# I\_MIM Mission Concept

The main objective of the International Mars Ice Mapper (I-MIM) mission concept is to identify and characterize near-surface water ice reservoirs on Mars. The primary payload, an L-band Synthetic Aperture Radar (SAR), is designed to map mid and low latitudes on the surface of Mars to map these reservoirs, supporting future planning of human missions to Mars.

The reflector that is placed at the end-effector of the space manipulator can also be used to establish telecommunications with Earth’s ground stations. This configuration provides high download data rates. The objective of this exercise is to design a space robotic manipulator that is capable of pointing the reflector towards the Martian surface and to the Earth by keeping the spacecraft body frame nadir pointed (e.g., 𝒁̂𝑺𝑩𝑭 towards the surface). This dual mode is fundamental in supporting the off-nadir pointing of the SAR required to map the ice reservoirs, and to download the data.

# Orbit design

## Objective

The objective of the first part of this exercise is to choose an orbit that is well-suited for the purpose of the I-MIM mission. Considering the coverage required by the mission (map all latitudes included between 25° N/S and 40° N/S), choose a set of orbital parameters that satisfies the science requirements. For the chosen orbit, provide:

1. The semi-major axis 𝑎
2. The eccentricity 𝑒
3. The inclination 𝑖
4. The argument of pericenter 𝜔
5. The right ascension of the ascending node Ω
6. Time series of the spacecraft attitude matrix for nadir pointing
7. (Optional) determine the time required to meet the coverage requirement

## Theoretical approach

## Code implementation

## Results

# Manipulator design

## Objective

The second part is to design a two-link manipulator that enables the science operations of the SAR. The assumed strategy is to collect data for one orbit, and to download data to Earth in the following orbit. Design a manipulator that allows an off-nadir (𝜂=15°) pointing of the array when collecting data, and to point the antenna to the Earth to download the data. The spacecraft attitude must be fixed during these operations. Assume that the AOCS subsystem of the spacecraft keeps the attitude nadir pointed by compensating the torques generated by the manipulator links. Address the following tasks:

1. Model the manipulator by using the Denavit-Hartenberg formulation.
2. Determine the Jacobian and the dynamical equations.
3. By assuming that the manipulator is initially fully stretched (𝜃1 = 𝜃2 = 0), determine the trajectory of the end-effector that enables a constant pointing of the instrument to T (i.e., off-nadir or Earth pointing orientation) from its initial position 𝑃0 to 𝑃𝑓.
4. Determine a control scheme of the manipulator that allows fulfilling the desired trajectory retrieved in point 3, by assuming that the atmospheric drag force is acting on the end-effector (assume that the antenna diameter is 8 m). The atmospheric drag can be computed by retrieving the atmosphere density from http://www-mars.lmd.jussieu.fr/mcd\_python/. The drag force can be assumed to be constant.

## Theoretical approach

## Code implementation

## Results

# Virtual manipulator

## Objective

Assuming that the AOCS subsystem does not compensate the torques generated by the manipulator links:

1. Model the virtual manipulator by assuming a spacecraft mass m = 500 kg.
2. Determine the trajectory of the end-effector for the virtual manipulator.

## Theoretical approach

## Code implementation

## Results

# Bibliography