Lunar Exploration Innovation Challenge

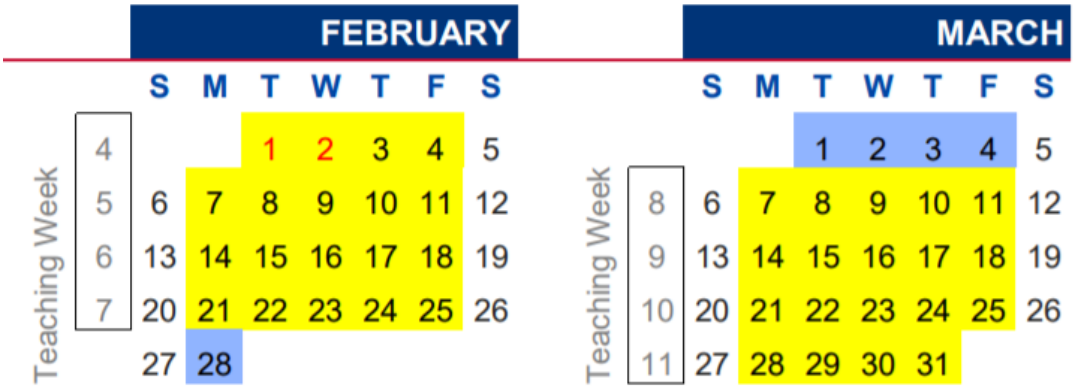
Theme: Exploration of lunar surface such as rocks/caves.

Team size: 3-5 students

Submission deliverables:

1) 5 - 10min video presentation
2) Supporting documents (CAD/code/simulations) with adequate explanations

Timeline:



Activity	Date
Publicising to all the students	24th Jan
Registration Deadline	5th Feb
Competition commencement with a short briefing (45min online)	7th Feb
Talk on challenges in Exploration	Feb 2nd/3rd-week (Teaching week 5/6)
Workshop: 3D printing	Feb 3rd/4th week (Teaching week 6/7)
Submission deadline	6th March
Result announcement (45min online ceremony)	12th March
Workshop-2: ROS	Week-8/9
Prototyping deadline	May 2nd week
Final Hackathon	May 3d week
Showcase	7th June

Prizes distribution:

Prize	Amount
1st	$1250
2nd	$1000
3rd	$750
4th	$500
5th	$250
People's Choice	$250

For People's Choice award, participants are given time from 7th March to 11th March to get votes for their idea over a google form.

Prototyping: $800
Top 5 teams would be receiving a prototyping fund of up to $800 each to build the prototype.

About
Participants are suggested to come up with at least one solution to explore lunar rocks/caves from the following categories: Design, Natural Science, Power & Telecommunication, Software, Others. Possible problem statements are listed in the description of each category. However, participants are encouraged to raise any other related problems fallen in the category and propose corresponding solutions. Participants can choose to select the "Others" category if the participant thinks it might not fall under any of the other 4 categories

Note: You may provide a solution by making necessary assumptions based on previous space missions or any other references. However, do state your assumptions clearly.

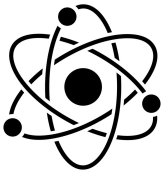
Design

This category involves you picking a challenge that reflects design including fabrication/material innovation in contributing to the exploration. Some of the possible problem statements *(but not restricted to)* could be:

1) Problem: Design of maneuverability system of the rover that can handle moving on various terrains, i.e., uneven surfaces/steep surfaces/unexplored areas like caves, volcanoes, etc. What kind of mobility system would be foolproof? Manufacturing

method and material choice are additional aspects of consideration for the rover to function properly in harsh environments.

2) Problem: Design of robot arm to be able to perform risky exploration tasks such as taking soil and rock samples. The robot arm should be scalable to accommodate various types of end effectors. The design of various end effectors needs to consider the degree of power, precision, and flexibility required for specific types of tasks.
3) Problem: Design a 2-way transport system between an orbiting space station and the surface of the moon. This may be used for the movement of supplies for astronauts, retrieval of rovers to extend the life of the mission, etc. You may consider the example of Habitation and Logistics Outpost(HALO) for the space station.



Natural Science

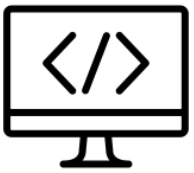
This category involves you picking a challenge that your team comes up with innovative science experiments that can be carried out on the moon in order to enhance humans' understanding of space. Some of the possible problem statements *(but not restricted to)* could be:

1) Problem: Design an experiment to collect rock and soil samples and analyze their age in an unexplored region/ or in caves. You can consider aspects such as what is the most efficient way to minimize the quantity of sample collected and what is the most reasonable method to deduce information from samples. Furthermore, is it possible to conduct real-time analysis on the moon?
2) Problem: Design an experiment to check for signs of life by extracting rock and soil samples. You can consider aspects such as what is the most efficient way to minimize the quantity of sample collected and what is the most reasonable method to deduce information from samples. Furthermore, is it possible to conduct real-time analysis on the moon?
3) Problem: Design a self-sustaining resource supply and recycling system on the moon. You may consider a habitat design with a number of astronauts of your choice taking into consideration optimizing food production, waste disposal, etc, or suggest any closed-loop cycle such as the carbon cycle(for earth) that helps in sustainable living on the moon.

Power & Telecommunication

This category involves you picking a challenge that your team comes up with innovative methods in managing the energy requirements for the rover to survive and pass the collected information to earth from inside the cave/volcano etc. Some of the problem statements *(but not restricted to)* could be:

1) Problem: Design of the power system for sustainable energy production by harnessing energy in the most efficient manner and storing it to increase the life of the mission. You may suggest various energy storage and harvesting solutions taking into consideration cost, durability, mass, feasibility.
2) Problem: Contingency system to deal with emergency situations like breakdown, crash, etc. You may consider explaining the safety considerations needed for the rover and a BlackBox kinda system to store all the information and pass it to earth and identify the most critical parts of the rover to be powered to handle the situation.
3) Problem: Passing critical information such as images, point cloud data, status, and condition of a robot that is exploring inside a cave to the earth. You may consider exploring the equipment needed, weight, size requirements, methods used to sample the data, etc



Software

This category involves you picking a challenge that your team comes up with innovative solutions that aid the science experiments, mobility, or any other part of exploring the moon. Some of the problem statements *(but not restricted to)* could be:

1) Problem: Recreating the 3D point cloud model of rocks, surface, and inside the cave using advanced Lidar technology and using visual odometry to keep track of the motion of the rover.
2) Problem: Autonomous Navigation and localization of the rover on the moon using ROS architecture or any other architecture. You may consider exploring the choice of your algorithm, what sensors are needed along with their specifications for path planning and localizing.
3) Problem: Coming up with a software-based solution for a contingency to deal with self-analyzing the condition of the rover to detect any abnormalities in the rover.

Others

This category gives your team the freedom to come up with your own challenge and corresponding solution to aid the mission of exploring the moon if your challenge doesn't fall under any of the above-mentioned categories.

1) Problem: Maintenance robot assisting the main robot that is responsible for collecting samples on the moon. It should be equipped with tools to repair the main rover if anything goes wrong. You may make necessary assumptions in choosing the capabilities of the maintenance robot.
2) Problem: Swarm robots to be deployed around/inside a rock for learning the topology. You can explain the preliminary mechanical design of the microbot communication, between a swarm of microbots to help consolidate the data collected and pass it to earth or consider preliminary analysis on the moon.
3) Problem: Investigation of the lunar region using teleoperation of robotic arm/ any other instruments that can be mounted onto the rover from earth or space station orbiting the moon. You may take into consideration the delay in sending commands and receiving feedback, and how to solve them?