# RBE 1001 Final Project Rules C 19

**These rules may be edited as the term progresses to clarify any questions. Ask questions early and often to be sure that there are no surprises. It is a good idea to discuss any custom parts with the instructors before you spend significant time designing them.**

## 1. Objective

1.1. To design and build a robot that can accomplish several tasks, both autonomously and semi-autonomously.

## 2. Overview

2.1. The primary task is to deliver pizzas to dorms on a pre-defined arena, but points can also be earned by moving a wooden structure, lifting the robot off the ground, and other tasks. These rules define the scoring for the OED competition and also serve as a reference for the CDR.

## 3. The Challenge

3.1. Definitions:

3.1.1. AERIAL DELIVERY: 1" diameter bars attached between the FARADAY DORMs, 12'' long and 15'' off the ground.

3.1.2. AUTO: The initial portion of each match when remote control of the robot is prohibited.

3.1.3. BAKER: A team member that is currently not holding a joystick.

3.1.4. CONSTRUCTION ZONE: The carpeted field area enclosed by the inside edge of the SPEED BUMPS, the far field wall, and the back edge of the DORMS.

3.1.5. DELIVERY LINE: A line 18" away from the short edge of each side of the field.

3.1.6. DORMs: Scoring locations, consisting of FLOORs and used for scoring PIZZAs. Each color side has 2 DORMs: FARADAY with 4 FLOORs and MESSENGER with 5.

3.1.7. ENDGAME: The last 30 secs of each TELE.

3.1.8. FLOOR: A platform fully within the volume of a DORM. The first FLOOR of each DORM is the carpeted field surface.

3.1.9. GOMPEI: One 15'' tall structure initially placed on centerline in the CONSTRUCTION ZONE against the far field wall.

3.1.10. GOAT'S HEAD PAN: A shelf 12" off the ground in GOMPEI where the GOLDEN PIZZA may be scored.

3.1.11. GOLDEN PIZZA: A PIZZA that can only entered onto the field by a BAKER during the ENDGAME or after their team has achieved a HAPPY DORM.

3.1.12. HAPPY DORM: Condition where a DORM has at least one PIZZA scored onto each FLOOR.

3.1.13. OED (Optional Extended Demonstration): An end-of-term tournament-style opportunity for teams to demonstrate their robot capabilities beyond the Lab 7 CDR.

3.1.14. PIZZA: A 5.5” x 5.5” x 0.75” block of wood used for scoring. At the start there will be 20 in each PIZZARIA, 5 in the CONSTRUCTION ZONE, and 1 per robot for preload.

3.1.15. PIZZARIA: Area outside of field where PIZZAs are stored then introduced onto the field through a slot by a BAKER.

3.1.16. SPEED BUMPs: 1.5” x 9.25” platforms extending from one side of the MESSENGER DORMs to the far field wall.

3.1.17. TELE: The last 120 seconds of each match when remote control of the robot is allowed.

3.1.18. WARMING OVEN: Area in the CONSTRUCTION ZONE where 5 ready-for-delivery PIZZAs are placed at the start of each match.

3.2. Field Description

3.2.1. The field is 8' x 12'. A wooden frame that is 2.5" high and 0.75" thick forms the field wall and defines the outer boundaries of the playing area.

3.2.2. The main surface of the playing area is "high-traffic" carpet that may have minor bumps and surface irregularities.

3.2.3. To aid in autonomous navigation, tape has been placed on the carpet and colored markers mounted on the dorms/pizza delivery slots.

3.2.4. Teams will begin with every part of their robot within the boundaries defined by the outer tape edge of the DELIVERY LINE and the respective short field border. Teams may start with one PIZZA fully supported by their robot. If unwanted, the PIZZA will be placed into the respective PIZZARIA.

3.2.5. All field dimensions should be considered an estimate. Exact dimensions can be measured by the team.

3.3. Challenge Timing

3.3.1. Each match is 2 minutes and 30 seconds long.

3.3.2. 0-30 seconds - Robots enabled under AUTO.

3.3.3. 30 seconds – Match timer paused, points scored in AUTO are awarded, timer restarted, TELE begins.

3.3.4. 30-90 seconds - Robot under first driver control.

3.3.5. 85-95 seconds - Driver switch period.

3.3.6. 90-150 seconds - Robot under second driver control.

3.3.7. 120-150 seconds – ENDGAME. GOMPEI may be moved and the GOLDEN PIZZAs may be introduced irrespective of HAPPY DORM status.

3.3.8. 150 seconds - Challenge ends, robots disabled.

3.4. Challenge Scoring

3.4.1. Scoring will be calculated when all items on the field have come to rest. PIZZAs scored must be fully supported by a FLOOR (for FLOOR 1, needs to have at least 50% of PIZZA within the vertical confines of the respective DORM).

3.4.2. A robot may only fully support (i.e. lift/carry) one PIZZA at a time.

3.4.3. At the end of AUTO, scores will be calculated as follows:

3.4.3.1. PIZZAs scored in FARADAY:

3.4.3.1.1. FLOOR 1: 4 points.

3.4.3.1.2. FLOOR 2: 12 points.

3.4.3.1.3. FLOOR 3: 12 points.

3.4.3.1.4. FLOOR 4: 4 points.

3.4.3.2. Robot fully supported by surface of CONSTRUCTION ZONE: 5 points plus 1.5 multiplier for any PIZZAs scored.

3.4.4. At the end of the challenge, additional scores will be calculated as follows:

3.4.4.1. PIZZAs in either DORM:

3.4.4.1.1. FLOOR 1 or top FLOOR: 2 points.

3.4.4.1.2. Intermediate FLOORs: 6 points.

3.4.4.2. HAPPY DORM: 30 points/each.

3.4.4.3. GOMPEI herded into team's side of field (must be moved totally across field center line): 20 points or 40 points if containing GOLDEN PIZZA.

3.4.4.4. Robot supported only by an AERIAL DELIVERY: 25 points/each.

3.5. Driver Rotation

3.5.1. During each challenge, teams will be required to switch their drivers halfway through the driver control period. There will be a 10 second period during which the drivers must complete the switch or the robot will be disabled.

## 4. The Robot

4.1. Size/Weight Restriction

4.1.1. At the start of each match, every part of the robot except for the flag holder (drinking straw, as specified in rule 3.2.4) must fit, unconstrained, in a stable position, within a box 15.25" by 15.25" by 18" in any orientation. The robot must be fully self-supported, in contact only with the horizontal, carpeted (or taped) surface of the playing field.

4.1.2. Each robot's weight must not exceed 10.0 lbs.

4.2. Construction Rules

4.2.1. The robot must be designed to operate by reacting only against features within the confines of the playing field boundaries.

4.2.2. Gaining traction by use of adhesives or by abrading or breaking the surface of the playing field is not allowed and will be considered field damage and subject to disqualification.

4.2.3. Teams must have their assigned team number clearly marked on their robot such that it is visible from 15' away. The numbers should be at least 1" high, 1/8” thickness and be on opposing sides of the robot.

4.2.4. Teams must place a standard drinking straw, cut to 6" long, such that the straw is perpendicular to the ground on their robot. The top of the straw must extend above the top of the robot while in its starting configuration.

4.2.5. A robot may not intentionally contaminate the playing field or an opponent's robot with lubricants or other debris.

4.3. Building Constraints

4.3.1. Each team will be expected to use parts only from the RBE1001 VEX lab kits, plus custom parts that they design and produce using the WPI Maker Spaces (e.g., 3d printing, laser cutting, etc.). A complete list of acceptable materials is given below.

4.3.2. Teams may NOT modify any of the VEX electronics or motors or cut any VEX metal.

4.3.3. Only one battery may be used on the robot at a time.

4.4. Materials

4.4.1. No materials outside of those given in your VEX kits may be used, with the exception of:

4.4.1.1. Custom-designed parts that make use of WPI maker spaces,

4.4.1.2. Cardboard or foam board,

4.4.1.3. Paper, plastic, rubber, cloth or other flexible, fabric-like materials,

4.4.1.4. String or twine,

4.4.1.5. Lubricants, and

4.4.1.6. Non-functional decorations (highly encouraged).

4.4.1.7. Duct tape is frowned upon, but permitted. You will likely receive mild scorn if it takes duct tape to make your system function.

4.4.2. Each team may spend up to $18 on materials and machine time to make parts (if applicable). "Found" materials will be charged at half the going rate (we encourage reuse!). If your teams would like financial assistance, see you instructor.

4.4.3. You may not use any stiff metal materials outside of what is in your kits (outside of what is built in the MakerSpaces). Aluminum foil falls under "fabric-like" materials, which may be used.

4.5. Energy Sources

4.5.1. The energy used by the devices in the competition must come solely from:

4.5.1.1. A change in altitude of the center of gravity of the device.

4.5.1.2. Energy stored by deformation of any approved materials.

4.5.1.3. Electrical energy delivered by the battery to the electronics and motors provided with the kit.

4.6. Electronics

4.6.1. Teams must keep clear and easy access to their robot controller, specifically the power switch. The indicator lights on the front or top of the controller must also be clearly visible.

4.6.2. All teams are required to program their robot using the template provided in lab.

## 5. Optional Extended Demonstration (OED) Structure

5.1. Teams will have the opportunity to demonstrate their robot in the OED. Instructors will be looking for improved accomplishment over what was demonstrated in Lab #7. The "accomplishment" portion of the final project cannot go down during the OED. The two top

teams at the completion of the OED will receive a 25% decrement return bonus of their overall final project score.

5.2. COALITION: Two teams which work together in a match during the OED. COALITIONs are chosen randomly for each match. A COALITION's teams always share a color.

5.3. Matches

5.3.1. Teams will be designated to be on either "Red" or "Blue" COALITION during the OED on a match-by-match basis as noted on the match list.

5.3.1.1. Prior to each match, a colored flag must be inserted into the robot's straw to designate the COALITION color. Flags will be provided at the start of the match and must be removed from the robot before leaving the playing field. Multiple infractions of this rule may result in a disqualification at the discretion of the referees.

5.3.2. Teams will be given their schedule of matches no later than the start of the first match of the OED.

5.3.3. The winner of the match is the COALITION that has the most points after the match has been scored and penalties assessed; they will be awarded 2 match points. Tied-match COALITIONs will each receive 1 match point; losing COALITIONs will receive 0 match points.

5.3.4. Ranking: At the end of the OED matches, teams will be ranked based on the following:

5.3.4.1. Highest total match points.

5.3.4.2. If tied, highest total point score.

5.3.4.3. If still tied, the highest AUTO points.

5.4. General Rules

5.4.1. All members of a team must drive their robot within the first two official matches of the OED in which the team places a robot on the field. Once all members have driven the robot, teams must continue switching drivers during their matches but any team member may come to the field to drive.

5.4.2. All referee decisions regarding rules of play and judgments are final.

5.4.3. Repeated or intentional receiving of penalties will result in a disqualification.

5.4.4. Definitions

5.4.4.1. Pinning: A robot is considered pinned when it is being held against a field obstacle or another robot by a robot from an opposing COALITION and cannot move in any direction. The closest referee will begin counting the pin from the moment the pin begins.

5.4.4.2. Penalty: 15 points are added to the opposing COALITION's score.

5.4.4.3. Disqualification: Robots may be disqualified based on their actions that violate the rules of the game. If a referee calls for a disqualification, the offending robot will receive a loss. The remaining members of both COALITIONs will receive their regular match points.

5.4.5. Robot and Field Interaction Rules

5.4.5.1. Penalties will be accessed each time a robot:

5.4.5.1.1. Fully supports more than one pizza at a time.

5.4.5.1.2. Intentionally removes a PIZZA from the field. (Will be returned by ref.)

5.4.5.1.3. Descores any opponent PIZZA. (Will be returned to respective scoring position by ref.)

5.4.5.1.4. Pins an opponent for more than 5 seconds. An additional penalty will be applied every five seconds until the offending robot has moved at least 12" away from the pinned robot.

5.4.5.1.5. Moves GOMPEI across the centerline in either direction prior to the ENDGAME.

5.4.5.1.6. Crosses or overhangs the centerline during AUTO.

5.4.5.1.7. Baker introduces a GOLDEN PIZZA before their COALITION has achieved a HAPPY DORM or the END GAME.

5.4.5.2. Robots may not intentionally tip an opposing team's robot. The tipping robot will be disqualified from the match if, in the referee's opinion, they initiated a lifting action that results in tipping.

5.4.5.3. Robots will be disabled for physically interacting with anything outside of the field.

5.4.5.4. All parts of the robot must remain attached to the robot for the duration of the match and must not cause any hazard of entanglement to the other robots. Any infraction of this rule may result in an immediate disqualification. Minor pieces that unintentionally become detached from the robot, do not affect the outcome of the match, or are the result of improper design/construction will not cause a disqualification.

5.4.5.5. Teams are allowed to modify their robots between matches as long as the robot remains compliant with all specifications and rules after the modification. Any significant modification should be brought to the attention

of the referees or head inspector prior to the start of the team's next match. Teams may be subject to re-inspection at the discretion of the referees/head inspector. While teams are allowed to modify their robots between matches, multiple robots per team are not allowed.

5.5. Safety Rules

5.5.1. Team members may interact with their robot during a match only through the transmissions of the radio-controller and PIZZA loading via the BAKER. Only designated Drivers may be in contact with the controls during the match.

5.5.1.1. All team members who will be driving during the match must stay within their COALITION station for the entirety of the match. Repeat violations of this rule may result in disqualification at the discretion of the referees.

5.5.2. Team members may not extend any part of their body onto the field. Violations of this rule will lead to disqualification at the discretion of the referee.

5.5.3. Referees will disqualify any robot they deem to be a safety hazard.

5.5.4. Referees may request that teams alter any portion of their robots that are considered safety hazards or damaging to the playing field or scoring objects at any point during the competition. It is the right of the referees to prevent teams from playing in matches until such changes are made to the robot.

5.5.5. Damage to the playing field, the objects, or the control system may result in the disabling or disqualification of the robot at the discretion of the referees. If the referee determines that further movement of the robot would result in field damage, it will be disabled.

5.5.6. Strategies aimed solely at the destruction of or damage to an opponent's robot or the field are not in the spirit of the competition and will not be allowed and may result in disqualification.