Overview

The objective of this project is to expose students to the engineering process through the design and construction of a motor-powered robot that walks under controlled direction. The robot (based on a kit) will have two legs and transverse uneven terrain 30cm (1ft.) past the start line and 60cm (2ft.) before the finish line. *(Track 4.5ft x 1ft)*

NOTE

All entries must be checked in *upon arrival* at MESA Day.

Judging Guidelines

The competition is judged based on scores for each of the components described in the following sections, including the design and construction; oral presentation, board display, a written report; and performance demonstration. The rubrics in the Scoring Sheet provide details on the scoring of each of the competition judging components with the following points for each category (100 points total):

1. **Design and Construction:** 25 points
2. **Oral Presentation, Board Display, and Written Report:** 50 points
3. **Performance Demonstration:** 25 points

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Design and Construction 25 points

The overall design and construction of the robot will be judged on the following characteristics:

1. **Materials and Tools** – The completed robot must be constructed based on the materials provided in the kit without substitution; however, additional materials may be added to the design. Suitable tools (screwdriver, soldering equipment, etc.) may be used to aid in the construction/assembly of the device; however, all components of the base kit must be used without substitution. In addition to the kit materials (again, not in lieu of), components, and parts, decorations, etc. may be added to the robot.

2. **Controls** – The robot must be constructed so that each side of the robot is controlled by a different team member, using independent/separate driving motor assemblies on each side. The control, motor coordination, grace, and speed of the robot will be factored into scoring.

3. **Operators** – The team may elect to switch which members control the robot during its performance on the track.

4. **Starting** – Once the robot is set up behind the starting line, the student must give a “three count” before allowing the device to travel down the track. Once the “three count” is completed, the switch, lever, trigger, etc. must be engaged to initiate the device’s movement down track. At no time should any physical action from a team member generate a force that directly contributes to the device’s motion while on the track.

5. **Tracking** – The robot must travel as fast and as straight as possible down a 4.5 ft x 1 ft track while overcoming two 0.5-in. (1.27-cm) obstacles. Robots will only be allowed to travel down the track once per MESA Day Competition.

6. **Time Limit** – A 15-min time frame will be given to students to complete the course.

7. **Speed** – The vehicle’s speed will be used as a factor in overall scoring. However, the team’s performance on other factors will be considered. See the Scoring Sheet.

8. **Restrictions** – Teams may only bring one robot to the competition.

9. **Bonus Points** – At minimum, manual control of the robot is required; however, a bonus (of 15 points) will be given for autonomous programming of the robot.
Design Presentation, Board Display, and Written Report 50 points

Each team will be assigned a setup location at MESA Day. In this location, student team members will complete their oral presentations and provide answers to judges’ questions about their device. All student members are to actively participate in the presentation. Teams must be prepared to give a 2- to 7-min presentation and answer any questions from the judges related to their design.

NOTE

Participation in the presentation or interjections by adults of team members are not permitted during the presentation.

The team’s design presentation must be accompanied with a tri-fold display board (36 x 48 in.) that contains the following information:

1. **School and School System Name.**
2. **MESA Advisor(s) and Principal’s Names.**
3. **Team Members and Their Roles** – Display board introduces all team members and their contributions to the project.
4. **Graphical Display** – A well-labeled graphic of how the model functions.
5. **Written Report** – A written report (as well as the complementary display) describing the engineering and design process the team employed; which includes the following:
   - How the team chose to wire the robot’s circuits (series or parallel) and why.
   - How the team chose to automate the device (manual or programming).
   - How the device was assembled and tested. Include sketches of the original design.
   - What improvements or changes were made to the design and why.
   - A complete (but brief) description of some of the problems the team encountered in designing the robot and how they resolved those problems.
     - The report must be presented physically on-site to judges in a fashion that provides ease of review (Ex: Ring Binders, Tabs, etc.)
6. **Bibliography** – List at least six resources used to solve the challenge problem. Include books and websites. Reference citations must be formatted according to the American Psychological Association (APA) style for reference citations.
7. **Materials** – List all component materials of the device in excess of the standard kit. Indicate the cost of these items. (Estimate the value of donated materials) At the bottom of this list, provide a total cost of the additional component materials used in the device, which must be less than $50 U.S. Dollars (USD). See the Example Budget Sheet.

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2 Available at: [http://www.apastyle.org](http://www.apastyle.org).
8. **MESA Logo** – Include the JHU/APL MD MESA logo, no smaller than 7 x 1.5 in., in the upper right corner of the display. The logo can be downloaded from the MD MESA website: [www.jhuapl.edu/mesa](http://www.jhuapl.edu/mesa)

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**Example Budget Sheet**

The following is an example of an itemized sheet listing each component and its cost:

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Popsicle Sticks</td>
<td>200</td>
<td>4.00</td>
</tr>
<tr>
<td>Marbles</td>
<td>2</td>
<td>2.00</td>
</tr>
<tr>
<td>Motor</td>
<td>1</td>
<td>5.00</td>
</tr>
</tbody>
</table>

**TOTAL:** 11.00

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**Judges’ Questions**

The judges’ questions may be centered on but not limited to the following:

1. How the design was tested and what improvements were made (engineering process).
2. Why the presented design was selected and how would it be useful in real-life situations.
3. Reason for the device's functionality, shape, styling, etc.
4. The scientific research required to construct a robotic device.
5. The team's selection of additional materials.
6. Steps taken to ensure team safety during construction.

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**Performance Demonstration** 25 points

The robot must be designed to walk under controlled direction (Either manual or programmed). The robot, (based on a kit) will have legs and the ability to traverse uneven terrain.

The following parameters will be measured for each device in the performance section:

1. **Speed** – Speed will be measured as distance traveled over time.
2. **Control** – The robot’s synchronization with commands will be judged.
3. **Motor Coordination** – Team’s ability to walk in tandem.
4. **Grace** – Robot’s ability to walk over all terrain types without falling.
5. **Decorations and Visibility of Parts** – The robot may be decorated, but all powered parts (motors, fans, switches, wires, etc.) must remain clearly visible.

6. **Starting Line** – The robot must remain behind the starting line before demonstration and may only be released onto the track in the sight of the judge(s).

7. **“Three Count”** – Once the robot is set up, the demonstrating team member should give a “three count,” during which time the device must not be in activation. Once the “three count” is completed, a switch, lever, trigger, etc. must be activated by brief physical contact from the team member to initiate the robot’s motion; this contact must not add force to the forward motion of the device. If the robot falls over, team members may pick it back up; however, the action must be brief with no forward motion added to the device.

8. **Bonus Points** – At minimum, manual control of the robot is required; however, 15 bonus points will be given for programmed control. Additionally teams will be able to score bonus points for robot course completion speed and creative presentation of their team and completed device (See Rubric).

**NOTES**

Two teams should be placed side by side in parallel lanes for the track event.

If a robot fails to cross the finish line within 15 minutes from the start of a run, that run will be ended and marked at 15 minutes and receive a time score of five (5) points.

**Repairs and Tools** – Teams will not be allowed to make repairs to the robot once it is on the track. However, adjustments/repairs are allowed before any official run. Any tools brought to the MESA Day for the robot event may not take up more than a 30- x 30- x 30-cm space and must be stored in a location that does not interfere with the competition.

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**Example Robot Assembly**

An example of a third-party assembly of a robot similar to the one used in this competition can be viewed here:

https://ieeetv.ieee.org/careers/ieee-robot-challenge

**NOTE**

Please be aware that the assembly described in the example video may not exactly meet this year’s specifications. Always check your rules during the assembly of any competitive device.

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**Design Bonus**

30 points
To distinguish themselves, teams can earn additional points for completing the following bonus design challenge, worth 15 points:

- Completely automating the robot’s motion via programming.

**NOTE**
All entries must be checked in upon arrival at MESA Day.

**Tie Breakers**

Ties will be broken via the use of the highest score on the following predetermined rubric indicators:

1. Design Performance
2. Oral Presentation, Board Display, and Written Report
3. Design and Operation

The following Scoring Sheets itemize possible points for each tie breaker category.

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**ALL DECISIONS MADE BY JUDGES ARE FINAL**

All MESA teams are also encouraged to enter the Maryland Engineering Challenges, from which this challenge draws its inspiration.

IEEE Robot Challenge

Scoring Sheet

School: _____________________________________  Judge: ____________________________________________  Total ____________/ 100 points

<table>
<thead>
<tr>
<th>Performance Area</th>
<th>Level of Mastery (Select One)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral Presentation, Board Display, and Written Paper – TIE BREAKER #2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student(s) significantly increase the judges’ understanding of the team’s approach to the engineering and design process—including but not limited to the following:</td>
<td>Section Total 50 Points</td>
<td></td>
</tr>
<tr>
<td>– Relevance – The presentation, and display board, offered a highly insightful view into how the design was tested and selected (including sketches of the original design).</td>
<td>(1) (2) (3) (4) (5)</td>
<td>_______/5</td>
</tr>
<tr>
<td>– Academic Rigor – The team presented a complete (but brief, 2-7 min) description of some of the problems they encountered in assembling and/or designing the device and how those problems were resolved.</td>
<td>(1) (2) (3) (4) (5)</td>
<td>_______/5</td>
</tr>
<tr>
<td>– Sources – The presentation and display board, include at least six cited sources used to assist the team in solving the stated problem (formatted using APA style for reference citations).</td>
<td>(1) (2) (3) (4) (5)</td>
<td>_______/5</td>
</tr>
<tr>
<td>– Team Member Contributions – The team introduced all of their team members and detailed the contributions of each on the display board.</td>
<td>(1) (2) (3) (4) (5)</td>
<td>_______/5</td>
</tr>
<tr>
<td>– Organization – Utilizing their display board, the team delivered a brief, engaging introduction, a uniquely interesting presentation, and a highly compelling conclusion within 2 to 7 minutes.</td>
<td>(1) (2) (3) (4) (5)</td>
<td>_______/5</td>
</tr>
<tr>
<td>– Display Board – Professionally assembled and utilized through key features of the oral presentation. Includes the JHU/APL Maryland MESA Logo in the upper right corner. The board should be the required size of (36 x 48 in.) and include a list of component material costs. Added material beyond the kit must not exceed $50 USD.</td>
<td>(1) (2) (3) (4) (5)</td>
<td>_______/5</td>
</tr>
<tr>
<td>– Professionalism – Clear speech (avoids “umm,” “like,” “you know,” etc.), good eye contact, professional posture.</td>
<td>(1) (2) (3) (4) (5)</td>
<td>_______/5</td>
</tr>
<tr>
<td>– Accurate Timekeeping/Pacing – Team presented within the 2- to 7-minute window without rushing or going too slow.</td>
<td>(1) (2) (3) (4) (5)</td>
<td>_______/5</td>
</tr>
<tr>
<td>– Working Knowledge – Student conversation(s) allow judges to readily assess that the students were highly involved in the engineering, design and construction process and that their ideas came to life in the device.</td>
<td>(1) (2) (3) (4) (5)</td>
<td>_______/5</td>
</tr>
<tr>
<td>– Written Report – Student physically present a clearly written report with the following: Title Page, Summary (Abstract), Table of Contents, Body, Conclusions and Recommendations (if any), Acknowledgements, Bibliography, Safety Measures, 300-500 words. (The written report will be reviewed on-site by the judge - 3 Ring Binders Recommended)</td>
<td>(1) (2) (3) (4) (5)</td>
<td>_______/5</td>
</tr>
</tbody>
</table>

Continued…

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3 Available at: [http://www.apastyle.org](http://www.apastyle.org)
### IEEE Robot Challenge Scoring Sheet

**School:** _____________________________________  **Judge:** _____________________________________  **Total ______________________ / 100 points**

<table>
<thead>
<tr>
<th>Performance Area</th>
<th>Level of Mastery (Select One)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Robot Challenge (Continued)</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Design and Construction – TIE BREAKER #3

Student team members readily engaged in the design and engineering process to produce a working solution to the presented problem, demonstrating a command ability to meet design requirements as demonstrated in their device— including but not limited to the following:

- **Commands** – The robot responded to manual and/or programmed commands. *See Bonus for Programmed Commands*
  - Not Demonstrated / Demonstrated: (0) / (5) _______ /5
- **Movements** – The robot completed the run/trial with graceful movement and successfully traversed the terrain (no falling or gross operational malfunctions). *Fallen Robots may continue but will receive a score of “Not Demonstrated”*
  - Not Demonstrated / Demonstrated: (0) / (5) _______ /5
- **Control** – The robot was controlled by two students working in tandem on separate sides with separate motors. If the robot completes the course due to pre-programming, score as “Demonstrated”.
  - Not Demonstrated / Demonstrated: (0) / (5) _______ /5
- **Visible Parts** – All powered parts of the device (switches, wires, motors, etc.) are clearly visible.
  - Not Demonstrated / Demonstrated: (0) / (5) _______ /5
- **“Three Count”** – The robot, able to stand on its own, was set at the starting line with a “three count” given by the team before operation (The three count must occur when judge is prepared- otherwise mark as “Not Demonstrated.”)
  - Not Demonstrated / Demonstrated: (0) / (5) _______ /5

#### Performance – TIE BREAKER #1

Time : The run time for completing the course with the robot

**Time (Used for Scoring): _______ min**

<table>
<thead>
<tr>
<th></th>
<th>1st Place (Fastest Run Time)</th>
<th>2nd Place (Runner Up)</th>
<th>3rd Place (Runner Up)</th>
<th>4th and 5th Place (Runner Up)</th>
<th>All Others (Honorable Mention)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 points</td>
<td>20 points</td>
<td>15 points</td>
<td>10 points</td>
<td>5 points</td>
<td></td>
</tr>
</tbody>
</table>

- **Time**: The run time for completing the course with the robot

#### Design Bonus

*Add the slated additional points if the following tasks are completed:*

<table>
<thead>
<tr>
<th>Task</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Programming</strong> – The robot completes the track due to pre-programming.</td>
<td>+____ (15)</td>
</tr>
<tr>
<td><strong>Speed</strong> – The team completes the course within or at three (3) minutes</td>
<td>+____ (5)</td>
</tr>
<tr>
<td><strong>Final Production</strong> – The robot, carrying case and team members show style, artistic creativity, team spirit and originality</td>
<td>Basic +2</td>
</tr>
</tbody>
</table>

**TOTAL SCORE (x/100 points): ______ /100**
<table>
<thead>
<tr>
<th>Overall Score for the Robot Challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>**TOTAL SCORE (x/100 points): **_____/100</td>
</tr>
</tbody>
</table>

**Judge’s Feedback**