Beyond Gravity Very Low Earth Orbit mission:

Exploring the Frontier: Engineering Challenges and Opportunities in Very Low Earth Orbit (VLEO)

Very Low Earth Orbit (VLEO), typically defined as altitudes below 300 km, represents a promising yet demanding frontier for satellite operations. While VLEO offers advantages such as improved spatial resolution for Earth observation and reduced latency for communications, it also introduces a suite of complex engineering challenges that differ significantly from those encountered in conventional Low Earth Orbit (LEO).

This study project invites students to investigate the unique physical and operational constraints of VLEO, focusing on altitudes between 250 and 300 km with a satellite in the order of 150 to 250 kilograms. Key areas of exploration include:

- **Orbital Drag and Decay:** At these altitudes, atmospheric drag is significantly higher, leading to rapid orbital decay. Students will quantify the required thrust and total impulse for orbit maintenance, assess the impact of drag on attitude control due to asymmetrical aerodynamic forces, and explore propulsion strategies for sustained operations.
- **Atomic Oxygen (ATOX) Effects:** The high concentration of atomic oxygen poses a serious threat to spacecraft materials. The project will evaluate material compatibility, investigate the need for protective coatings or shielding, and identify design strategies to mitigate ATOX-induced degradation.
- **Aerodynamic Influences:** Unlike higher orbits, aerodynamic forces begin to play a non-negligible role in VLEO. Students will assess whether aerodynamic shaping can meaningfully reduce drag and explore design features that could enhance orbital longevity and stability.
- **Thermal Environment:** The thermal dynamics at VLEO differ due to increased atmospheric density and proximity to Earth. The project will analyze thermal variations and propose thermal control strategies suitable for this regime.
- **Additional Considerations:** Students are encouraged to explore other relevant factors such as plasma interactions, increased collision risk with debris or atmospheric particles, and implications for communication systems and sensor performance.

The goal is to develop a comprehensive understanding of the VLEO environment and propose innovative solutions to enable sustainable and efficient satellite operations in this challenging orbital regime.

For this project one or multiple payloads should be chosen by the student team. The choice of payload should be made in such a way that it can take advantage of the increased resolution that a very low earth orbit offers.