# Minimal Fuel Landing Problem: Optimal Control

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## BACKGROUND.

One of ISRO's research goals is to optimally lower spacecrafts on the moon and mars. Scheduling thrust vs time, to minimize fuel used, is an 'optimal control problem' (OCP).

For Aerospace applications, the minimum fuel landing and the minimum time space attitude maneuver is essential.

Existing ways of solving OCPs are:

- Simplify the problem for analytical implementation.
- Apply convex optimization which is fully iterative in nature.

In this work we are interested in combining the best of both the worlds using data obtained from high fidelity simulation.

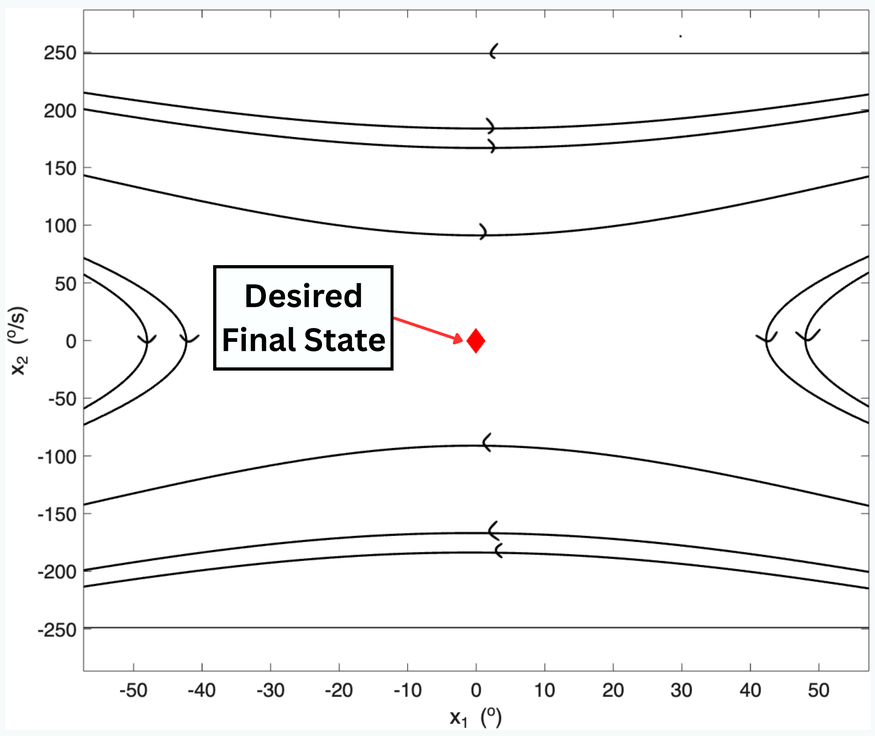
## Goals

- **Solve high dimensional problems**
  - The curse of dimensionality cripples some methods. Using Physics-Informed Machine learning we can minimize that limitation.
- **Use of the Extreme Theory of Functional Connections (X-TFC)**
  - X-TFC uses a pretrained solution to give an initial approximate solution.
- **Constrained Controller**
  - The X-TFC model learns a solution that only commands achievable values of thrust.

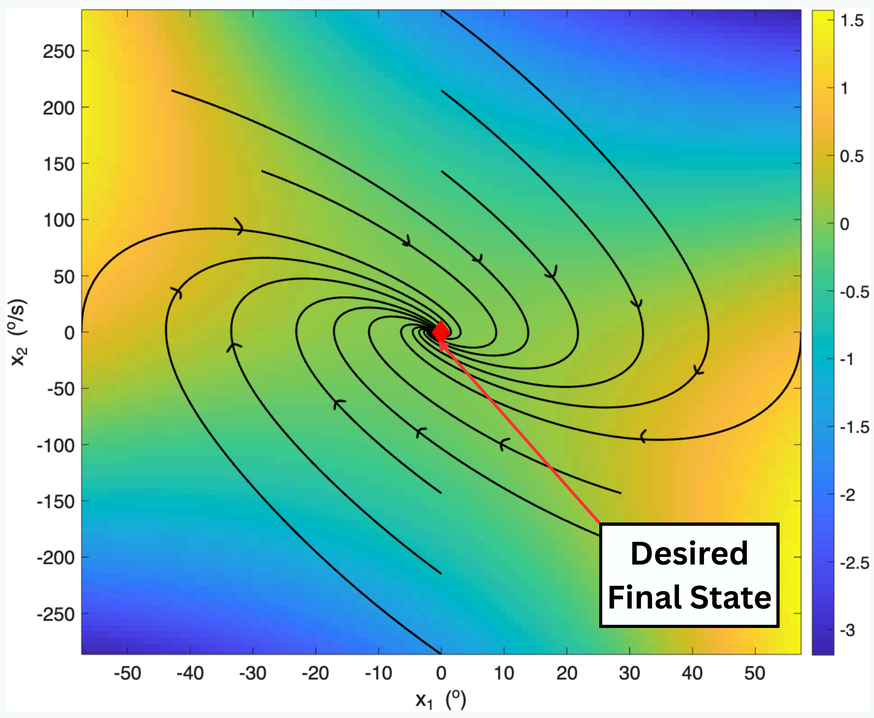
## Results using a simpler model problems

### Inverted Pendulum Problem:

**Unstable Uncontrolled Phase Plot:**
(Unstable Uncontrolled Trajectories)




**Controlled Phase Plot with 'Value Function' (Colored):**




Method works for Spacecraft Detumbling Problem.

Further Plans:

- Spacecraft Attitude Control Problem
- Minimum Fuel and Minimum Time Landing Problems