

# PSU IEEE FORD Robotics Day 2018

## Official Contest Rules

Last revised: Wednesday, 13 2017

The IEEE Penn State Chapter is pleased to announce the PSU Robotics Day. This year's event includes the robotic Sumo wrestling competition, Line Follower competition, and a new game that will soon be announced!

## Event Information

The following information discusses the general rules and regulations of the PSU IEEE Robotics Competition. This section also includes general information regarding the event.

### 1. Eligibility

**Who May Participate:** The contest is open to any person or any team, regardless of their place of residence or group affiliation. You may participate as an individual or as a member of a team representing a school, university, church, scouting organization, commercial business, or any other organization.

**Divisions:**

<b>K-8 Division</b>	Open exclusively to students enrolled in grades K-8.
<b>High School Division</b>	Open to students in enrolled grades 9-12. Younger students are permitted to participate in the high school division if their robots meet all of the requirements.

**Most Senior Member:** The most senior member of a team determines the division in which that team should compete. If any member is in grades 9-12, then the team must compete in the high school division.

### 2. Roles of Students and Mentors

**Students:** Students should play the lead role in the design and development of their robots. Students should consult parents, teachers, engineers, and other knowledgeable people for guidance and suggestions, but the majority of the design and implementation should be done by the students.

**Mentors:** The best way for mentors to help students is to provide them with the knowledge and skills that will allow them to tackle this competition and future competitions on their own.

### 3. Schedule of Events

**Date:** Saturday, April 21, 2019

**Location:** Hetzel Union Building  
State College, PA, 16801

**Building Entrance:** The contest will be held in Heritage Hall. We will have signs to help point you in the right direction on the day. The doors will be open at 8:30 am on the day of the competition.

**Parking:** Parking will be available at the Nittany Parking Deck, Westgate Building, Eisenhower Parking Deck, East Parking Deck, or any parking garage in State College. You must walk over to the HUB as there is no parking there! Please do not try to park there or in a restricted faculty lot there.

## **4. Lunch**

**Lunch:** Pizza and soft drinks will be provided at the competition.

## **5. Publicity**

**Public Awareness:** All participants and advisors are encouraged to publicize this event as much as possible. Please feel free to invite guests. Admission is free to everyone.

**Public Event:** The Penn State IEEE Robotics Competition is a public event. Photographs, videos, and names of participants and their creations may be obtained and published on websites, in newspapers, or in other publications by any guest, reporter, or other person who attends the event. In this regard the Robotics Competition is just like a typical high school basketball game or other public indoor sporting event. People who attend the event should have no expectation of privacy in the public spaces of the school.

## **6. Good Sportsmanship**

**Spirit of the Contest:** The contest organizers have attempted to foresee any contingencies that might arise, and to develop a set of rules that will ensure a fair and enjoyable competition. It is possible that unforeseen circumstances which are not specifically covered by the rules might arise. In this event we would ask for your patience, cooperation, and assistance in order to ensure that the contest's primary goal of inspiring young inventors is achieved.

**Respect for Rules:** Any robot which, in the opinion of the contest organizers, violates the spirit of the contest rules will be eliminated.

**Respect for Officials:** There may be times when referees and judges will make decisions that are not obvious to everyone in attendance. In addition, even though they will try their utmost to be fair and accurate, the referees may occasionally make mistakes. In order to keep the contest moving along, there is no provision for appealing a decision. Anyone who chooses to participate in the contest must be willing to accept the decisions of the referees and judges.

**Respect for Others:** All team members and advisors are expected to behave in a courteous and professional manner. Excessive arguing, profanity, or unacceptable conduct by a participant or an advisor will result in the disqualification of the entire team.

## **7. Robot Behavior Restrictions**

**Harmlessness:** In general, robots should be built to not destroy an opponent. A robot can push, block, intercept, run into, and hit other robots. The intention of the sumo competition is just that. A robot should not be built to hinder the action of another robot. This means no blocking sensors, no pulling wires, no jamming devices. Ultimately the decision is up to the referee who inspects your robot and the referee who officiates your matches.

- Physical Integrity:** All parts of a robot must be designed to remain attached during a match. Robots are not permitted to throw or scatter any materials within the Sumo ring. It is not permissible for a robot to launch projectiles, to put down an oil slick, or to scatter thumbtacks or other obstacles in an attempt to impede the progress of its opponent.
- Foreign Substances:** A robot may not use any liquids, powders, aerosols, gels, explosives, compressed gases, razor blades, or any other materials that might result in bodily injury, leave a residue on the opponent or on the Sumo ring, or cause damage to the opponent or to the Sumo ring.
- Flight:** Robots are permitted to jump, hop, and reach, but they are not permitted to hover or fly. In general, no portion of a robot's mass should ever be supported by air.
- Robot Name:** The PSU IEEE reserves the right to reject any and all robot names should they be deemed inappropriate or offensive.

## 8. Awards and Prizes

- Judged Categories:** Most Creative Robot Design - K-8 Division  
Most Creative Robot Design - High School Division  
Excellence Award - K-8 Division  
Excellence Award - High School Division
- Excellence Award:** The excellence award is given to the team with an interesting presentation, thorough documentation (including an engineers notebook or design notebook), appropriate sportsmanship. The robot must be built following the engineering process with photos and documentation at each step.
- Scored Categories:** K-8 Sumo Division Champion  
High School Sumo Division Champion  
K-8 Line Follower Division Champion  
High School Line Follower Division Champion  
Grand Sumo Champion Contest Winner  
Grand Line Follower Champion Contest Winner
- Prizes:** Prizes will be announced at the competition. The contest organizers will try to find sponsors who are willing to offer prizes for each of the above award categories. The exact nature and value of the prizes will depend upon the level of support that can be obtained from area businesses and other sponsors.

## 9. Communications

- Announcements:** For up-to-date news and information regarding this contest, please visit:  
<https://sites.psu.edu/psuieee/robotics-competition/>
- Questions/Feedback:** If you have any questions, suggestions, comments, or feedback, please contact:  
**Wouter Cos, Outreach Chairperson**  
**IEEE Student Chapter**  
**wqc5212@psu.edu**
- Rule Changes:** The organizers reserve the right to make minor rule changes should it become apparent that some aspect of the existing rule set is not workable. No rule changes will be made unless absolutely necessary to ensure a successful contest.
- All participants are urged to read and carefully consider the rule set, and to contact the organizers as soon as possible if you have questions or discover a problem with the rules. Absolutely no rule changes will be considered after April 1, 2018.

# Poster Presentation Information

The following information discusses the rules and regulations regarding the poster presentations that will be given at the PSU IEEE Robotics Day.

## 1. Team Tables and Posters

**Team Tables:** On the day of the contest, each team will be provided with a table in the gymnasium at which to store their supplies and work on their robot. 110 volt AC power is available for tables that request it. If you will be needing power, please bring a 25 foot extension cord and a power strip.

**Posters:** Each team is encouraged to make a poster or presentation describing their robot. This should include:

- the name of your robot
- the division in which your robot is competing
- the name of your school, church, scout pack, or other organization (if applicable)
- a description of how your robot works, including diagrams and/or photographs

Posters may be freestanding or attached to the front of the table with tape. Teams may display multiple posters if desired. Teams may also create videos or multimedia presentations to display at their tables.

**Intended Audience:** The poster will be viewed by members of the general public who attend the contest. It will also be viewed by members of other robotic teams, team advisors, and contest judges.

## 2. Team Presentations

**Presentation:** Each team should give a brief oral presentation to the judges. All team members should be prepared to answer questions posed by the judges about how the robot was designed, implemented, and tested. Students should be prepared not only to explain what they did, but why they did it.

**Duration:** The presentation should not exceed 8 minutes.

**Materials:** Teams should display their robot and poster(s) to the judges during the oral presentation.

**Intended Audience:** You should design your oral presentation for a group of judges who are very knowledgeable about science, technology, and mathematics, but not necessarily familiar with all of the hardware and software that your team is using and are not necessarily experts in robotics.

**Objectives:** Each team will be judged on the content and quality of its oral presentation, interaction with judges, and poster(s). Each of these elements of the presentation should demonstrate to the judges that the team members have assimilated and gained mastery of the concepts they have explored while preparing for the contest.

**Works-in-Progress:** Students who do not complete their robots in time for the contest are encouraged to bring their works-in-progress and present them to the panel of judges. A team whose robot is less than 100% complete is still eligible for the Most Creative Robot Design and Best Presentation awards.

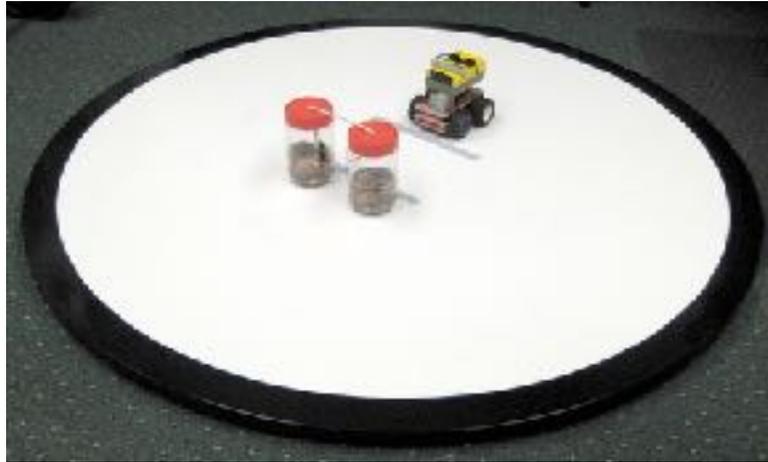
- Photographs:** A photograph of each team, together with their robot and poster, will be taken immediately before the team's presentation.
- Awards:** After reviewing all presentations, the judges will select the winners of the following awards, which will be presented during the awards ceremony:
- Most Creative Robot Design - K-8 Division
  - Most Creative Robot Design - High School Division
  - Best Presentation - K-8 Division
  - Best Presentation - High School Division
- Preventing Backlog:** In order to prevent a presentation backlog, teams are encouraged to give their oral presentations at their earliest opportunity. If your robot is ready to compete and your next contest is more than 30 minutes away, please visit the judges' table immediately to give your presentation in a relaxed atmosphere with no time pressure. If you do not have an opportunity to give your presentation prior to competing, please visit the judges' table as soon as you are finished competing for the day. If everyone visits the judges' table at their earliest opportunity, we can avoid a backlog that might otherwise delay the awards ceremony.

## Sumo Information

The following information discusses the sumo competition rules and regulations.

### 1. Sumo Ring Specifications

- Dimensions:** 48" diameter, 0.75" thickness
- Material:** MDF (medium-density fiberboard)
- Support:** The Sumo ring is supported by six adjustable feet which are used for leveling.
- Elevation:** The top surface of the Sumo ring is between 1" and 1.5" from the floor.
- Color:** The top surface is painted satin white.
- Border:** The outermost two inch region of the top surface and the vertical edge are painted glossy black. The black border is applied on top of the white paint. When sliding an object from the white area onto the black area, some resistance will occur in addition to the color change at the transition. This behavior is by design.
- Starting Lines:** Two parallel grey lines are located on opposite sides of the center of the ring. The lines, consisting of medium-grey vinyl electrical tape, are 9" in length and 0.75" in width. The white space between the lines forms a 6" x 9" rectangle whose center is aligned with the ring's center.
- The grey vinyl tape has a thickness of approximately 0.007". This can affect wheel traction and resist a sliding object. This behavior is by design.



## 2. Deadweight Specifications (K-8 division only)

**Overview:** K-8 Division robots wrestle with a deadweight. The deadweight assembly consists of two plastic jars that are partially filled with sand and whose lids are connected by a short length of rope.

**Jars:** Two 18-oz plastic jars of JIF creamy-style peanut butter are emptied of their contents and washed. The paper labels are removed from the jars. Any remaining adhesive is removed with a petroleum-based solvent such as paint thinner.

**Jar Base Preparation:** A sheet of 100 grit sandpaper is placed face-up on a flat surface. The base of each

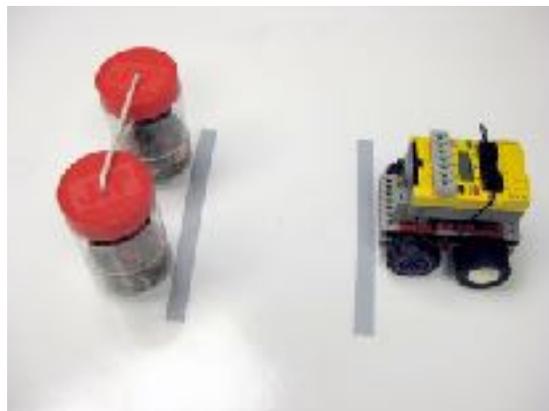
upright jar is pressed firmly against the sandpaper and twisted left and right several times to roughen the area that will make contact with the Sumo ring surface. Each jar is then inverted and a liberal coating of contact cement (e.g. Devcon brand) is applied to the roughened area with a cotton swab and allowed to dry for 24 hours. This has the effect of doubling the friction between the jar and the Sumo ring.

**Jar Lid Preparation:** A 3/16" round hole is drilled in the center of each jar's plastic screw-on lid.

**Rope:** A short length of 3/16" diameter white rope is inserted through the hole in each jar lid. A knot is tied at the end of each rope such that when the lid is screwed onto a jar, the knot is on the inside of the jar. A lightweight stiffening washer is used to prevent the knot from pulling through the lid during vigorous competition.

**Jar Spacing:** The positions of the knots are adjusted such that when the jars are standing upright on a horizontal surface and then gradually separated from one another, the rope become taut when the shortest distance between the jars is between 2.0" and 2.5". The referee will separate the jars in this manner at the start of each round.

**Weighing Procedure:** When constructing the one-pound deadweight, the contest organizers will fill each jar with sand until it reaches the given weight limit, and then seal the jar. They will do this for each weight category, and have a standard set of jars for each round. The weight of the lids and rope will not be taken into account.



### 3. Robot Control Methods

**Remote Control:** All robots in the K-8 division will be remotely controlled by a member of the team known as the "operator". The remote control mechanism may employ radio control, infrared, visible light, sound, or any other means of communicating with the robot that does not provide a mechanical link between the robot and the operator. Wires, cables, puppet strings, push rods, and all other types of mechanical links are prohibited.

**Autonomous Control:** All robots in the high school division must be completely autonomous (self-controlled) after being manually started by a member of the team known as the "starter". Autonomous robots must operate entirely under the control of their internal software and hardware logic. All types of remote communication or remote control or are prohibited while the robot is competing.

### 4. Robot Design Restrictions

**Maximum Size:** The robot's length and width must each not exceed 9 inches at the start of each match. The robot may expand to any size at any time after it is permitted to move.

There is no restriction on the robot's height.

**Maximum Weight:** The maximum weight of the robot is 4.0 pounds, including all batteries and any other components that will be attached during the contest. Deadweight can be used, as it will increase traction and make it more difficult to push. It is important to note that the pairings will be random, so contestants should keep the competitor in mind. All scales have some degree of error, so contestants should take that into consideration when designing their robots.

**Hardware:** Any type of mechanical and electronic hardware can be used to construct a robot in any of the divisions, including (but not limited to) Lego RCX, Lego NXT, VEX, HandyBoard, MAKE Controller, PIC, BASIC Stamp, C Stamp, Parallax Propeller, PDA, cell phone, Nintendo Game Boy, or FPGA.

In general, any type of hardware that does not present a potential safety risk to people and is not potentially damaging to the Sumo ring or to other robots is permitted. Please exercise good judgment in order to avoid the possibility of disqualification for safety reasons.

**Original Design:** This contest is intended to stimulate creative, original thinking and problem-solving. Contestants are permitted to use commercially available robotics invention systems and components, such as Lego Mindstorms or VEX, which are capable of being configured in thousands of unique ways.

Contestants should avoid using ready-made, off-the-shelf robots or vehicles. It is not permissible for a K-8 division team to use an off-the-shelf radio-control toy car. It is not permissible for a high school team to follow step-by-step instructions to assemble a pre-designed Sumo robot kit.

While commercially available components, such as motors and sensors, are permitted, the overall layout and design of the robot should be the result of the team's own, original thinking.

**Actuators:** All types of motors and mechanical actuators are permitted, subject to the above safety requirements.

**Jamming Devices:** Devices which emit high levels of sound, light, or other forms of energy which might flood or jam an opponent's sensors are strictly prohibited. (Note: The K-8 division champion will compete against the High School division champion. For this reason, the jamming device prohibition applies to all divisions.)

**Stickiness:** Robots are not permitted to use adhesives or vacuum devices, including but not limited to double stick foam tape, suction cups, or sticky tires, to adhere to the surface of the Sumo ring.

During qualification, the robot will be placed on a sheet of copier paper for five seconds and then slowly lifted. If any part of the paper remains attached to the robot for more than five seconds after the robot is lifted, the robot is too sticky and will not qualify.

During the competition, if the referee determines that a robot has deployed a concealed mechanism that violates the stickiness rule, the robot will forfeit the current match.

## 5. Additional Design Restrictions (High School division only)

- Software:** All types of robotic software and programming tools are permitted.
- Sensors:** In general, all types of sensors are permitted, subject to the above safety requirements. Builders are encouraged to explore and develop creative and unconventional methods of sensing the robot's environment. The human body can sense brightness, colors, shapes, temperature, sound frequency, sound intensity, joint angles, muscle loading, odors, flavors, and more. A system that relies on a single sensing method may be less capable or less reliable than a system that makes effective use of two or more sensing methods.
- Passive Sensors:** Passive sensors are those which are designed to detect naturally occurring energy. All types of passive sensors are permitted.
- Active Sensors:** Active sensors direct a burst of light, sound or other form of energy at a target and use passive sensors to measure how the target interacts with the energy. Robots are permitted to use active sensors, such as optical rangefinders and ultrasonic distance sensors, which emit harmless levels of energy for the purpose of probing the environment.
- Command Sensors:** Autonomous robots are not permitted to receive any type of communication or commands while a match is in progress. Built-in devices capable of receiving remote commands, such as the IR port on a Mindstorms RCX brick, do not need to be disabled and may be employed as normal sensors. We rely on the honor system to ensure that autonomous robots operate without human assistance or human interference.

## 6. Weigh-ins and Inspections

- Initial Qualification:** Shortly after arriving at Hetzel Union Building, each team registered to compete in the sumo competition should visit the Qualification Table for weigh-in and inspection by contest officials. If the officials discover any aspects of a robot that do not comply with the rules listed above in sections 4 and 5 of the sumo competition rules, they will point them out during inspection. The team is then expected to modify the robot and bring it into compliance before the start of the contest. If the robot cannot meet the weigh-in and inspection requirements, it will not be allowed to compete.
- Reinspection:** Teams are encouraged to continue testing and refining their robots prior to the actual competition. If any modifications are made which might cause a robot to violate any of the rules in sections 4 and 5 of the sumo competition rules, the team should revisit the Qualification Table so that the robot can be reweighed and reinspected. There will also be a mandatory reinspection before the start of each round.

## 7. K-8 Contest Protocol

- Overview:** The K-8 division contest will consist of six rounds in which each robot individually wrestles a deadweight during a 60-second match. The deadweight will have a mass of one pound in the first round and its mass will increase by one pound in each of the five subsequent rounds. The winner of each round will be the robot that pushes the deadweight off the Sumo platform in the shortest time.
- Staging Area:** All robots within a division will be required to assemble in the staging area until all rounds for that division are complete.
- Operator Selection:** Prior to the start of each round, each K-8 team should designate one of its members as

the “operator” who will control the robot during the round.

- Robot Selection:** When a robot’s name is announced by the referee, the team is expected to arrive at the Sumo ring, position their robot at the starting line, and be ready to compete within 2 minutes. If the team does not appear within 30 seconds, the referee will announce the robot’s name again. If the team is not present and ready to compete within 2 minutes of the first announcement, the robot will forfeit the round.
- Team Position:** The referee will instruct all members of the team, except for the operator, to stand on the side of the Sumo ring that is farthest from the audience, at least four feet away from the Sumo ring. This rule is intended to ensure that the audience has an unobstructed view of the Sumo ring and the team members who built the robot.
- Robot Position:** The operator should immediately place the robot behind one of the starting lines. The referee will then place the deadweight directly behind the opposite starting line. The robot may be placed in any desired position and orientation so long as it is behind the extended starting line and its overall length and width do not exceed 9” x 9”.
- Match Initiation:** After the operator has positioned the robot, the referee will say “One, Two, Three, GO!” Upon hearing the word “GO”, the operator may begin to move the robot under remote control.
- Operator Position:** The operator is permitted to move freely around the outside of the Sumo ring during the round. The operator is permitted to lean over the Sumo ring if necessary. The operator is not permitted to touch any part of the robot, any part of the deadweight, or any part of the Sumo ring at any time, nor to toss or drop any foreign objects into the Sumo ring. Any contact with the robot, with the deadweight, or with the Sumo ring, or any introduction of foreign objects into the Sumo ring, will cause the current round to be immediately forfeited, even if the violation was accidental.
- Scoring:** A human timer will use a stopwatch to measure the elapsed time from the word “GO” until some part of the deadweight touches the floor. The time will be recorded, with a numerical precision of 0.01 seconds, for each robot who competes in the round. The robot that takes the shortest time wins the round and receives one point. In the unlikely event that two or more robots have identical, winning times, then the tie resolution process will take place.
- Loose Parts:** A robot is considered to be touching the floor whenever any part of the robot touches the floor, even if that part is no longer attached to the robot. If a part falls off a robot and remains on the Sumo platform, the current round continues. If the part subsequently falls off the platform and onto the floor, the robot receives no score for the round.
- Elimination:** If a robot becomes disabled or fails to push the deadweight off the platform, or if any part of the robot touches the floor before the deadweight, the robot receives no score for the round. If a robot is unable to score in two consecutive rounds, that robot is eliminated from subsequent rounds.
- Tie Resolution:** If two or more robots are tied for first place in any round, then a rematch is held for those robots in order to determine the round winner before proceeding to the next round.
- Division Champion:** The robot that wins the most rounds becomes the K-8 division champion. If two or more robots have won an equal number of rounds, then those robots will compete in an additional round using a seven-pound deadweight, and the robot that pushes the

deadweight off the platform in the shortest time becomes the division champion.

## 8. High School Protocol

**Overview:** High School division robots will compete in double-elimination tournaments. Pairs of robots in the same division will compete in matches lasting up to three minutes and consisting of up to three rounds.

The robots wrestle with one another while trying to avoid falling off or being pushed off by their opponent. The first robot that touches the floor outside the ring loses the round. The first robot to win two rounds wins the match.

**Staging Area:** All robots within a division will be required to assemble in the staging area until all matches for that division are complete.

**Starter Selection:** Prior to the start of each match, each team should designate one of its members as the “starter” who will position and start the robot at the beginning of each round in the match.

**Robot Selection:** When a pair of robot names are announced by the referee, each team is expected to arrive at the Sumo ring within one minute. If a team does not appear within 30 seconds, the referee will announce the robot’s name again. If the team is not present within one minute of the first announcement, the robot will forfeit the match.

**Team Position:** The referee will instruct all members of the team, except for the starter, to stand on the side of the Sumo ring that is farthest from the audience, at least four feet away from the Sumo ring. This rule is intended to ensure that the audience has an unobstructed view of the Sumo ring and the team members who built the robot.

**Clear Zone:** All contestants and the referee are required to remain at least four feet away from the Sumo ring at all times while a round is in progress. This is necessary to ensure that the opposing robot is always the nearest object in a robot’s field of view.

**Coin Toss:** Prior to the first round, the referee will toss a coin to determine which starter will position their robot first in every round. At the beginning of each round, the first team’s starter will have 30 seconds to position their robot. Then the second team’s starter will have 30 seconds to position their robot.

**Robot Position:** The starter may place the robot in any position, angle, or location on the ring except that no portion of the robot may cross the extended starting line nearest the contestant. The robot must fit within the required 9” x 9” starting dimensions.

**Round Initiation:** When both robots are ready to compete, the referee will say “One, Two, Three, GO”. On the word “GO” each starter should press a button to start their team’s robot. Each robot should be programmed to wait at least 5 seconds after the button press before it begins to move. Both starters should join their team members, at least four feet away from the Sumo ring, before the robots begin to move.

**Countdown:** Each robot must remain entirely motionless during the five-second countdown. No part of a robot is permitted to move in any direction until after the five-second period has elapsed.

**Initial Motion:** Each robot must initially move away from its starting position for a minimum distance of three inches in any direction before crossing the extended starting line. This rule is intended to give each robot a brief window of opportunity in which to initiate a clever

strategy before having to grapple with the opponent.

- Failure to Start:** If, during the five-second period, it becomes apparent that a robot is not executing its countdown, the team's starter may ask for a restart. If a restart is not requested during the five-second period, then the round will proceed normally. A team's starter may request at most one restart during each round.
- False Start:** If a robot begins moving during the five-second countdown, the robot has committed a false start and a restart will be required. If the same robot commits another false start during the same round, the robot automatically forfeits the match.
- Scoring:** The first robot that touches the floor outside the ring loses the round. If both robots touch the floor at the same time, then the round is restarted. The first robot to win two rounds wins the match.
- Loose Parts:** A robot is considered to be touching the floor whenever any part of the robot touches the floor, even if that part is no longer attached to the robot. If a part falls off a robot and remains on the Sumo platform, the current round continues. If the part subsequently falls off the platform and onto the floor, the robot from which the part originated loses the current round.
- Elapsed Time:** Time is measured only while a round is in progress. The clock is always started at the word "GO". Each time a robot touches the floor or a round is stopped for any other reason, the clock is stopped. Elapsed time may be added or subtracted during a match only for the purpose of correcting a timekeeping error. No time is removed from the clock when a round is restarted.
- Tie Resolution:** If the total elapsed time for the match reaches 3 minutes and the score is 0:1 or 1:0, the match is stopped and the robot that has won more rounds wins the match. If the score is tied at 0:0 or 1:1, then the match continues without interruption in a two-minute overtime period. The first robot to score during overtime wins the match. If neither robot scores during overtime, then the referee and two judges will vote to decide which robot exhibited more technical merit in its movement and operation, and that robot will win the match.
- Voluntary Forfeit:** Either team's starter may ask the referee to stop a match at any time for any reason. The team that made the request will automatically forfeit the match, and the win will be awarded to the opposing team.
- Deadlock:** If two robots appear to be hopelessly entangled with one another or otherwise deadlocked, the referee will ask both teams' starters whether they wish to restart the current round. If both starters agree, then the referee will stop the current round. The starters will reposition the robots behind the starting lines and the round will be restarted.
- Elimination:** The double-elimination format of the contest requires that a robot be eliminated after losing two matches.
- Division Champion:** The robot that wins the last match in the double-elimination contest becomes the division champion.

## **Line Follower Information**

The following information discusses the line follower competition rules and regulations.

### **1. Line Follower Track Specifications**

**Dimensions:** The track shall fit upon an area of 42" x 96".

- Material:** The track shall be made of drywall with computer paper mounted on it. All markings shall be HP Printer ink. The track shall be printed with an HP inkjet printer from the PSU Engineering Copy Center.
- Support:** The track shall lay flat on the floor. Should this prove to create issues for the robots, the event organizers may change this.
- Color:** The surface of the track shall be satin white. The starting portion of the track for all brackets shall be matte black.
- Border:** The outermost two-inch region of the top surface of the track shall be painted matte black. This edge shall be printed onto the track upon creation.
- Starting Follow Line:** All tracks shall have an 18.0" starting follow line. This starting line shall be matte black and linear (i.e. no curves/turns). This shall be the easiest part of the track for all robots.
- Starting/Finish Line:** On either side of the starting length shall be a thin black line. This line shall be matte black and no thicker than 0.100 inches. This starting line shall be printed on the track upon creation. The purpose of this line is for officials to determine the robot's round time.
- Follow Line:** The line that the robots shall follow shall be 1.00 inches thick.
- Track Release:** The track shall not be released to the public until the date of the competition. It is recommended that if one would like to produce a test track that one does so in Microsoft PowerPoint or similar software.

## **2. K-8 Track Specifications**

- Follow Line:** All lines shall be solid black lines.
- Radius of Curvature:** All turns shall have a radius of curvature of at least 10.0 inches. This shall be measured from the inner most portion of the curve. The entirety of the track will be smooth connecting lines.
- Edge Following:** Should a team choose to utilize the edge following method for their robotic design, they shall be required to follow the outer most edge of the track. Edge following is the process where the robot tracks the edge of a line by checking if the robot is on the black line or off of the line (white vs. black) as opposed to attempting to remain on the black line the entire time.
- Calibration:** All robots will be given a sheet of paper with a sample of the track printed upon it. This shall be for the team to calibrate their robot. All calibration methods must be documented, and said procedures must be watched by an event coordinator.
- Background:** There shall be no background images or obstructions.

## **2. High School Track Specifications**

- Follow Line:** All lines shall consist of dark colored lines potentially including, but not limited to, black, blue, green, red, and/or orange.
- Radius of Curvature:** All turns shall have a radius of curvature of at least 4.00 inches. This shall be measured from the inner most portion of the curve. The entirety of the track will be smooth connecting lines.
- Edge Following:** The robots may not do edge following.

**Background:** There may be a background image or design printed into the background. This image may overlap the track. It shall be printed using colors much lighter than those used to print the track.

### 3. Robot Control Methods

**Autonomous Control:** All robots must be controlled autonomously through one of two methods. Method 1: The robot may be coded to autonomously follow the track. Method 2: The robot may use analog and digital logic integrated circuits to autonomously follow the track (sometimes known as BEAM-Type robots).

### 4. Robot Design Restrictions

**Maximum Size:** The robot's length and width must each not exceed 9 inches. There is no height restriction on the robot.

**Maximum Weight:** There is no weight limit for any robots competing in the line following competition.

**Hardware:** Any type of mechanical and electronic hardware can be used to construct a robot in any of the divisions, including (but not limited to) Lego RCX, Lego NXT, VEX, HandyBoard, MAKE Controller, PIC, BASIC Stamp, C Stamp, Parallax Propeller, PDA, cell phone, Nintendo Game Boy, or FPGA.

In general, any type of hardware that does not present a potential safety risk to people and is not potentially damaging to the line following track or to other robots is permitted. Please exercise good judgment in order to avoid the possibility of disqualification for safety reasons.

**Software:** All types of robotic software, coding algorithms, and/or languages are allowed. Under no circumstances may any team use prewritten code. All code must be written by the students and original. All circuitry in logic chip-based robots must be original.

**Original Design:** This contest is intended to stimulate creative, original thinking and problem solving. Contestants are permitted to use commercially available robotics invention systems and components, such as Lego Mindstorms or VEX, which are capable of being configured in thousands of unique ways.

Contestants may **NOT** use ready-made, off-the-shelf robots or vehicles. It is not permissible for any team to use an off-the-shelf line following kit or copy designs from the internet, verbatim. Failure to follow this rule shall result in immediate disqualification.

While commercially available components, such as motors and sensors, are permitted, the overall layout and design of the robot should be the result of the team's own, original thinking.

**Actuators:** All types of motors and mechanical actuators are permitted, subject to the above safety requirements.

**Jamming Devices:** Devices which emit high levels of sound, light, or other forms of energy which might flood or jam an opponent's sensors are strictly prohibited.

**Sensors:** In general, all types of sensors are permitted, subject to the above safety requirements. Builders are encouraged to explore and develop creative and unconventional methods of sensing the robot's environment. The human body can sense brightness, colors, shapes, temperature, sound frequency, sound intensity, joint

angles, muscle loading, odors, flavors, and more. A system that relies on a single sensing method may be less capable or less reliable than a system that makes effective use of two or more sensing methods.

**Passive Sensors:** Passive sensors are those which are designed to detect naturally occurring energy. All types of passive sensors are permitted.

**Active Sensors:** Active sensors direct a burst of light, sound, or other form of energy at a target and use passive sensors to measure how the target interacts with the energy. Robots are permitted to use active sensors, such as optical rangefinders and ultrasonic distance sensors, which emit harmless levels of energy for the purpose of probing the environment.

**Transmitters/  
Command Sensors:** Under no circumstances may robots receive any type of communication or commands while navigating the track. Built-in devices capable of receiving remote commands, such as the IR port on a Mindstorms RCX brick, must be disabled.

## 5. Check-in and Inspections

**Initial Qualification:** Shortly after arriving at Mount Nittany Elementary, each team registered to compete in the line follower competition should visit the Qualification Table for inspection by contest officials. If the officials discover any aspects of a robot that do not comply with the rules listed in Section 4 of the line follower competition rules, they will point them out during inspection. The team is then expected to modify the robot and bring it into compliance before the start of the contest. A robot may not compete until it has successfully passed weigh-in and inspection.

**Reinspection:** Teams are encouraged to continue testing and refining their robots prior to the actual competition. If any modifications are made which might cause a robot to violate any of the rules in Section 4 of the line follower competition rules, the team should revisit the Qualification Table so that the robot can be reinspected.

**Code and Logic:** All contestants must have a copy of their commented code to present to officials at the time of inspection. They will be required to upload the code to their robot in front of the inspecting official. This is to prevent pre-made code from being loaded onto the robot. Laptops to upload the code will not be provided unless extenuating circumstances present themselves. For robots not utilizing code, original schematics, created in any software, must be presented to the official performing the inspection.

## 6. Contest Protocol

**Overview:** The contest will consist of three rounds in which each robot individually navigates the track provided as quickly as possible. Each round will be timed and the best of the three rounds shall be placed on a leaderboard. The robot with the shortest time shall win.

**Staging Area:** All contestants (with their robots) within a division will be required to assemble in the staging area until all rounds for that division are complete.

**Starter Selection:** Prior to the start of each match, each team should designate one of its members as the “starter” who will position and start the robot at the beginning of each round in the match.

**Robot Selection:** Robots will be selected at random to complete the track. When a robot’s name is announced by the referee, the team is expected to arrive at the line following track

within one minute. If a team does not appear within 30 seconds, the referee will announce the robot's name again. If the team is not present within one minute of the first announcement, the robot will forfeit the match.

**Team Position:** The referee will instruct all members of the team, except for the starter, to stand on the side of the track that is farthest from the audience, at least four feet away from the track. This rule is intended to ensure that the audience has an unobstructed view of the track and the team members who built the robot.

**Clear Zone:** All contestants and the referee are required to remain at least four feet away from the track at all times while a round is in progress.

**Robot Position:** The starter must place the robot's front wheels behind the designated starting line.

**Round initiation:** When the robot is ready to compete, the referee will say "One, Two, Three, GO." On the word "GO" the starter shall press initiation button. The robot must then wait 5 seconds to start (+/- .5 seconds) navigation of the track. If the robot starts too soon, or too late, the round shall be restarted. If this issue occurs more than three times, the team forfeits one of their rounds and will be permitted to preform needed repairs and undergo another round of inspection.

**Failure to Start:** If, during the five-second period, it becomes apparent that a robot is not executing its countdown, the team's starter may ask for a restart. If a restart is not requested during the five-second period, then the round will proceed normally. A team's starter may request at most one restart during each round.

**False Start:** If a robot begins moving during the five-second countdown, the robot has committed a false start and a restart will be required. If the same robot commits another false start during the same round, the team forfeits that round.

**Scoring:** A round is defined as three laps of the line follower track. The robot completes a lap once its back wheels cross the start line. Once the referee yells GO (as discussed earlier in this document), a timer will begin. This timer will run until the robot's back wheels have crossed the start line for the third time (3 laps). Once this occurs, the referee will allow the starter to stop his or her team's robot and prepare it for the next round.

**Penalties:** Should a robot leave the track, for any reason except for interference by another team or natural occurrence, a penalty shall be applied. The penalty system is outlined below. A 'leave' is defined as the robot crossing the light colored guideline located two inches from both sides of the primary line. The information below shows the amount of time added to the final time to account for any/all penalties.

Robot leaves track but corrects itself:	5 seconds
Robot leaves track for more than 10 seconds, but corrects itself:	10 seconds
Robot leaves track, and requires human intervention:	20 seconds
Robot leaves track area, and requires human intervention:	30 seconds
Robot damages track:	Disqualification

The points mentioned above may only occur twice per lap (or six times in total) before the round is nullified. Nullified rounds may not be repeated.

**Stopping:** Once the robot has completed the track, the clock will be stopped. Once the clock is stopped, the designated starter will be allowed to approach the track, retrieve the robot, stop it (i.e. press stop, turn it off, etc.) and prepare it for the next round.

**Rounds:** A round shall be defined as three full completions of the track.

**Tie Resolution** In the event of a tie, the two robots in question shall compete on a spare track.

Standard rules shall apply as before, but there shall be only one round for each robot. Should the robots remain in a tie after the tie-breaker round, both robots shall be deemed champion, and the second place spot shall be eliminated.

**Elapsed Time:** Should a robot's total elapsed time begin to approach an extraneously large time, officials reserve the right to forfeit the round for the robot. The team may choose to preform repairs or modifications to their robot under close supervision should the robot exceed the five and a half minute limit per completion rule.

**Voluntary Forfeit:** The team's starter may ask the referee to stop a round at any time for any reason. In doing this, the team forfeits the given round and will not be allowed to repeat the round for any reason.

**Winner:** The team whose robot has the shortest time for any single round shall be deemed the winner of the division. The team with the second shortest time and third shortest time shall be deemed the second and third place winners, respectively, of their divisions.

**Grand Winner:** The winner of both the K-8 and the High School division shall compete on a one round track that shall be different than the tracks used to complete other rounds. The details of this track shall consider the limitation of both divisions to ensure a fair match. All rules discussed in this section shall apply as previously discussed. The winner of this single round shall be deemed the grand winner of the line follower competition.

## Registration Information

The following information discusses event registration

### 1. Registration Deadline:

**Deadline:** All team registrations must be received on or before **April 14, 2018**. Unless extenuating circumstances arise, there shall be no exceptions. Extenuating circumstances shall be discussed with the even coordinator.

### 2. Registration Costs:

**Costs:** There is no cost to register for this competition. The PSU IEEE is very thankful to our corporate sponsors for making this possible.

### 3. Registration Methods:

**Methods:** To register one must visit <https://sites.psu.edu/psuieee/register-for-robotics-day/> and click on the link "Registration. There will be no paper or email registration, no exceptions.

### 4. Participation Limits

**Limits:** Maximum of 6 teams per organization, with a maximum of 5 students per team, and a maximum of 140 total students. Registration is on a first-come, first-served basis. Participants are encouraged to register early.

There is a maximum number of 2 guests per registered participant, meaning if one team has 6 participants, only 12 guests may attend. No exceptions.

A robot may **NOT** be registered to compete in both competitions simultaneously. Limit one robot per competition. No exceptions.

After successful registration, a confirmation email will be sent. If this email is not received after 10 days, please contact Outreach Chair.

## 5. Withdrawal

### **Withdrawal:**

If you register several robots and it subsequently becomes apparent that one of them will not be ready in time for the contest, please notify us as soon as possible so that your unused slot can be made available to someone else. Consider bringing any unfinished robots to display at your team table as a “work-in-progress”.