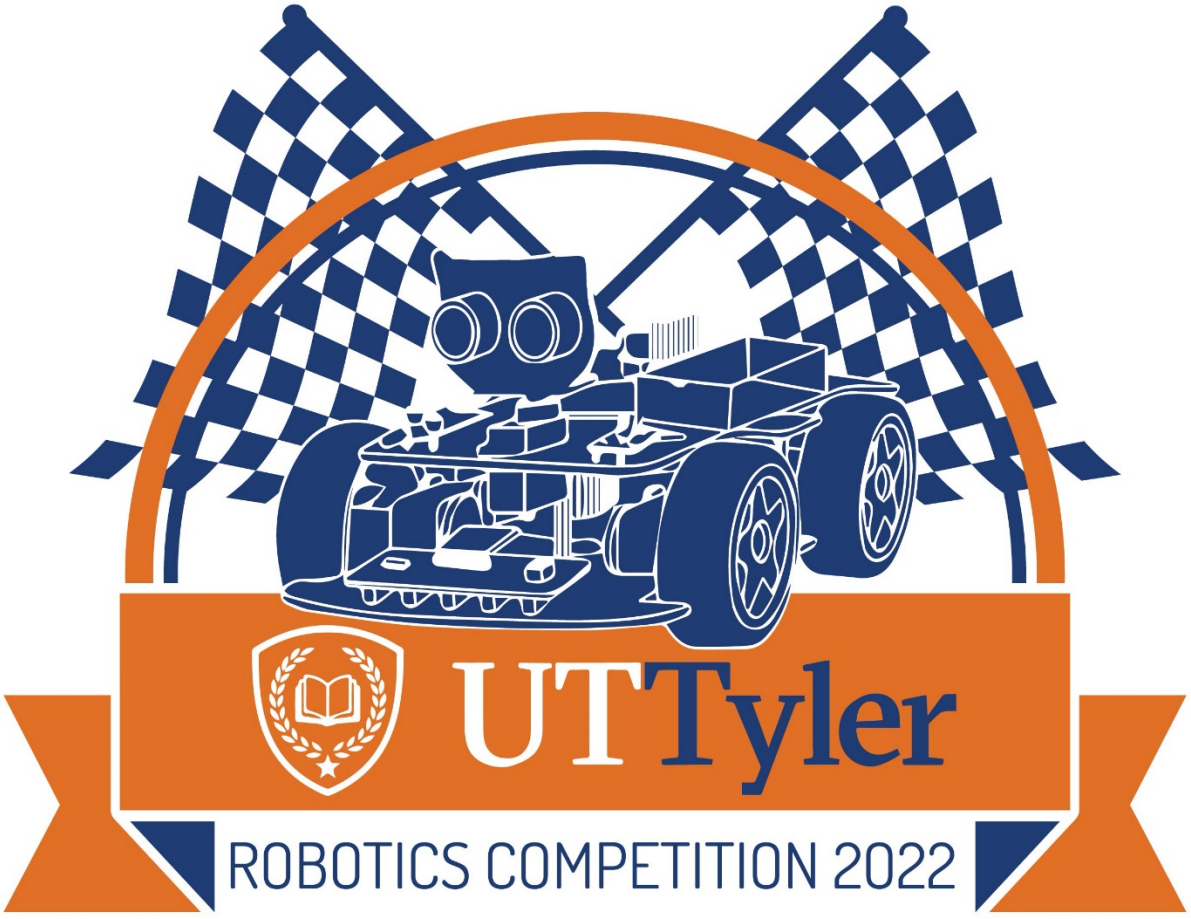
2023 UT Tyler College of Engineering

Ratliff Relays

Robotics Competition



UTTyler COLLEGE OF ENGINEERING

#42, Best Undergraduate Engineering Programs — U.S. News & World Report, 2023

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Introduction and Problem Statement

Introduction:

The University of Texas at Tyler was founded in 1979, and the College of Engineering was added in 1997. Currently the College of Engineering offers degrees across eight areas: undergraduate degrees in Civil Engineering, Chemical Engineering, Construction Management, Electrical Engineering and Mechanical Engineering, and graduate degrees in Civil, Electrical and Mechanical Engineering. Over the past several years, the College has opened a new teaching site at the Houston Engineering Center (where students can earn undergraduate degrees in Civil, Electrical and Mechanical Engineering), and grown to nearly 1000 students in total enrollment.

The purpose of this competition is twofold: (1) to provide students the opportunity to wrestle with an open-ended, practical engineering problem, and (2) increase awareness of STEM Challenges across the state of Texas. The competition focuses on three distinct aspects: (1) creating an innovative solution to a robot build and programming challenge, (2) delivering an oral report and poster relaying design, technical and management information regarding the project, and (3) physically testing the solution and displaying the elements to be judged. The bulk of the activities that form the competition are analogues for the real-world skills that practicing engineers and project managers in the new millennium must possess.

As a final note, the rules and structure for this competition borrow heavily from the Sonoma County Robotics Triathlon 2022 Competition. No specific attempt has been made within the robotics competition rules herein to cite each individual instance of a similar rule, philosophy or structure from one competition to the other – as noted, the rules and structure of the robotics competition borrow heavily from the Sonoma County competition. More information for the Sonoma County Robotics Triathlon can be found at:

https://drive.google.com/file/d/1LvDryP4fAdGXmJk2BYHXarMnNRr20Hlg/view

Problem Statement:

Science is the field of study that makes hypotheses about how the world around us works and tests those hypotheses to see if they are true. The scientific basic mode of investigation is often trial and error. Science tends not to be interested in the application of proven principles. For example, *F = MA* is a true basic scientific fact. This true equation is applied in several other disciplines but science itself is satisfied with the equation itself once proven true.

Engineering is the application of scientific truths. We use means, methods, and materials and combine them in a design to solve a problem. Engineers also use trial and error but rather than to validate the underlying principles of science, usually this process is applied to see if the DESIGN solves the problem. The design process is not complete until the problem has been fully solved to the satisfaction of the project owner.

Your design problem statement is: Using your knowledge of physics, electronics and programming, your team must:

DESIGN

PROTOTYPE

TEST

IMPROVE

And BUILD a final version

of a robot that satisfies the “build” criteria in this set of rules and criteria and that is operationally capable of completing the tasks noted in Section 3.

Chapter 1 – General Rules

1.0 Registered Participants

Student teams will consist of 4 or 5 students. Registered participants (i.e. one of the 5 team members) are the only persons eligible to present or answer questions during the Oral Presentation and are the only persons eligible to compete in the races. Each team shall designate a registered participant as their team captain.

1.1 Liability Waiver

Registration of participants will include the completion of the liability waiver included in these rules as Appendix B.

1.2 Team Sponsorship

The use of company names shall be permitted for information only in the Design Report, Oral Presentation and Product Display, but sponsorship is not to be recognized as part of any of these activities.

1.3 Ethics

Teams shall compete fairly in this competition. As such,

a. Teams shall give proper credit to outside sources of help, including past classmates, websites, reference materials, etc. Plagiarism and false statements are clear violations of the ethos of this competition.
b. Copyright infringement shall be avoided.
c. False or malicious statements about other teams in the competition will not be tolerated.

1.4 General Information

General information about the competition, including the rules, may be found at: www.uttyler.edu/engineering/.

1.5 Spirit of the Competition

Under the "Spirit of the Competition," the judges may take disciplinary action, including warnings, point deductions, or disqualification of a team or entry for inappropriate use of materials, language, alcohol, uncooperativeness, or general unprofessional behavior or unethical behavior of team members or persons associated with a team.

1.6 Appeals

Appeals during the competition shall be filed by the designated team captains using the Appeals Form (Appendix C) provided. The judges will make every effort to resolve an appeal. All appeals shall be resolved by the Awards Ceremony.

1.7 Robot Removal and Return

It is the responsibility of the participating teams to remove their entire robot and any associated debris from the host site after the competition. The robot shall be disassembled, packaged with all parts, and returned to the Department of Electrical Engineering. The host has the option to remove any remaining debris from the site and bill the responsible team. Failure to properly clean-up and return the robot will result in the loss of a letter grade on this assignment and loss of all competition points, at a minimum.

1.8 Safety

It is the responsibility of all participants to be knowledgeable of Occupational Safety and Health Administration (OSHA, www.osha.gov) policies. Refer to Chapter X for Safety considerations specifically for construction day.

1.9 Dates and Schedule

Teams should register to participate no later than March 1, 2023. All teams that register before March 1 will be supplied a robot by UT Tyler (which will ultimately be returned after competition, see Rules 1.7).

Teams will be supplied their robot by March 15 after registering.

There will be a Zoom session for mentoring teams as they get situated with their Robots. This session will allow them to ask questions, get help, etc. – to make sure that they aren't simply unable to get started working with their robots. Teams may indicate that they wish to attend either of two Zoom sessions: Wednesday, March 29 From 5-7 PM, OR April 1 from 10AM - Noon. Teams should indicate which by sending an email to coe@uttyler.edu no later than March 25th at 5 PM.

There will be one In-Person mentoring session for any final physical tweaks, for teams to potentially test, and any other activities that they need to complete in preparation for the competition on April 22nd. The In-Person mentoring session will be Saturday April 8 from 10AM to Noon. Teams should register to attend this session by sending an email to coe@uttyler.edu, no later than Monday, April 3 at 5 PM.

The competition will take place on Saturday, April 22, 2023. A preliminary Schedule of Events is shown below:

8-9 AM	On-Site Check-In
9-9:30 AM	Welcome and Technical Briefing
9:30 – 10 AM	Laboratory and Campus Tour
10AM – Noon	Robot Final Construction and Testing
Noon – 12:30 PM	Lunch (Provided)
12:30 – 1:30 PM	Poster and Presentation Preparation
1:30 – 2:30 PM	Poster and Presentation Judging
2:30-4 PM	Robot Racing
4 – 4:30 PM	Award Ceremony

Chapter 2 – Robot Scenario

2.0 General

The robot used for this competition will be the OSOYOO Robot Car Starter Kit for R3.

The following link provides some further details:

https://www.amazon.com/OSOYOO-Controlled-Educational-Programming-Mechanical/dp/B07XXPW9XP/ref=as_li_ss_tl?ie=UTF8&linkCode=sl1&tag=ardrobokits-20&linkId=79c690ac84ba079445cc1e274b972210&language=en_US

The robot will be supplied by the Department of Electrical Engineering – see Appendix C for details regarding getting access to the robot and how the robot will be returned.

Chapter 3 – Robotic Challenge

3.0 General

The objective of this event is to complete the 3 elements of the triathlon in the shortest time possible. The three elements are: a) obstacle course; b) line follow; and c) ping pong ball drop.

3.1 Rules and Objective:

At the start of the challenge, the robot is placed inside the starting box as indicated below. A 40 mm ping pong ball will be given to participants to place on their robot to carry through the course to the throwing area.

1. Once a robot starts the course, it must remain autonomous or be disqualified.

2. A robot that wanders off the race course will be disqualified.

3. Robots must navigate inside the obstacle course, find the line, follow the line to the red ball dropping area and drop the 40mm ping pong ball inside the coffee can.

4. Robots that go around the obstacle course to reach the line following or dropping area are disqualified.

5. The robot who completes the three tasks in the shortest time wins.

The obstacle course is fully described in Chapter 6 of these rules.

The first challenge will be line following, with the objective being least time to finish. The second challenge will be obstacle avoidance, with again, the objective being least time to finish. The overall scores for this category will be based on a combination of times between the first two challenges. Time permitting, a third round of tiebreaker will involve placement of the ping pong ball. It may not be possible to complete the third challenge – this will be at the discretion of the organizers on the day of the event.

3.2 Additional Criteria

The routing and planning of the robot should be done by programming.

3.4 Safety

Participant safety is always the first priority. This section introduces the basic requirements for maintaining a safe environment during the construction phase and in the competition event. Each team member is responsible for safety during the meetings, the design and construction phases, and the competition event.

General Safety Rules

- Always work in a safe and responsible manner.
- Wear personal protective equipment (PPE), safeguards, and other safety equipment as required.

- Identify and report any unsafe or hazardous conditions.
- Encourage everyone around you to behave safely.
- Be careful when using sharp, high-voltage, or heat-generating tools.

Batteries

Batteries contain chemicals in the form of acids. These acids can burn your eyes, skin, and clothing. When using batteries, observe the following points:

- Avoid shorting the battery terminals. If metal parts contact the battery terminals simultaneously, it will create a short circuit which may cause overheating and the battery may explode.
- Do not overcharge any battery above the manufacturer's maximum recommended rate.
- Check your batteries for any damages before using them.
- Dispose of all old batteries properly and safely.

Soldering

Soldering can be dangerous due to the heat generated by the iron and the chemical fumes released from the solder and flux. When soldering, the following points must be considered:

- Use only lead-free solder and an electric soldering iron.
- Wear personal protective equipment (PPE) to protect your eyes and face.
- Solder in well-ventilated areas.
- Never touch the metal parts of the soldering iron. Your skin may suffer severe burns due to high temperatures.
- Wear proper attire that protects your arms and legs to avoid getting burned.
- After handling solder, always wash your hands with soap and water.
- Work on a fire-resistant surface.
- When not in use, keep your soldering iron in its protected holder.
- Never leave any hot tools unattended as anyone could accidentally contact the hot elements.
- Pay attention to objects that may be near the soldering iron and may catch fire.
- Soldering irons often retain heat after they are switched off and should only be placed on appropriate surfaces.

Any entry deemed unsafe or hazardous by the judges shall not be permitted unless corrective measures are taken. If corrective measures are not or cannot be made the entry shall be disqualified from further competition.

Chapter 4 – Design Poster

Philosophy: The intent of this section is to provide the specifications for the Design Poster that will be presented orally to the judges (See Chapter 5).

4.0 General

The poster should be formatted to fit a 36x48" trifold foamboard that will be provided to the team on site. Teams should bring a set of markers and supplies in order to construct this poster during the contest period.

Complex, ill-defined design projects have many facets – between the first step of problem definition and the later step of construction, among the most important in-between are (a) project management, (b) analysis, (c) testing and materials development, and (d) design. Examples of these aspects for the current project are described in brief below.

Project definition – As noted above, how does your team define the problem and what are your major success criteria, and how were these factors determined?

Project management – Teams may use this section to provide further details regarding the management of the overall project and/or construction. Potential discussion items include logistics (construction, competition day, display, etc.), materials and power usage, competition day planning, risk management, etc. Teams that do not select Project Management as their special focus area may choose not to provide additional information in this section beyond that covered in Section 4.1.3. Teams that do select Project Management as their special focus area may choose to include their additional information within this section or within an expanded, 2 or more page version of Section 4.1.3, such that the overall length of Section 4.1.3 and Section 4.1.4 together does not exceed more than 4 pages.

Analysis – Teams may use this section to include quantitative results from the analysis of forces, stresses, power, velocity, sensor performance etc.

Testing and program development – Present descriptions of experiments and results for any tests that your team conducted to determine the force transfer mechanisms, the function of the various servos and sensors, and the other key aspects of your robot's electrical and kinematic performance. What is the power demand of your robot during the competition, and how was this determined? Provide a description of the programming of the robot to perform its tasks, and how the various logic elements were decided upon. Discuss which sensors were selected and why, what level of precision was able to be achieved and what sources of error are there in your measurements.

Design – Describe the integration of problem definition, testing, analysis, and construction. Describe the iterative nature of the project design development. Provide reasoning behind identification of major design criteria and how your team determined if they had been met.

Construction and Implementation - Describe construction methods and techniques. Discuss methods of quality assurance and quality control within your programming development. Provide the total person hours required to complete the project.

4.1 Contents

The poster should include specific sections as outlined below.

4.1.1 Problem Statement

The problem statement should include the team's overall conception of the problem that they are trying to solve. What are the important features? What are the limitations?

4.1.2 Goals and Objectives

This section should be used to identify the top 3-5 goals and objectives that the team is seeking to accomplish.

4.1.3 Testing and Analysis

Teams may use this section to include quantitative results from the analysis of forces, stresses, power, velocity, sensor performance etc. Present descriptions of experiments and results for any tests that your team conducted to determine the force transfer mechanisms, the function of the various servos and sensors, and the other key aspects of your robot's electrical and kinematic performance. What is the power demand of your robot during the competition, and how was this determined? Provide a description of the programming of the robot to perform its tasks, and how the various logic elements were decided upon. Discuss which sensors were selected and why, what level of precision was able to be achieved and what sources of error are there in your measurements.

4.1.4 Flowchart

Include one flowchart, block diagram for the overall system level design, circuit diagram, algorithm, a table listing all the components used and observations in building the robot. The flowchart will include the design steps of what happens when the robot is deployed as an Obstacle avoidance robot.

4.1.5 Optional

Use this portion of the poster, if space allows, to include any other information that your team wishes to present to the judging panel.

4.1.6 Summary and Conclusions

Provide a summary of the overall project.

Chapter 5 – Poster Oral Presentation

Philosophy: The intent of this section is to highlight the details of the Poster Presentation. In general, each team will discuss their poster with a panel of judges for approximately 5 minutes, and then have a question and answer period of 5 additional minutes.

5.0 General

The poster presentations should relay the important points of the project (presenting the key points of the Design Poster). All poster presentations shall be conducted in a professional manner (defined as a presentation that a professional engineer would give to a perspective client.) Oral presentations shall be presented in English.

Good engineering presentations usually include the following items:

- An introduction that allows an audience to relate immediately to the topic at hand and motivates them to engage with the remainder of the material
- A problem statement that is well organized and may include goals, objectives, issues, etc.
- An agenda and/or outline
- Well organized technical content that tells a logical, coherent story
- Good visuals that highlight the analysis, data and technical information
- Strong conclusions and/or summary statements that allow the viewer to key in on the important takeaways

The *MIT MechE* Communications lab provides a good set of materials regarding engineering presentations, available at: https://mitcommlab.mit.edu/meche/commkit/technical-presentation/.

5.1 Presenters

Presenters may be any of the registered participants who are officially on the team.

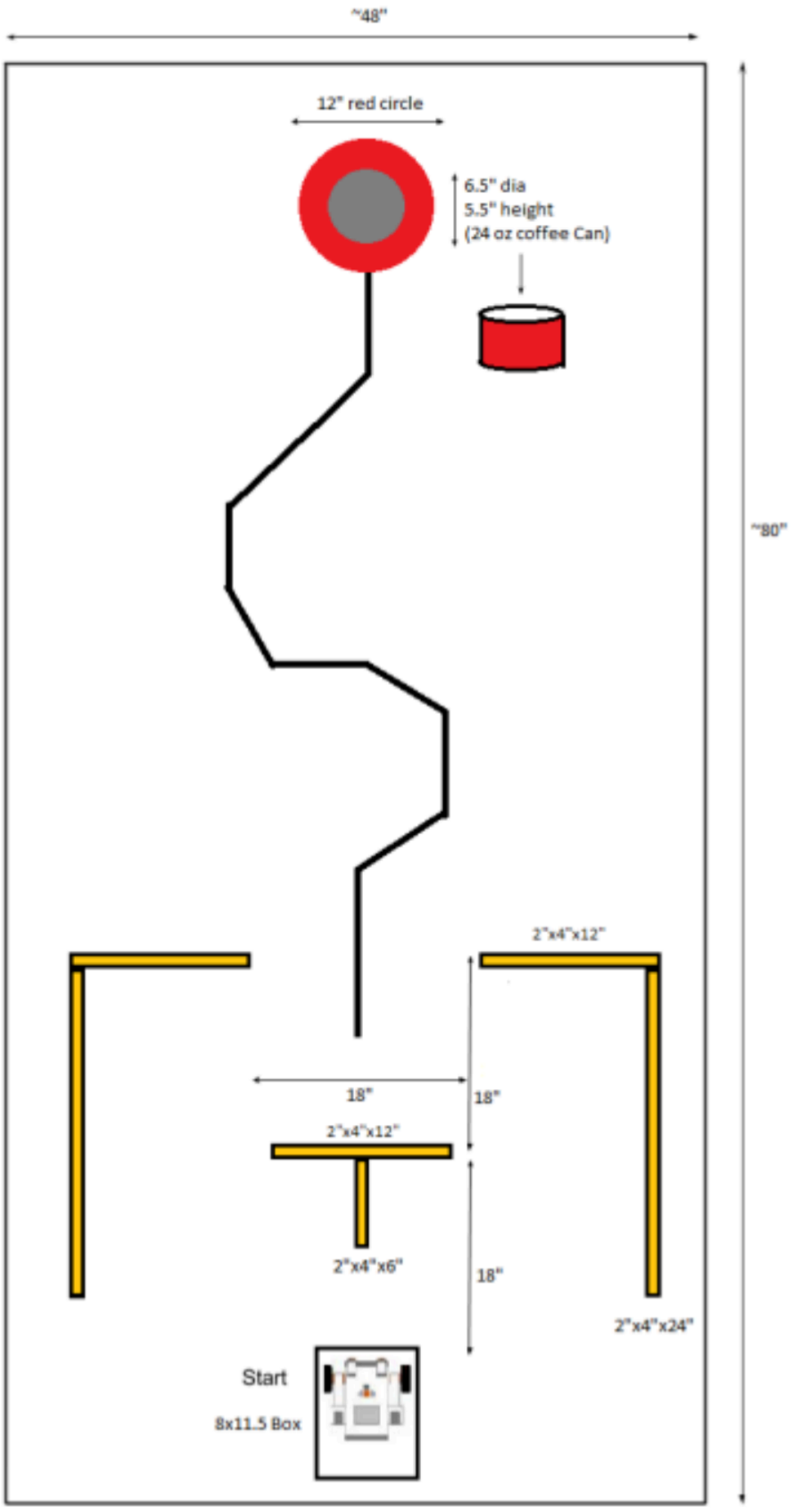
Chapter 6 – Obstacle Course Description

6.0 General

The obstacle course consists of 6 pieces of unfinished 2x4 lumber: two (2) L sections and one (1) T section. The lumber sections are secured by metal L and T brackets on top of the lumber. See the diagram below for details.

The line following portion uses 3 feet of the playing field surface area. 3⁄4" black electrical tape marks a track leading from the start in middle of the obstacle course. The line following course will not be exactly as shown in the diagram below. The track will consist of connected straight segments. No part of the track will be within 8" of the area edge or within 12" of other portions of the track. No angle between adjacent segments will be less than 135 degrees (i.e. the turns will at most be 45 degrees) and no segment will be shorter than 4 inches. The end of the track is a 12" red circle. In the center of the circle is a standard 24 oz coffee can.

The final challenge is to place the 40mm ping pong ball in a red 24 oz coffee can, which measures 6.5" diameter x 5.5" height. The coffee can is weighted down with 3 cups of sand. The can is placed at the center of the red circle. The robot must place the ping pong ball inside the coffee can. Teams will assemble the robotic kit as provided and evaluate the design, come up with a solution to place the ping pong ball in the can, and design a “controller circuit” that can be used to switch between different states of the robot. The controller circuit act as a central switch that can be attached to the microcontroller of the robot kit using a breadboard.


~48"
12" red circle
6.5" dia
5.5" height
(24 oz coffee Can)
~80"
2"x4"x12"
18"
18"
2"x4"x12"
2"x4"x6"
18"
2"x4"x24"
Start
8x11.5 Box

7.1 Timing

Robot performances are timed. Teams will have three minutes grace period to set-up their robot within the location denoted in the diagram above – failure to be ready after this 3 minutes will result in a one minute time penalty for each 15 seconds over the three minutes it takes for the team to announce that they are ready. Timing begins when the robot starts movement and stops when the ping-pong ball lands inside the coffee can or on the ground.

A 60 second penalty is added If the ball leaves the robot before the end of line following,

A 30 second penalty will be added If the ball does not land inside the coffee can.

The course must be completed within 3 minutes or the robot will be disqualified.

Chapter 7 – Scoring

7.0 General

Scoring is divided into 3 parts:

a)	Design Poster	Maximum 25 Points
b)	Poster Oral Presentation	Maximum 25 Points
c)	Robot Performance	Maximum 25 Points

7.1 Ranking

Placing for each event shall be determined by the ranking of the overall scores. In the event of a tie, the average of the raw scores will determine the actual placing. In the event that the tie remains after averaging the raw scores, then the tie will remain. Competition points shall be determined by dividing points for the positions involved in the tie. For example, if a second place tie occurs in the Design Paper event, points for second and third places will be averaged and awarded to the tied teams, if a tie remains after an average of the raw scores. The team with the next highest score will receive points for fourth place.

7.2 Points

Points are awarded under the following rubric for each of the four events:

1st Place – 25 Points
2nd Place – 22.5 Points
3rd Place – 20 Points
4th Place – 17.5 Points
5th Place – 15 Points
6th Place – 12.5 Points
7th Place – 10 Points
8th Place – 7.5 Points
9th Place – 5.0 Points
10th Place – 2.5 Points
11th Place and Higher – Zero Points

7.3 Deductions and Disqualification

Teams may be disqualified for: (a) violations of the Spirit of Competition, (b) Sportsmanship violations, (c) Failure to follow safety rules, (d) Disrespect to other participating teams, judges, volunteers, etc.

Deductions are described in the scoring sheets provided in Appendix A.

7.4 Appeals

The judges will inform the team captains about the deductions that have been assessed against the canoe and/or team in the various events. The raw scores and standings shall not be provided to the teams, only the deductions being applied. The team captains will then be afforded the opportunity to appeal the deductions through a written response that will then be reviewed by the judges. Designated

team captains are the only individuals that may appeal the deductions. The decisions of the judges following their review are final and the judges will accept no further appeals beyond those decisions.

Appendix A – Scoring Sheets

Design Poster Scoring (Out of 100 Points)

Grammar, organization, clarity and overall quality of writing, graphics, etc.	30 Points
Technical, Engineering and Construction Content	30 Points
Project Management, goals, objectives content	30 Points
Creativity and Innovation	10 Points

Poster Presentation Scoring (Out of 50 Points)

Verbal skills (voice projection, tone, confidence, etc.)	10 Points
Non-verbal communication (body language, etc.)	10 Points
Content of presentation	30 Points

Robot Performance Scoring (Out of 100 points)

Time	0-100 points
Top 10% of all times	100 Points
Top 25% of all times	80 points
Top 50% of all times	60 points
Top 75% of all times	40 points
Successful completion of course	20 points

Appendix B – Liability Waiver

A liability waiver will be included in a revision of the rules to be issued in early September, 2022.