

STUDENTS
2SPACE

QUBE2SPACE

RULEBOOK 2023



ORGANISED WITH SUPPORT FROM:



**UNIVERSITY
POLITHNICA OF
BUCHAREST**



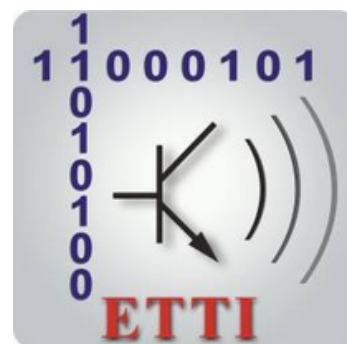
**INSTITUTE CAMPUS UPB
BUCHAREST**



**FACULTY OF
AEROSPACE
ENGINEERING**



**FACULTY OF
AUTOMATIC CONTROL
AND COMPUTER
SCIENCE ENGINEERING**



**FACULTY OF
ELECTRONICS,
TELECOMMUNICATIONS
AND INFORMATION
TECHNOLOGY**



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Introduction

2SPACE Team, established in 2019, is the only team of students in Romania that designs and launches rockets, especially for international student competitions. Innovation and technology merge in the development of current and future projects that will take the team to the next level, and our goal is to achieve our objectives and develop as many new concepts as possible in the academic environment. We aim to be highly involved in the field's development and attract both students and pupils to this aspect of science.

Together with the POLITEHNICA University of Bucharest, we want to implement the second edition world's first PocketQube competition, aiming to attract as many students as possible to this impressive and fascinating branch of science.

The POLITEHNICA University of Bucharest - UPB (www.upb.ro) is the largest and oldest technical university in the country and one of the most prestigious universities in Romania.

The institution's tradition, developed over 200 years, is preserved through a continuous process of modernization.

The mission of the POLITEHNICA University of Bucharest was conceived as a combination of education, research, and innovation, representing the key to a knowledge-based society and economy.

What is a PocketQube?

A PocketQube is a miniature satellite for various altitude experiments. It has a cubic shape with a side length of 5-10 cm and weighs no more than 250 g. The electronics are usually purchased and assembled to fit the available space requirements in the rocket. To date, 43 satellites have been launched, a number that is continuously increasing, given the high interest shown by student teams from around the world.

The educational goal of the competition

Throughout the PocketQube competition, high school teams will go through all the phases of a real space project, from choosing the secondary mission, designing the satellite, integrating electronic components, testing systems, flight preparation, to processing experimental data. Throughout this process, students:

- Learn by putting theoretical information into practice;
- Engage with the industry and solve common engineering problems;
- Learn to coordinate and work in a team;
- Apply concepts and knowledge from various fields (physics, programming, mathematics).





COMPETITION TIMELINE AND DEADLINES

Faza 1 - Proiectarea teoretică a PocketQube-ului	
Înscrierea echipei și atașarea tuturor documentelor	30 MAI - 10.00 24 IUNIE - 23.59
Anunțarea echipelor eligibile pentru participarea la competiție	25 IUNIE - 10.00
Meet Q&A - DISCORD	2 IULIE - 10.00
Trimiterea Raportului Preliminar	15 IULIE - 23.59
Trimiterea Raportului Tehnic Final	26 AUGUST - 23.59

Faza 2 - Construirea PocketQube-ului	
Anunțarea echipelor eligibile pentru finanțarea proiectului	7 SEPTEMBRIE - 10.00
Confirmarea participării	9 SEPTEMBRIE
Construirea satelitului conform Raportului Tehnic Final	14-16 OCTOMBRIE
Prezentarea sateliților în cadrul RoboChallenge	4-6 NOIEMBRIE

Faza 3 - Pregătirea de zbor	
Desemnarea celor 3 echipe câștigătoare	6 NOIEMBRIE - RoboChallenge
Integrarea în rachetă și testele de zbor	25-27 NOIEMBRIE
Lansarea ca payload în cadrul Project LUNA - 2Space	Se stabilește ulterior.



The Phases of the Competition

The entire competition is based on the participation of high school teams in all project phases. To progress to the next phase, all previous deadlines and requirements must be met. Thus, from team registration in the competition to satellite launch, each team goes through a rigorous selection process.

Phase 1 -> Theoretical Design

Phase 2 -> Actual Construction

Phase 3 -> Flight Preparation and Launch

Team Composition and Eligibility Criteria

For a team of students to be accepted in the competition, the following conditions must be met:

Each team must consist of 3 to 8 students, with one designated as the team leader.

- The students must be enrolled, at the time of registration, in a high school education program in Romania (grades IX-XII/XIII) or in a vocational school.
- The team may optionally have a guiding teacher.
- Students from different educational institutions can be part of the same team.
- Each student can be a member of only one team.

Teams are allowed to modify their composition by adding or replacing a maximum of one member, only during the first phase. This change should be communicated in advance via email.



Application and registering process

The registration for the competition will be done through the competition's website or by accessing the following link: <http://students.2space.ro/inscriere-qube2space.html>. After the eligibility of the teams has been verified, they will receive a confirmation email regarding their registration for the competition.

Documents required for registration (to be attached within the registration form): student certificate **or** grade transcripts.

1. The student certificate will be issued by the school's administration for all team members. If team members are from different educational institutions, then a student certificate from each respective institution will be required.
2. The grade transcripts must be endorsed. All transcripts will be scanned, ensuring the visibility of the endorsement, the student's photo, and their personal details, and they should be compiled into a single PDF file.

Completing the Form

- The designated team leader must complete the registration form.
- The requested documents must be uploaded in PDF format only.
- The form can be completed on the platform and submitted only once.



MISSIONS

1. Primary mission

The team is required to design and program a PocketQube to fulfill the following primary mission: Measure the following parameters throughout the entire flight:

- Atmospheric pressure
- Acceleration on three axes

The acquired data must be stored on an SD card in either ".csv" or ".txt" format, with a minimum sampling frequency of 5 Hz. After the flight, the team will need to analyze the data (e.g., calculate altitude using the measured pressures) and generate graphs based on the obtained data (e.g., acceleration on axes as a function of altitude).

2. Secondary mission

The secondary mission of the PocketQube is at the discretion of the team. They can draw inspiration from real satellite missions, collect scientific data for a specific project, or demonstrate a technology. Teams are responsible for selecting the main objectives, constraints, and functionalities, thereby defining their own secondary mission. Participants are free to conceive an objective as long as they can demonstrate its scientific, technological, or innovative significance. Teams must consider the limitations and requirements of the PocketQube mission and its feasibility (both technically and administratively, regarding time and budget).



PHASE 1 -> THEORETICAL DESIGN

In the initial phase, teams will be required to prepare a preliminary technical report and a final technical report that will outline their idea, execution plan, necessary components, and all details related to the project implementation. These reports will serve as the differentiating factor among the participating teams and will determine the selection for the next stage. The role of each report is to closely monitor the progress of the teams and assess technical accuracy, providing continuous feedback.

Each report must be written in Romanian, using Arial font, size 12, and submitted as a scientific paper in PDF format. The limit for the preliminary technical report is a maximum of 10 pages, and for the final technical report, it is 25 pages.

Preliminary Technical Report

Preliminary Technical Report The purpose of this report is to provide feedback to the teams regarding their ideas in the preliminary stage. It must be submitted by July 15th, 23:59, to the contact email address contact@students.2space.ro. Teams failing to submit the document by the indicated date will not receive bonus points in this stage.

The Preliminary Technical Report must include:

- Abstract
- Introduction
- Primary and secondary mission
- Proposed methods for implementing functionalities
- Required equipment
- Steps necessary for project completion
- Block diagram
- Conclusions



Final Technical Report

This is the final version of the technical report, which will contain all the details related to the development of the PocketQube that need to be followed in the second stage.

The Final Technical Report must include:

- Abstract
- Introduction
- Primary and secondary mission
- Proposed methods for implementing functionalities
- Required materials
- Required equipment
- Project implementation steps
- Hardware limitations
- Block diagram
- Circuit schematic
- Functional diagram
- Testing 3D renderings (optional for extra points)
- Used code (if applicable)
- Conclusions

Along with the final technical report, teams will submit a document in xlsx format containing the list of required materials. In case 3D printing of a component is desired, the g-code file for its production should be included.

Pre-printed components are not allowed. All components will be printed before the competition using PET-G material and will be provided to the teams along with the other components. If a team wishes to have a component printed after submitting the final technical report, they will be penalized.

An appendix will include a sample structure for the Preliminary Technical Report, which can be used by the teams. Subsequently, the Final Technical Report of each team will be posted on the official competition platform. A template for the xlsx document with the required materials will also be provided, which all teams must adhere to.



Budget and Component Acquisition

The components will be purchased by the Politehnica University of Bucharest, and they must fit within a budget of 160 euro. The procurement of these components will take place within 30 days from the team's acceptance in the funding phase.

For each component used, links from two distributors must be provided. The products can only be purchased from one of the mentioned sources. Additionally, the prices for budget compliance must match those provided in the links. It is recommended to purchase the components from the same supplier. Only parts strictly used within the project can be procured.

Electronic Components Suppliers:

International:

Farnell: <https://www.farnell.com/>

DigiKey: <https://www.digikey.ro/en>

TME: <https://www.tme.eu/>

Romania:

OptimusDigital: <https://www.optimusdigital.ro/ro/>

Cleste.ro: <https://cleste.ro/>

Sigmanortec: <https://www.sigmanortec.ro/>

Emag: <https://www.emag.ro/>

PCB manufacturi:

JLCPcb: <https://jlcpcb.com/>

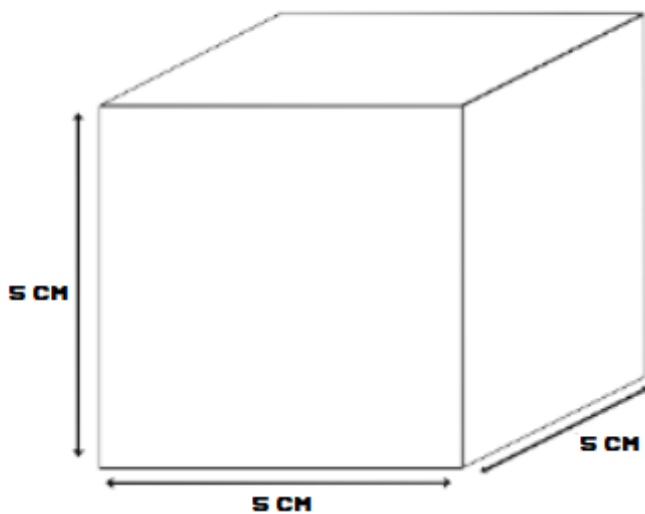
PCBWay: <https://www.pcbway.com/>



PHASE 2 -> ACTUAL CONSTRUCTION

In the second phase of the competition, students will construct the PocketQube, adhering to the Technical Final Report prepared by themselves. It must meet specific technical requirements of the competition and comply with all safety measures. The Technical Final Report will serve as a guide during this phase, and based on it and the construction experience, a final presentation will be obtained.

CERINȚE POCKETQUBE



Mass: maximum 250g;
p: 5cm x 5cm x 5cm;
U: 10cm x 10cm x 10cm.

A PocketQube is composed of one or more P-Units. The maximum dimensions accepted in the competition are those of a single P-Unit. Additional points will be awarded to teams that manage to fit within a single P-Unit.

Satellites that do not conform to the PocketQube standard will be penalized. For example, a satellite with dimensions of 5cm x 5cm x 7cm will be penalized, whereas a satellite with dimensions of 5cm x 5cm x 10cm will not.



- Each PocketQube will contain an audible signal (mandatory) and an optional visual signal to verify if it is powered on.
- The power supply will be provided from outside the PocketQube through a locking connector, with polarity clearly marked. The PocketQube must be able to operate with supply voltages ranging from 6-8.4V, with a maximum current usage of 500mA.
- Ground radio wave transmission is only permitted in the 33cm wavelength band
- The use of hazardous materials such as explosives, significant quantities of radioactive materials, or lead is not allowed.
- The PocketQube must not in any way affect the rocket's flight or communicate with it.
- Harmonic signals in the 430-440 MHz or 1.2-1.7 GHz band are not used to avoid interference with onboard rocket equipment.
- Data recovery must be ensured in the event of a forced shutdown by disconnecting the power source.
- The possibility of satellite ejection for bonus points is allowed.

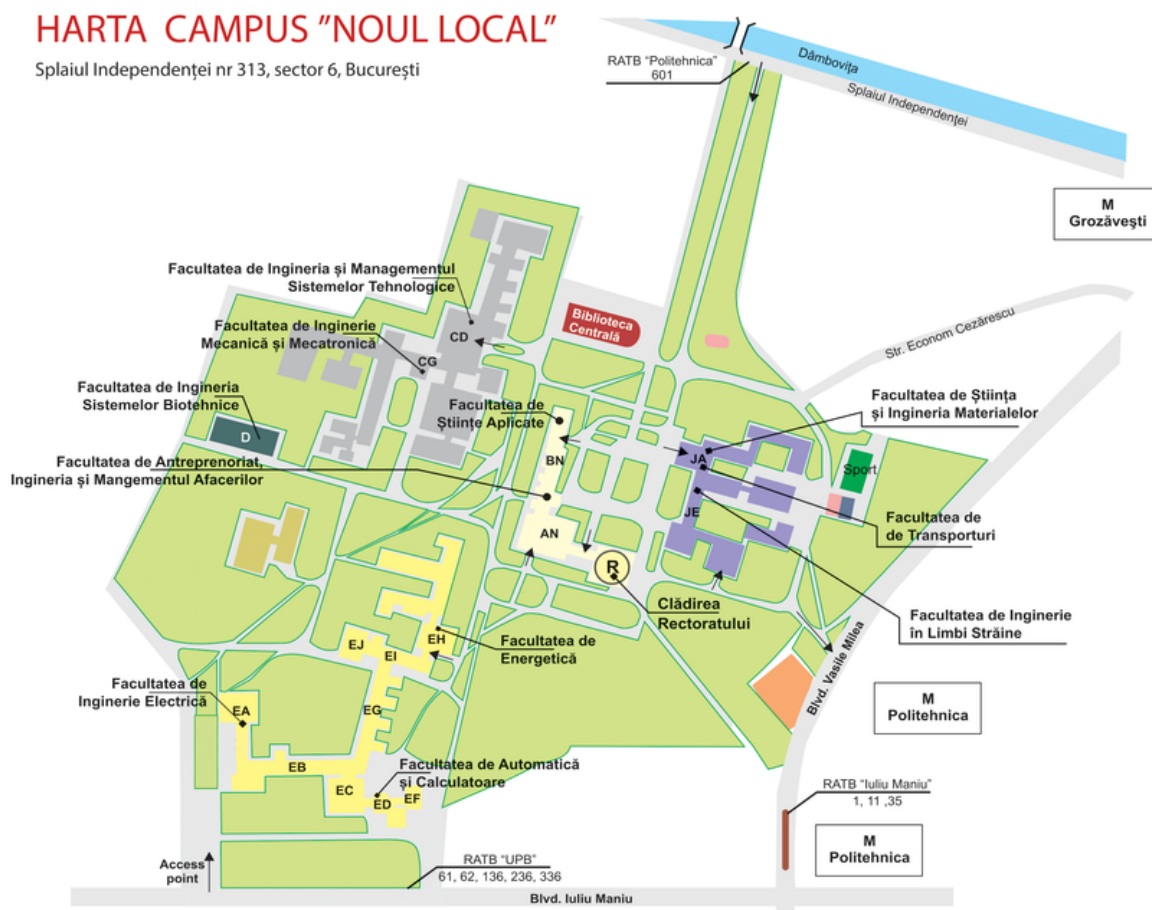


Event details

On November 3rd, the presence of all qualified teams at the campus of the University Politehnica of Bucharest is mandatory. Individuals who do not reside in Bucharest will be accommodated in the UPB dormitories within the complex. Access is facilitated by the Grozăvești metro station. During the competition, students will have the opportunity to purchase meals during meal breaks at the university canteen (one meal costs approximately 15 lei). Teams accompanied by coordinating teachers may, if desired, visit nearby areas such as Carrefour Orhideea, Mall AFI Cotroceni, and Mall Plaza Romania.

For more efficient orientation of students within the UPB campus, the following links are provided:

- Complex Regie: <https://maps.app.goo.gl/YcKWxjmRwtHj9ch9A>
- Biblioteca UPB: <https://maps.app.goo.gl/mnNSqU7oeu4htyUt5>
- Aula UPB: <https://maps.app.goo.gl/yekTn9uezEP1Tkmk9>





Construction

The construction will be carried out until November 5th, 2:00 PM, according to the provided schedule, using the supplied equipment and included parts. The addition of additional components is not permitted. The projects will be built strictly by team members without the assistance of coordinating teachers.

Final Presentation

Each team will have a designated booth at RoboFest starting from November 5th, where they can display informative and promotional materials such as flyers, roll-ups, stickers, etc. Through these materials, teams will present their projects to the students and participants at RoboFest, as well as promote their team/school of origin.

Members of the jury will visit each booth, where the projects will be presented, and they will have the opportunity to ask questions to the team members.

On November 6th, after all jury members have evaluated the projects, the award ceremony will take place, where the top 3 winning teams will be announced. These teams will proceed to Phase 3 of the competition - Flight Preparation and Launch.



Schedule QUBE2SPACE

Thursday 3rd November

09.00 - 13.00 Arrival of Participants - Regie Complex

15.00 - 16.00 General Briefing - Safety Training - UPB Library

16.00 - 20.00 Workshop - UPB Library

Friday 4th November

09.00 - 13.00 Workshop - PUB Library

13.00 - 14.30 Lunch Break - PUB Cafeteria

14.30 - 18.00 Workshop - PUB Library

18.00 - 19.00 Opening Ceremony - AULA of PUB

Saturday 5th November

09.00 - 17.00 Debugging Session - Expo Zone Hall

15.00 - 17.00 Jury Evaluation - Expo Zone Hall

Sunday 6th November

09.00 - 13.00 Jury Evaluation - Expo Zone Hall

14.00 Award Ceremony

16.00 Closing Ceremony - AULA of PUB



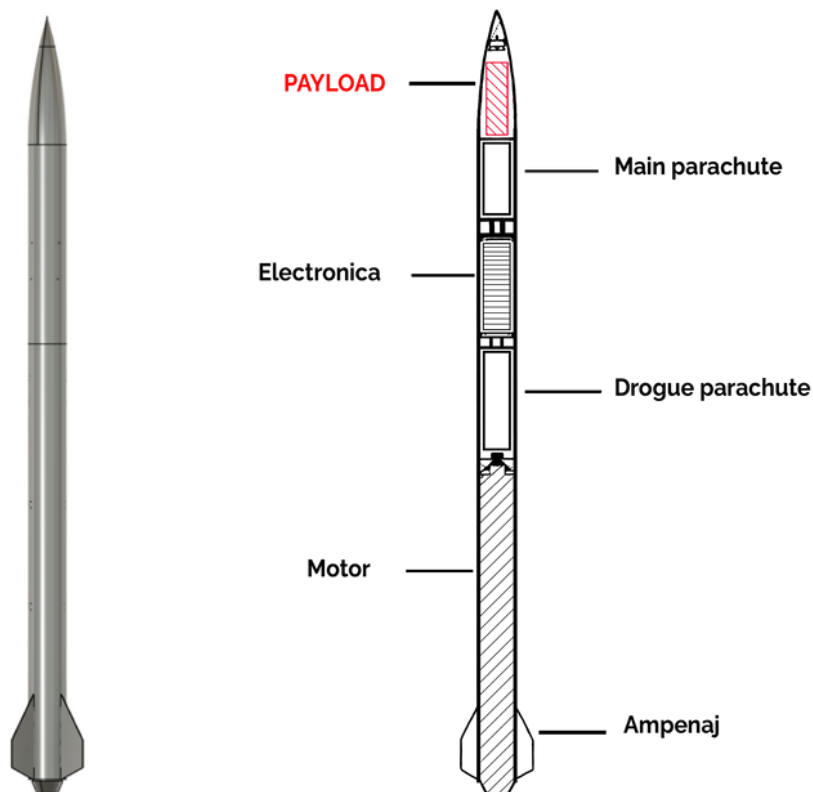
PHASE 3 -> FLIGHT PREPARATION AND LAUNCH

The three winning teams will have their PocketQubes launched as part of Project LUNA.

In the event that all three winning PocketQubes are ejectable, their ejection will be carried out. An ejectable PocketQube is a PocketQube that can be ejected and recovered. The ejection and landing system will be built by the 2SPACE team together with the competition winners, if applicable.

Prior to rocket launch, the PocketQubes will be prepared alongside members of the 2SPACE team to ensure they are ready for launch and integrated into the specially designed payload module. This module will be placed inside the rocket's cone, where it will remain throughout the flight.

The PocketQubes will be powered on a few minutes prior to launch and will be shut down either after the recovery of the rocket or automatically upon completion of their respective missions (preferably).





Rocket specifications



The purpose of the LUNA rocket is to fly to a predetermined altitude, with parameters of interest being measured using onboard sensors. The rocket is composed of three structural sections:

- Lower Section - motor support;
- Upper Section - contains the recovery system and electronics;
- Nose Cone - where the payload is mounted.

Characteristics:

- Apogee: 9000 m;
- Ascent time: 45 s;
- Motor burn time: 7 s;
- Flight duration: 11 min 30 s;
- Maximum acceleration: 110 m/s^2 ;
- Vertical speed (maximum): 2300 km/h;
- Rocket length: 2.5 m.

During the flight, there will be no extreme temperatures or significant temperature variations.



Scoring and Awarding

Jury

The jury appointed by the Politehnica University of Bucharest will consist of professors from the Politehnica University of Bucharest and representatives from the 2SPACE team who will evaluate the teams' performances. The jury members assess the teams during each phase and announce the results at the end of each phase. The jury will be composed of 5 members, and their areas of expertise range from science to engineering and applicability

Comitetul juriului este format din:

- representative professor from the Faculty of Aerospace Engineering;
- representative professor from the Faculty of Automatic Control and Computers;
- representative professor from the Faculty of Electronics, Telecommunications, and Information Technology;
- representative from Politehnica University of Bucharest;
- a representative from the space industry;
- Leader of the 2SPACE team

The judging process will take place in two stages, after the first and second phases of the competition

- **Stage 1:**

After the **theoretical design phase**, the final technical reports must be submitted no later than **August 26th, 23:59**. They will undergo the judging process, and on **September 7th**, the 20 eligible teams for the second phase will be announced.

- **Stage 2:**

After the **actual construction phase**, on **November 6th**, during the **RoboChallenge** competition, the completed projects will be presented, and following this judging stage, the three winning teams will be selected to advance to the final phase: **Flight Preparation and Launch**.



Stage 1

The performances will be evaluated based on the following criteria:

1. Scientific Relevance

Secondary Mission, chosen by the team members, must have a well-defined objective with scientific relevance, and the chosen method for data collection must be appropriate to ensure scientific relevance. The originality of the idea and its application method are also scored.

2. Feasibility

Teams must demonstrate the feasibility of the project from both technical and administrative perspectives, considering time and budget constraints. It is important to have well-defined and achievable execution steps within the established timeline. Additionally, certain margins should be considered to ensure that the team can successfully complete the project.

3. Technical reporting

The ability to create a readable and comprehensive preliminary report. Points are awarded for detailing the proposed methods for implementing functionalities, the necessary stages, required equipment, and block diagram.

3. Bonus points

Creativity and relevance of the two reports will be scored. Bonus points will be awarded only to teams that have submitted the preliminary technical report on time.

Grading scale

The ratio between the items to be evaluated is as follows:

1. Scientific Relevance - 30%
2. Feasibility - 30%
3. Technical Reporting - 30%
4. Bonuses - 10%"



Stage 2

The performances will be evaluated based on the following criteria:

A. Technical achievement

The jury will consider the technical methods by which teams have achieved their results, the reliability and robustness of the PocketQube, and how it functions. The innovative aspects of the project will be evaluated, such as the selected tools and the hardware/software used.

The evaluated aspects will be:

- **Mission Complexity:** The technical level of the PocketQube, understanding of technical aspects, and the originality of engineering aspects.
- **Mission Performance:** The technical performance of the PocketQube in terms of execution and data collection for the Primary Mission and the Secondary Mission.

B. The scientific value

The scientific relevance of the mission, the quality of the technical report (both written and oral), and the scientific understanding will be taken into account. These criteria will be evaluated based on the team's analytical capabilities and their ability to interpret the results appropriately.



The aspects to be evaluated will be:

- **Scientific Relevance:** The measurements will have a predetermined purpose, the extent to which the satellite is used in an original manner, and whether the data collection is appropriate for achieving the objective.
- **Technical Reporting:** The ability to summarize the final report clearly and provide a readable and comprehensive document, proper labeling of graphs, the use of correct units of measurement, and the ability to present and interpret data from a scientific perspective.

C. Professional Competencies

The aspects evaluated will be:

1. **Communication:** Oral presentation skills, the ability to deliver an engaging and visually appealing presentation.
2. **Scientific Understanding:** The level of understanding of the scientific principles underlying the project and its reflection in the technical report and presentation.

Grading scale

The ratio between the items to be evaluated is as follows:

Realizare tehnică	35%
Valoarea științifică	35%
Competențe profesionale	20%
Cerințe opționale	10%
Total	100%



The awards

The awards will be given based on the following categories:

- **The best PocketQube project**
 - This award will be given to the team with the highest overall score;
- **Best Technical Project**
 - This award will be given to the team with the highest score in the "Technical Achievement" category, based on the submitted technical report;
- **The most remarkable scientific mission**
 - This award will be given to the team with the highest score in the category of 'Scientific Value'.

***Special mentions**

- The jury may award a limited number of special mentions if they consider that certain teams have put significantly more effort compared to others.

Misconduct, disqualification

- A team may be disqualified if it is discovered that its members are not students (enrolled in a high school).
- Copying the project from the internet results in the disqualification of the team.
- Purchasing a pre-built, pre-designed electronic assembly from the internet without the team's contribution leads to disqualification. The team's work is verified by attaching photos/videos in the project documentation, in the Final Technical Report.



The awards

Some of the prizes will be awarded by our sponsors, and Politehnica University of Bucharest will provide prizes consisting of kits and promotional materials.

The three winning teams will be rewarded with the opportunity to have their PocketQubes integrated as payloads into the Luna rocket assembly, which will fly at a later announced date.

Mentions:

- A team can receive only one prize;
- If a team achieves the highest scores in multiple categories, the award corresponding to the category with the most points in the Scoring Scale (Best Technical Project or Most Outstanding Scientific Mission) will be awarded. . In the event that a team has the highest score in both categories, the prize awarded will be for the one with the greater difference in score to the last team.



Personal Data Protection

1. The personal data belonging to the participants (such as name, surname, phone number, email address) will be the responsibility of the Organizer to be registered, stored, organized, and processed in accordance with the competition and the present regulations. The consent of the participants is necessary for the processing of their data by the Organizer's partners.
2. The Organizer is obligated to comply with the legislation regarding the protection of personal data. During the competition, the Organizer will maintain the confidentiality of participants' personal data and will use it in accordance with the regulations and applicable laws.
3. Law 190/2018 on the protection of personal data and the free movement of such data ensures the following rights to the participant: the right to be informed (Art. 12), the right of access to data (Art. 13), the right to intervene on the data (Art. 14), the right to object to data processing (Art. 15), the right not to be subject to an individual decision (Art. 17), and the right to seek legal remedies (Art. 18).
4. The organizer undertakes, upon request sent to the email address contact@students.2space.ro, to: 1. Inform the applicant, free of charge, about the personal data being processed. 2. Align the processing of personal data with Law No. 190/2018 on the protection of individuals with regard to the processing of personal data and the free movement of such data, rectify, update, or delete data in accordance with the law; and/or 3. Cease the processing of personal data upon request.
5. By registering for the competition, the participant acknowledges and agrees that their data will be shared with the partners of the 2SPACE Association.



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