall.**

## Tasks (555 Maximum Total Points):

- 1. Decoration:** Decorate your STEMbots as something technology themed that your team has a personal interest in (i.e. Computer parts, mother boards, circuits, etc.). Points will be awarded per STEMbot decorated.  
*5 points each for each STEMbot*  
*10 POINTS MAX*
  1. This task may be completed individually by **two (2)** STEMbots.
- 2. Broken Glass:** In a busy lab it is common for beakers to fall and break into many jagged pieces. Sweep up a broken beaker that has been cracked into 4 different pieces. Points will be awarded per piece swept into a 2D waste bin, with more points awarded per piece swept into a 3D waste bin with 4 sides and an open top. Additional bonus points will be awarded if the broken glass is placed randomly on the board by your judge.  
*5 points per piece of glass swept into 2D waste bin*  
*10 points per piece if pieces are placed in 3D waste bin*  
*5 additional bonus points per piece if randomly placed by judges*  
*60 POINTS MAX*
  1. Each piece must be swept into waste bin one at a time.
  2. This task can be completed only once and by **one (1)** STEMbot.
- 3. Chemical Mixing:** Mixing chemicals with different qualities is a key skill needed to become a successful chemist. Mix 4 different chemicals by “pouring” them one at a time into a beaker. Bonus points will be awarded if done with 2 bots pouring 2 chemicals each into the same beaker.  
*5 points per chemical mixed*  
*20 points if all chemicals are mixed using 1 STEMbot*  
*30 points if all chemicals are mixed using 2 STEMbots*  
*30 POINTS MAX*
  1. Each chemical must be poured into the beaker one at a time.
  2. Beaker must be 3D and at least 2” tall
  3. Chemicals DO NOT need to be 12” away from task
  4. This task can be completed only once using **one (1)** STEMbot by itself or **two (2)** STEMbots working together at the same time
- 4. Optics:** Light has the ability to be absorbed, reflected or refracted. Follow the path of “reflected light” that is bouncing off up to 6 “mirrors” (5 straight path lengths) using sensors. To score points, your STEMbot must clearly follow the path of light bouncing from mirror to mirror. Simply navigating past the mirror will not score you points. If the STEMbot knocks over a mirror, that mirror will not be included in the

calculation of the additional points. Bonus points will be awarded if your second bot follows a similar path of a different color.

5 points per path length

15 bonus points if bot 2 follows a similar path of a different color.

40 *POINTS MAX*

1. This task can be completed only once using **one (1)** STEMbot by itself or **two (2)** STEMbots working together at the same time

5. **Organ Transplant:** Modern medicine has advanced to the point that malfunctioning organs can be surgically removed and replaced by functioning organs of the same blood/tissue type. Remove a bad heart from a 2D “body” placing it in a biohazard container (2D), and replace it with good heart to same location. Bonus points will be awarded if completed using 2 STEMbots with one removing the heart, and the other replacing it in the same location

*15 points if completed using one STEMbot*

*30 points if using 2 STEMbots*

30 *POINTS MAX*

1. The Biohazard container must be at least 12” from the removal site.
2. Both the heart removal site and the biohazard container cannot be larger than a 4”x4” square. The body can be as large/small as you would like as long as it fits the 4”x4” removal site.
3. This task can be completed only once using **one (1)** STEMbot by itself or **two (2)** STEMbots working together at the same time.

6. **Debugging:** When coding, it only takes a single incorrect character to ruin an entire code or program. Debug a line of code using different colored blocks to denote bugs in a computer terminal. Using red, yellow, green, blue, and black colored blocks, remove ALL colors but red from the line of code in the terminal. Coding blocks will be randomly ordered in the location of your choosing by the judges.

*5 points per bug removed – 5 bonus points if all four bugs are removed*

*0 points if the red code block is removed*

25 *POINTS MAX*

1. The removed “bugs” do not need to be placed in any particular location after being “debugged” as long as they are no longer in the terminal. The red code block must remain inside the defined computer terminal to score.
2. All blocks of code must be in a line touching.
3. This task can be completed only once and by **one (1)** STEMbot.

7. **Make a Phone Call:** With phones being one of the most used devices on the planet, keeping in touch with other STEM professionals is just a call away. Make an audible phone call during your challenge while pacing back and forth. Points will be awarded

if completed using one STEM bot with more points if using 2 STEMbots calling in sync

10 points if completed using one STEMbot

10 bonus points if the call is synchronized with another STEMbot

**20 POINTS MAX**

1. Call must use both sound and motion.
2. Call must last at least five (5) seconds.
3. Synchronizing the start of the call can be done by Bluetooth but is not required.
4. This task can be completed only once using **one (1)** STEMbot by itself or **two (2)** STEMbots making a call at the same time.

8. **Broken Tech:** The maker movement has inspired DIYers to fix and or rebuild broken technologies. Rebuild a broken piece of technology by replacing the malfunctioning pieces for new pieces. Each piece of tech may be made up of 2-5 pieces with one piece staying in place as functioning tech.

*1 piece replaced=10 points, 2=15 points, 3 pieces=20 points, 4 pieces=35 points*

*10 Bonus points if completed using two STEMbots*

*0 Points for pieces not touching pieces touching/connected to the functioning piece*

**45 POINTS MAX**

1. Tech pieces must be 3D, and the new pieces that will be replacing the broken pieces must start at least 12" from the broken tech site.
2. Pieces must be touching at the end of the build
3. This task can be completed only once using **one (1)** STEMbot by itself or **two (2)** STEMbots working together at the same time.

9. **Gear Box:** In Engineering, the use of gears can help to increase or decrease torque using a crank and set of gears. Place a gear on a shaft next to an already placed gear and shaft. Your STEMbot must crank the gear 2 times clockwise and 2 times counter clockwise, causing both sets of gears to move. Bonus points will be awarded if one bot places the gear, and the other bot cranks it.

*30 points if successfully completed by one STEMbot,*

*20 Bonus Points if one bot places the crank and the second bot cranks it*

**50 Points Max**

1. Gear must start at least 12" from shaft site.
2. Crank must turn at least two full revolutions (720 degrees) in each direction.
3. Mark the crank so the judges can tell if you completed the task.
4. This task can be completed only once using **one (1)** STEMbot by itself or **two (2)** STEMbots working together.

10. **Bridge Building:** Civil engineers are tasked with building publicly used structures including roads and bridges. Build a bridge by placing 2 blocks (of any shape) at either end of the bridge, and one spanning piece across the top of the blocks. The bridge must be at least 2" tall and 6" long with more points awarded if the bridge is

over 10" long. Additional bonus points will be awarded if one of the STEMbots crosses the bridge.

*20 points if the 2" x 6" bridge is constructed*

*30 points if the bridge is 10" or more in length*

*15 Bonus points if one bot successfully crosses the bridge*

*45 POINTS MAX*

1. Bridge pieces must begin 12" from building site.
2. This task can be completed individually by **one (1)** STEMbot or by Two (2) STEMbots with one STEMbot building the bridge and the other STEMbot crossing the bridge (no additional points if done by 2 bots)

11. **Circuitry:** All electric based technology requires the use of simple to complex circuits to supply power to the device or tech. Complete a circuit by connecting one end of a wire to the positive terminal of a "battery", and the other end of the wire to the negative terminal of the battery. Points will be awarded if the circuit is complete with bonus points awarded if the circuit powers a real light.

*15 points if circuit is complete*

*30 bonus points if the circuit is completed using a real battery and light source*

*45 POINTS MAX*

1. A real battery and wire does NOT need to be used for this task.
2. If using a real battery and light source, points will ONLY be awarded if the light turns on for ANY length of time.
3. This task can be completed only once and by **one (1)** STEMbot.

12. **Computer Build:** With today's technology resources, computers can be built from a variety of components readily available to consumers. Collect computer parts from a computer scrapyards and build a PC on a desk using a computer screen, cpu, fan, keyboard and mouse. Points will be awarded for each piece added to the build with bonus points awarded if all 5 pieces are successfully added to the build on the desk.

*5 points per item – 15 bonus points if all 5 items are added to the build on the desk*

*40 POINTS MAX*

1. Scrapyards must be at least 12" from the desk.
2. Desk can be 2D but must have dimensions of no more than 12" x 6".
3. All pieces must be completely within the dimensions of the desk to count.
4. Pieces do NOT need to be touching to count.
5. This task can be completed only once and by **one (1)** STEMbot.

13. **Geometry:** Basic geometry can be seen in daily use by a variety of STEM professionals. Have your STEMbot draw a shape with a pen or pencil. More points will be awarded if the STEMbot grabs the pen or pencil from the field with bonus points awarded if the bot drops the pen or pencil at the end of the task.

*30 points if successfully completed*

*35 points if the bot completes the task by picking up the pen/pencil from the field*

10 bonus points if the bot drops the pen/pencil once completed

45 POINTS MAX

1. Shape can be a square, circle or triangle.
2. You may use anything (pen, pencil, marker, etc.) that helps mark the board or piece of paper placed in the location you plan on doing this task (highly recommended).
3. Pen/Pencil does NOT need to be 12" from the drawing location.
4. This task can be completed only once and by **one (1)** STEMbot.

14. **Coordinate Planes**- Coordinate Planes help mathematicians visualize linear equations while doing anything from basic algebra to calculus. Place a location marker (like those seen on GPS apps) in each of the 4 coordinates of your playing field. Points will ONLY be awarded if all four markers are placed with one in each coordinate plane. Bonus points will be awarded if 2 STEMbots place 2 coordinates each.

20 points if 4 markers are successfully placed

10 bonus points if completed using 2 STEMbots

30 POINTS MAX

1. Location markers must be at least 12" from the destination.
2. This task can be completed only once using **one (1)** STEMbot by itself or **two (2)** STEMbots working together at the same time.

15. **Newton's Apple**: It is said that Isaac Newton discovered gravity when an apple fell on his head while sitting under a tree. In this task you will knock an apple off of a 12" tree. Points will be awarded if your STEMbot knocks the apple off the tree with more points awarded if the apple lands on the STEMbot. Bonus points will be awarded if one STEMbot knocks the apple off the tree and it lands on the second STEMbot.

20 points if apple is knocked off the tree

30 points if apple is knocked off the tree and lands on the STEMbot

10 Additional points if one STEMbot knocks the apple off the tree and it lands on the second STEMbot.

40 POINTS MAX

1. The STEMbot does NOT need to catch the apple to score points.
2. This task can be completed only once using **one (1)** STEMbot by itself or **two (2)** STEMbots working together at the same time.

## FAQs **New in Red!**

1. Can I use Zip Lines?
  - a. Yes, you may use zip lines to deliver items to other locations. As long as all of the items are arranged within the target location as described in the rules.
  
2. Can the robot initiate a movement that leads to the completion of a task?
  - a. Yes, your robot can initiate the movement of the object, even if it is on a string. As long as the action is initiated by the robot and not using guide rails. However, if the purpose of the string is specifically to keep the object on course, it is not allowed. See Rule 11, "Anything designed to keep the object in/on the conduit is not allowed"
  
3. Will I receive updates on the competition?
  - a. All those that register will receive regular updates including answers to questions posed to the Robotics Design Committee. These will be supplied in updated versions of this document available on the 4-H robotics website, and the IL 4-H Robotics Facebook Page.
  
4. Are magnets allowed?
  - a. Yes magnets are allowed. In fact, some of the mindstorm accessory components have magnets in them.
  
5. Can both bots score at the same time?
  - a. If using 2 robots, both robots may be doing something at the same time, however both cannot be scoring at a time. This means that robot 1 cannot be doing task 5 while robot 2 is doing task 6. This is to prevent points from being missed during the table runs.
  
6. Can we use ramps to complete tasks?
  - a. Yes! You can use ramps for these challenges, as long as there are no guide rails. That is the only stipulation.
  
7. Do I have to label each location?
  - a. All locations/destinations (Biohazard Container, Bridge Building Site, etc.) must be clearly labeled.
  
8. Who do I ask if I have a question about the competition or tasks?
  - a. Begin by asking on the Facebook page, and if you do not see the answer to your question there, contact your local educator or send your question to [Illinois4h-stem@illinois.edu](mailto:Illinois4h-stem@illinois.edu)
  
9. Can The 3D Waste Bin be any height?
  - a. **The waste bin and other 3D Delivery locations Must Be at least 1" tall.**
  
10. In task 7 do the STEMbots have to turn around when pacing, or can they just pace back and forth?
  - a. **Your STEMbot does NOT need to turn around when pacing. Pacing back and forth is fine.**
  
11. How far do the objects need to be from the starting location?
  - a. **Items must begin 12" horizontally as measured by the distance from the robot on the table, to the base of the target item on the table. This is measured in 2-Dimensions on the mat. This distance only applies to the distance between items being delivered and their target location, NOT necessarily the total travel distance of the STEMbot.**
  
12. In the general rules #7, it states that "items must begin 12" horizontally from the target..." Does that also mean that all robots must move a min of 12" from their prior task before starting their next one? Or can a robot complete task 1, move just a few inches and begin task 2?
  - a. **No the Distance is in reference to items that need to be delivered. It has nothing to do with how far robot moves between tasks**
  
13. General Rules #11 states " Items must be delivered or transported individually." This means that we cannot line something up and have the robot move it as a group, correct?
  - a. **Correct, one at a time.**

14. For the zip line, can we line up several items on the same zip line and fly them in one after the other? Or would that require a different zip line for each item? Or would we have to take the first item off before moving the next one?
  - a. Each item would need to be moved one at a time. This means that if using the same zip line, the robot must trigger the action for each individual object, not a string of objects. This can be achieved in a number of ways.
  
15. For Broken Glass, the rules say " Additional bonus points will be awarded if the broken glass is placed randomly on the board by your judge." Must this be "anywhere" on the board or within a designated space? In other words, can we specify a space where the judges can randomly place the pieces?
  - a. The Judge would randomly place the items within a specific location that you define. That location can be no less than 12" from the target, however.
  
16. Because everything must start at least 12" from the target destination, can anything start on the robot, except for the pen/pencil for geometry? For example, can something be on the robot at the beginning, at least 12" away, and then be taken off, delivered, or used in the target location?
  - a. At the competition, you will see many forms and usages for the STEMbot. Some will be rovers, while others may be another kind of bot altogether. In short, yes, things can be on the bot at the start. As long as you do not violate the 12" rule, the one at a time rule, or others listed in the Challenge document.
  
17. For Circuitry, do we have to use a real wire, or can we use something to represent the wire? If powering a real light, does the light source need to be on the board or can it be on the robot?
  - a. You can use something that represents a wire as long as you are not powering a real light. If powering a real light, you must use a real wire and complete a real circuit.
  
18. Can part of the circuit be on the robot itself?
  - a. Yes, as long as you do not violate any other rules listed in the Challenge Document.
  
19. Can snap circuits with battery installed be used in place of actual wire to make an actual light turn on?
  - a. Unfortunately not.
  
20. In the general rules #7, it states that "items must begin 12" horizontally from the target..." Does that also mean that all robots must move a min of 12" from their prior task before starting their next one? Or can a robot complete task 1, move just a few inches and begin task 2?
  - a. No the Distance is in reference to items that need to be delivered. It has nothing to do with how far robot moves between tasks



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