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## Engineering Design Challenge 3

# Mars Colonization

## Rules & Game Description

Congratulations! Your job application to Lebanese Rocket Society – Mars Division has been accepted! As head of the Robotics team, you are in charge of building the rover that will help us establish the first human colony on Mars! You settle into your new job after going through the press conference – and a couple of live TV interviews – and begin working on your task.

### Date & Location

The challenge will take place on Saturday January 27, 2018 at the American University of Beirut.

### Eligibility

Teams of 2 to 5 members can be part of the challenge. All team members should be enrolled either as undergraduate or graduate students in a university as of the competition announcement date.

### Guidance and Advising

Teams are recommended, but not required, to have an advisor. An advisor can be anyone; a professor, an engineer in a company, or even a university student, who is willing to provide consultancy when needed. Note that EDC organizers and members of the judging panel are not allowed to be advisors.

Advisors should only guide teams throughout the competition, not do their work. They may suggest ideas and provide feedback for teams, however they must not help with any hardware or software implementation.

Teams should inform EDC organizers of their advisor for recognition purposes.

### Awards

The team with the highest overall score gets a monetary prize of **\$1500**. The first and second runners up get prizes of **\$1000** and **\$500** respectively. Other awards will be distributed among teams who demonstrate proficiency in certain aspects of the competition

## General Rules

- 1) A rover is any object that aligns with the rules. No shape, material, platform, or size is imposed – creativity is encouraged! Teams are expected to take the challenges into consideration when designing their rover.
- 2) Each team must use only one rover to play the games. Minor changes or repairs can be made to the rover between rounds.
- 3) The rover cannot be interacted with by hand except when allowed explicitly in the rules (eg pit area, or starting/resetting...)
- 4) The rover should not damage the playing field or pose any safety hazards. Teams who violate this rule on purpose would be disqualified. Refer to the safety regulations for more information.
- 5) Only one team member, designated the operator, can interact with the rover in pit areas, bring it back to the starting zone, or control the rover in the base building game. The operator cannot change during the round, but different team members can be operators for different rounds.
- 6) All dimensions in field drawings have a tolerance of 5%. CAD drawings of the field are available on the competition website <http://aubrobotics.com/edc>.
- 7) Judges take the final decision in rule matters.

## Scoring

Teams will be assessed based on the following two measures, for a total of 100 points:

- 1) Preliminary Check (10 points):  
This will be given to basic functionality checks around one month before the competition day. The checks are to ensure teams are preparing well for the competition.
- 2) Game Performance (50 points):  
Robots will play 3 games, described below, to score points.
- 3) Technical Assessment (40 points):  
This will be based on design evaluation by a team of judges from different universities/companies, according to the judging rubrics specified in a separate document.

## Games

Teams play three games to score points – Surveying, Terraforming, and Base Building. Note that the games are in no particular order of difficulty. The rovers operate autonomously and are scored independently – except for the Base Building game where two teams compete in one of the tasks, and the rovers can be remote controlled through any wireless technology.

The **pit area** is an isosceles triangle with base 1.5m and height 75cm. In all games, the rover starts in the pit area, and the operator can interact by hand with the rover there.

The score for all games is added up for the game performance percentage. Each game can earn a maximum of **20 points**. While the sum of perfect scores of the 3 games is 60, the total score is capped at **50 points**; any score equal or greater than 50 counts as a perfect score for the game part. This is to encourage teams to focus on games they can do better in. Note that, however, in result of a tie in total score, the scores in individual games may be used to decide the winners.

All game fields are surrounded by a black border wall at least 30cm high.

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## SURVEYING

Your scouting mission has arrived on the red planet! Now, your rover should search for resources and take samples to map out the landing site, preparing for our colony.

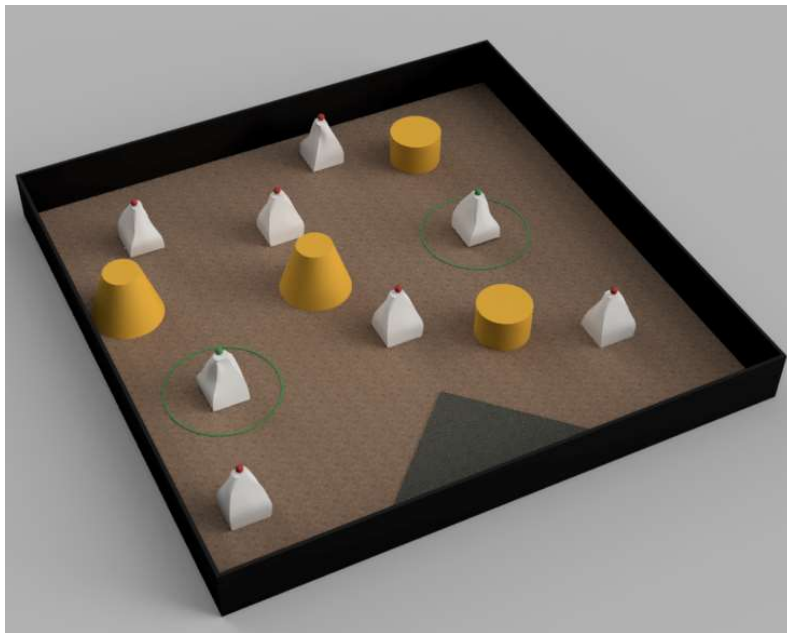
**Goal:** The rovers should sample mineral deposits and observe radioactive deposits.

Note that due to the long communication delay between Earth and Mars – because of the finite speed of light – the rover should operate autonomously.

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### SURVEYING – FIELD DESCRIPTION

- The game takes place in a 3m×3m map. The exact configuration is not known beforehand, but samples are provided for training.
- The map will have **obstacles** (rocks/volcanos) colored yellow, blocking some paths. The width of each obstacle does not exceed 40cm.
- **Deposits** are polygonal rocks that are guaranteed to fit completely in a cylinder of diameter 20cm, and height 40cm, although they can be smaller.
- **Deposits** will have a sphere of diameter of 4cm (ping pong ball) on top that changes color to indicate type of deposit.



Surveying field sample

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## SURVEYING – GAME RULES

- The rover should operate autonomously, except for starting or restarting the rover.
- The rover starts in the **pit area**.
- **Deposits** are of two types; **mineral deposits** with a red top (color of iron oxides), and **radioactive deposits** with a green top. The rest of the deposit is colored white.
  - **Mineral deposits** must be sampled by bumping them; after which their top part stops lighting red. The bumping needs to be strong enough to trigger the change. Successfully sampling a mineral deposit counts as **2 points**.
  - **Radioactive deposits** must be observed by coming within 20cm from them, without bumping. For an observation to count, the robot needs to come inside the radius, partially or completely, then leave. The top part of the deposit becomes blue when the robot comes within 20cm from it, and then turns off when it leaves the zone. Successfully observing a green radioactive deposit is worth **4 points**. Bumping a radioactive deposit before leaving the radius makes it worth only **1 point**.
  - When the top part of the deposit is turned off, it's considered deactivated, and does not yield additional points or penalties.
- The deposits would be placed randomly at the beginning of each trial, numbering **6 mineral** and **2 radioactive deposits**.
- The match timer lasts for **2 minutes**, and does not pause for any reason.
- At any point during the match, the rover might be brought back to the **pit area** for a penalty of **2 points**. The operator can interact with the rover to reset it. Rovers that leave the map area are brought back to the start zone with the same penalty.
- The team has **3 trials**. The trial with the maximum score is used for scoring purposes.

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## TERRAFORMING

Sending robots to Mars is a huge undertaking, but sending humans is a whole different story. The barren, hostile environment makes any manned mission to Mars a suicide mission. Can you tame the red planet?

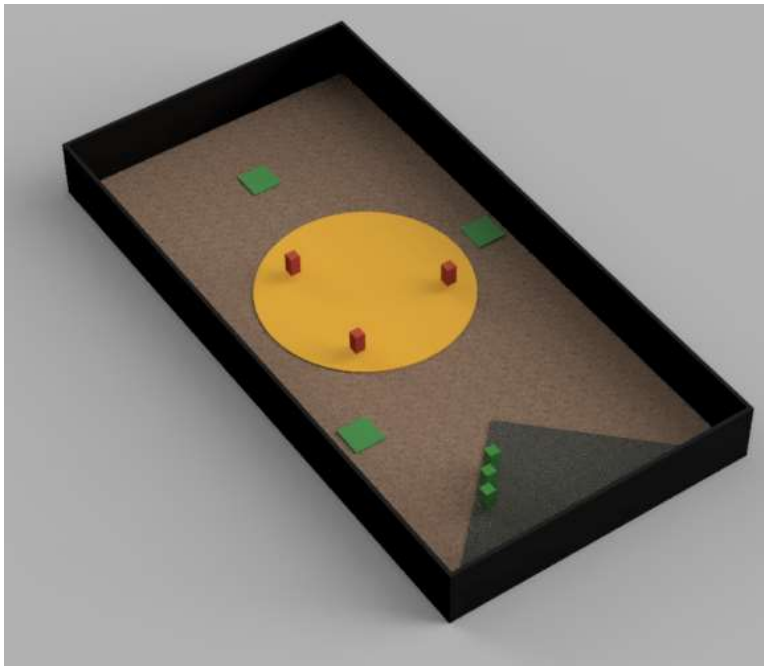
**Goal:** To terraform the planet, you'll need to clear the proposed base site, and plant algae farms to generate oxygen in the atmosphere.

The rovers operate autonomously.

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### TERRAFORMING – FIELD DESCRIPTION

- The game takes place in a 1.5m×3m map, shown in the field drawings.
- **Algae units** and **boulders** are 5cm×5cm×10cm cuboids, each weighing 0.25kg.
- **Algae destination areas** are 15cm×15cm green squares.
- The **base area** is a yellow circle of diameter 1m.



Terraforming field drawing

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**TERRAFORMING – GAME RULES**

- The rover should operate autonomously, except for starting or restarting the rover.
- The rover starts in the **pit area**. The operator can load or unload items manually in the pit area.
- The rover can complete two tasks, in no particular order.
  - *Clear the land:* The rover must move **3 red boulders** out of the **base region**.
    - At the start of each trial, the boulders are placed randomly in the base region.
    - The team gets **2 points** for each boulder completely removed from the base region.
    - The team gets an extra **1 point** for each block moved completely or partially inside the pit area.
  - *Plant algae:* The rover must be able to load **3 green algae units** from the pit area, and unload them onto three different **algae destination squares** – each into its own square. The operator can manually load and unload the blocks.
    - The team gets **1 points** for each block unloaded manually. For manual unloading, the rover must stand completely still within 20cm of an algae square.
    - The team gets **3 points** for each block unloaded automatically.
    - Manual loading can only happen in the pit area.
    - The team gets an additional **2 points** if at least one block is loaded automatically.
- The match timer lasts for **2 minutes**, and does not pause for any reason.
- At any point during the match, the rover might be brought back to the **pit area** for a penalty of **2 points**. The operator can interact with the rover to reset the program or load/unload game items. Rovers that leave the map area are brought back to the **pit area** with the same penalty.
- The team has **3 trials**. The trial with the maximum score is used for scoring purposes.

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## BASE BUILDING

The pioneers are finally here! They are building small outposts as nuclei for future human colonies. Two teams of scientists are working on their stations side by side in friendly competitive spirit.

**Goal:** The rovers need to lay infrastructure, provide power, and raise their flag over the base.

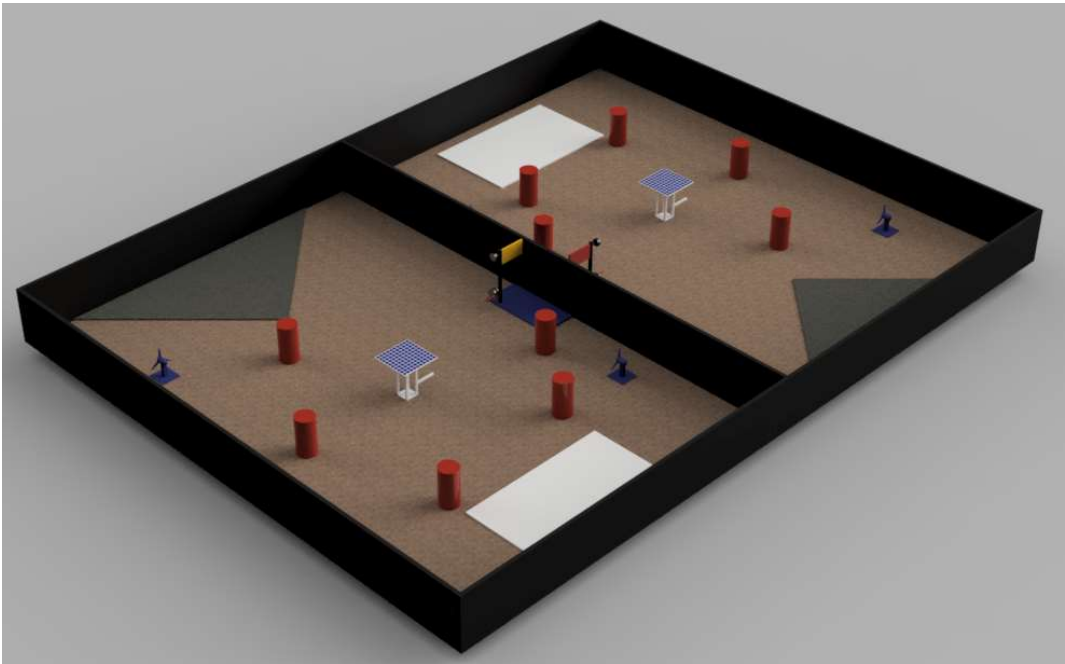
Scientist pioneers would be driving the two teams' rovers.

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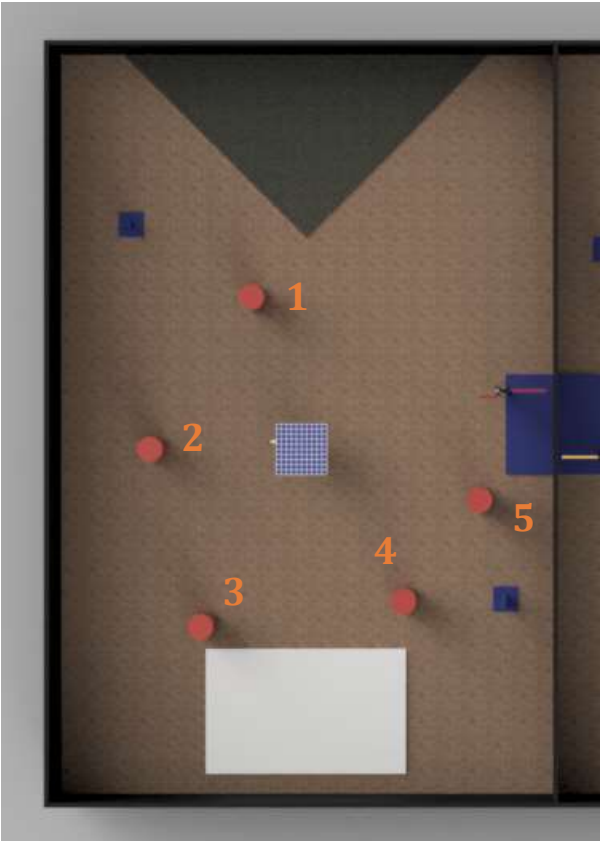
### BASE BUILDING – FIELD DESCRIPTION

- The game takes place in a 3m×4m map; split into two 3m×2m regions for two teams. Each team must play in their designated region.
- **Checkpoints** are cylinders with diameter 10cm and height 20cm, with a sphere of diameter of 4cm (ping pong ball) on top that can light up to indicate being hit.
- **Wind turbines**, the **solar panel**, and the **flag pole** are as shown in the field drawing CAD files.





Base Building field drawing



Base Building top view and checkpoint order

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**BASE BUILDING – GAME RULES**

- Any wireless technology is allowed for controlling the rover, as long as it does not interfere with other teams' rovers, or the judges' ability to score the match.
- The 2 rovers start at opposite ends of the arena, in the pit areas.
- The game consists of 3 objectives; Laying Infrastructure, Providing Power, and Raising Flag.
  - *Laying Infrastructure:* The rover must bump **5 checkpoints**, numbered 1 to 5, in order, to lay a path for cables and ducts for the base. While the bumping must be in order, the rover can complete other tasks, or even come back to the pit area, between checkpoints.  
The team gets **1 point** per checkpoint. The bump needs to be strong enough to trigger it. Bumping a checkpoint in the wrong order does not give points nor penalties.
  - *Providing Power:* Power to the base is provided through a mix of wind and solar power.
    - There are **2 wind turbines** placed at predefined coordinates. The wind turbines must be moved to the target area to generate power, for **2 point** per turbine.
    - The solar panels must be adjusted to get the best sun exposure. The robot moves a handle to change the panels' angle to get **4 points**. The solar panels would light up when the angle is within  $45^{\circ} \pm 5^{\circ}$ .
  - *Raising Flag:* After bumping all checkpoints in the Laying Infrastructure part, the rover can raise the flag over the common area. The rover rotates the wheel near the **flag pole** for 1 rotation counterclockwise to raise the flag, and get **4 points**. The rover that raises its flag completely before the other rover gets an extra **3 points**.  
The rover does not get any points if it raises its flag before all checkpoints are bumped.
- The rover should not try to affect the performance in the other rover playing at the same time, except for racing to raise the team flag. Any team that violates this rule loses the round with 0 points, and the other team get to repeat their trial.
- At any point during the match, the rover might be brought back to the start zone for a penalty of **2 points**. The operator can interact with the rover to reset the program. Rovers that leave the map area are brought back to the start zone with the same penalty.
- Both rovers have **3 minutes** to complete the game. The match timer does not pause.
- The team has **3 trials**. The trial with the maximum score is used for scoring purposes.

## **Changelog**

- Sept 22, 2017: Rules released