<u>Problem Statement-2</u>

[Two body robotic interaction]: Symbiotic Aerial-Ground or Aerial-Aerial Autonomous System (SAGAS or SAAAS)

I. Problem Statement **SAGAS**

Design a cooperative system consisting of a terrestrial rover and an Unmanned Aerial Vehicle (UAV). Teams must design these two distinct platforms to function interdependently in a complex, obstacle-rich environment. The system must overcome the inherent limitations of each individual platform—specifically, the limited line-of-sight of the rover and the restricted battery life of the drone—by establishing a symbiotic relationship featuring collaborative mapping and dynamic, mobile (drone on ground vehicle) docking, and as a bonus challenge, recharging.

II. Tool (not restricted to the following) may be required

Mechanical & Robotics Engineering: Design and fabricate a rover suspension capable of traversing within IITK. Concurrently, design a robust, precision docking mechanism on the rover to facilitate aerial "hitchhiking" and secure transport of the drone.

Computer Science & Artificial Intelligence (CV/AI): Develop and implement a "Collaborative SLAM" (Simultaneous Localization and Mapping) architecture. The drone must act as an elevated sensory node, relaying aerial topographical data to the rover to optimize ground pathfinding and obstacle avoidance.

Electrical Engineering: Architect low-latency, high-bandwidth data links between two independently moving platforms. Furthermore, teams must design a highly efficient power management and distribution system capable.

Aerospace Engineering: Program flight controllers to ensure precise drone stabilization, spatial awareness, and the aerodynamic adjustments required to autonomously land on a mobile, dynamically moving ground target.

This project mandates a fully "Symbiotic" robotic ecosystem. Teams must demonstrate Dynamic Docking: when the drone's power reserves reach a critical threshold, it must autonomously track, land on, and secure itself to the moving rover to recharge (utilizing the ground unit as a mobile power bank). Conversely, when the rover encounters a navigational blind spot or impassable barrier, the drone must autonomously launch to scout and map a bypass route. This collaborative interdependency represents the current frontier of field robotics research.

Edge Computing: deploying computationally heavy AI and machine learning models directly onto resource-constrained edge hardware (e.g., NVIDIA Jetson, Raspberry Pi).

Prototyping & Fabrication: Workshop and makers space will be available for project teams.

III. Final Deliverables & Evaluation

Comprehensive Systems Architecture Report: Detailing mechanical CAD, wiring schematics, Collaborative SLAM algorithms, simulation demo (midterm evaluation after 6 months)

Endterm evaluation: Live Working Prototype Demonstration at IITK air-strip

A physical trial demonstrating the system's ability to navigate using aerial-assisted pathfinding, culminating in a successful autonomous dynamic docking and recharging sequence.

I. Problem Statement **SAAAS**

Every thing remains same as SAGAS except here two body robotic interaction is between two drones.

One drone-"B" will be carrying heavy payload (1kg), thus can travel only specific distance. Another light-weight drone-"A" will be carrying only battery packs (no other payload) which can be exchanged on this drone autonomously.

Exchange of batteries should happen safely, i.e. earlier discharged battery from "B" should be carried back by "A" after replacing it with charged battery.

This exchange operation may happen air-to-air (will carry extra points for this) or may happen on ground after landing the drones, but it should be autonomous.
This will help to extend the range of “B” beyond limits as similar pairs can be bootstrapped to create battery delivery to extremely long distances.

Choose any one task in this problem statement either SAGAS or SAAAS