

Scientist of Utopia

Description:

“**Scientist of Utopia**” is a prestigious case study competition organized by Technex, the annual technical fest of IIT BHU.

The competition consists of two rounds: the first round is conducted online, and the second round takes place offline at IIT BHU.

Event Structure:

The event consists of two rounds:

Round 1: Each team will work on the case study and submit their solutions online. The submissions will be judged based on the Quality of analysis, innovative solutions proposed, and the depth of understanding demonstrated. Teams with the most promising submissions will qualify for the second round.

Round 2: This will be an offline event in which contestants will be asked to present and defend their solutions in front of the judges. This round will test contestants' ability to articulate their ideas, respond to questions, and defend their solutions effectively (Ps: Be prepared for some new questions one can ask related to your solution). The judges will evaluate the presentations based on clarity, coherence, depth of understanding, and the feasibility of the proposed solutions.

Eligibility:

1. All students from authorized institutions are eligible to participate.
2. The Team Size limit is a maximum of 3. The participants in a team may be from the same or different institutions and programs.
3. Participation is restricted to college and university students only.
4. Bring a physical ID card, which is compulsory for all college students.

Introduction

In the utopian realm, the Utopians have pioneered groundbreaking research in energy innovation, specifically harnessing energy from a mini-universe—a pocket dimension with exotic properties enabling the extraction of limitless power. However, this experimental endeavor was housed within a secure facility on the moon's surface but was destabilized during an accident, and the endless energy presents a multifaceted challenge that threatens the stability and harmony of Utopian civilization.

Firstly, the Utopians observe the emergence of the Celestial Nexus, an enigmatic force in space that disrupts the orchestrated dance of planets and stars, causing gravitational anomalies akin to a celestial carnival ride. This unprecedented phenomenon leads to erratic planetary movements and gravitational fluctuations, destabilizing the cosmic order and posing risks to Utopia's home planet and surrounding celestial bodies. Complicating matters further, the Utopians detect the approach of a black hole towards their solar system. This gravitational behemoth exerts a powerful influence, particularly affecting their planet's orbit around their star, leading to destabilization and potential ecological ramifications due to tidal disruptions and gravitational anomalies.

The Utopians initiated a comprehensive Space Mission to navigate this complex crisis, deploying a state-of-the-art spacecraft with advanced instruments and technology. Tasked with investigating the Celestial Nexus, mitigating gravitational anomalies, and safeguarding the mini-universe facility, this mission embodies the Utopians' resilience, ingenuity, and determination to preserve their civilization's harmony and prosperity. As cosmic detectives in a rapidly evolving celestial landscape, the Utopians embark on a perilous journey to restore balance, confront existential threats, and transcend the boundaries of scientific exploration. Help Utopians in their crucial journey to safeguard their planet's future.

PROBLEMS

Question 1:

After many trials and attempts to understand the “new” gravity, the utopians unraveled the fluctuations that are occurring in gravity, which have the following implications for Earth’s gravity:

$$g_e(t, r) = G M_e / r^2 + A \cdot \cos(\omega t),$$

To further understand this nexus event, the utopians assumed the following modified equation for black holes as well:

$$g_b(t, r) = G M_b / r_s^2 + B \cdot \cos(\alpha t)$$

(t is time, r_s is Schwarzschild radius, r is the earth's radius, and B , α , A , and ω are constants)

Utopians-initiated observations (all in SI units) around a black hole, as its gravity engulfed a star into itself, and the obtained results deviated from their expectations. The discrepancy raises questions about the accuracy of the chosen equation, prompting further exploration into the factors influencing gravity around the black hole.

Time(t) in seconds	Radius $r \cdot 10^4$ in m	Gravity $g \cdot 10^{14}$ of black hole
0	1	26.696
50	2	10.374
75	3	1.9662
100	4	5.3685
125	5	0.06784

Help the utopians start their journey by:

- Determining the factors that are causing unexpected outcomes in data. (Hint: masses other than black hole will have their component as well).
- Derive the correct equation for the black hole, with the values of all constants in it.

(Use $G = 6.674 \cdot 10^{-11}$, and mass of blackhole = $4 \cdot 10^{33}$, all in SI units)

Question 2:

As the utopian mini-universe energy generator is on halt, there is insufficient energy to power the earth for a long time, and see it getting ruptured by the approaching black hole. One can only assume that a power source exists, i.e., one huge enough to reignite their lunar facility and continue energy production. The extraordinary amount of energy used to fix the lunar base during this event possibly comes from the following origin: It can be the gravitational potential energy of the matter falling toward the approaching black hole during accretion or a gravitational collapse. The utopians are thinking of taking their chances to make usable energy out of anomalies caused by approaching black hole. Help the utopians by providing your means of harnessing energy through different theoretically possible ways, from gravitational collapse or gravitational waves of mini-universe (Take necessary assumptions).

Question 3:

While scientists progress on harnessing energy for the facility, the gravitational anomaly poses another peril. The moon landing is now quite a peculiar and delicate task to execute due to changed gravity.

Help the scientists to determine:

- a. The escape velocity for the rocket.
- b. The newly established moon orbit around the Earth (take necessary assumptions).
- c. List some necessary upgrades or precautions in the “old” gravity spacecraft, as changed gravity can cause some danger for humans and spacecraft as they enter space for the first time in the changed environment.
- d. As the shuttle approaches the L_1 (corresponding to Earth and Moon), the sinusoidal component of gravity has great implications. Suggest some ideas to overcome this difficulty.

Question 4:

As the lunar facility is currently shut down, it needs to reignite, and to turn it on; we will need its password.

The last time when the facility was turned on February 28, 2081, at 08:29:19 (28-02-2081/08:29:19), the password was a string:

“STX_w-NUL_}-STX_DEL_BS_~/NUL_w:STX_v:SOH_v”

The scientists plan to restart the facility on December 31, 4354, at 16:57:55:627 (31-12-4354/16:57:55:627). The encryption for the password is more sophisticated this time. Can you assist the utopian scientists in decrypting the password string for the upcoming restart?

INSTRUCTION FOR SUBMISSION:

1. A maximum of three members can participate in a team.
2. Intercollege teams are allowed.
3. The First Round deadline for submission is 10th March 2024. (**tentative**)
4. Participants must register on the Technex Website, and the solutions should be submitted in the format mentioned below through the unstop portal: [Here](#)
5. The solution should be submitted in PDF format only. The file's name should be UTOPIA#1_ <TEAM_NAME>_SOLUTION. The language should be ENGLISH only.
6. The decision of the judges shall be final and binding.
7. The Timings for Round 2 will be from 15th March 2024 - 17th March, 2024. (**tentative**)
8. The submission format should be as follows:
 - The team's name, details of team members (name, contact number), and college name should be mentioned on the first page.
 - Solutions should be brief and to the point. The challenges encountered should be mentioned. Any figures, diagrams (well-labeled), and charts mentioned should be properly referenced in the text.
 - If you feel the figures, diagrams, and/or charts are losing detail while scaling down in PDF, make a ZIP or RAR file with the solution. The file should be named the same as the PDF and submitted to info.astronomyclub@gmail.com. Highlight the innovation in your solution.
 - The solution should not exceed ten pages.
9. Problem Statement is subject to changes.

EVENT COORIDNATORS:

Madhav Bansal : +91 7017816416

Sanskar Singh : +91 7905400186

*Event organisers have the authority to do amendments in rules and PS