AME 250
Spring 2023
Term Project

Achieving Weightlessness in a Plane for Astronaut Training

Astronauts experience weightlessness during space missions, and it is essential to prepare them for the experience beforehand. One way to achieve weightlessness on Earth is by using parabolic flight maneuvers. In this project, we will explore the dynamics of parabolic flights and how they can be used to simulate weightlessness for astronaut training.

Objectives: The main objectives of this project are:

1. To understand the physics behind weightlessness and parabolic flights.
2. To analyze the motion of a parabolic flight using simple mathematical models and simulations.
3. To explore the design of parabolic flight trajectories for achieving weightlessness.

Methodology: The project will involve the following steps:

1. Literature review: Students will conduct a thorough review of the existing literature on weightlessness, parabolic flights, and astronaut training. The review will cover the physics and mathematics related to weightlessness.
2. Mathematical modeling: Students will use simple mathematical models to simulate the motion of a parabolic flight and the range of weightlessness achieved by such flights.
3. Trajectory design: Students will explore the design of parabolic (and optionally other) flight trajectories that can achieve weightlessness for various durations. They will consider factors such as aircraft speed, altitude, and maneuverability.

Deliverables: The deliverable for this project will be a written report, which will consist of the following sections and which will be graded on the scheme shown:

1. <u>Introduction and literature review</u> **(20 points)** (<u>assessment tool for PI 1 and PI 2 of ABET Outcome 7</u>)
2. <u>Development of mathematical model(s)</u> **(30 points)**
3. <u>Implementation of mathematical model(s) and results</u> **(30 points)** (<u>assessment tool for PI 3 of ABET Outcome 7</u>)
4. <u>Conclusions</u> **(20 points)**

Assessment: The project will be assessed based on the following criteria:

1. <u>Quality of the literature review</u>: Sufficiency, validity of sources, proper and consistent referencing of sources, syntax, and grammar.

2. Accuracy and completeness of the mathematical model(s) used: Assumptions made, sufficiency, numbered and referenced equations, well-explained steps in derivation, typeset mathematical expressions, properly and consistently referenced sources, if any.
3. Accuracy and reality check of implementation results: Graphical representation of results (in particular, trajectory shapes, duration of weightlessness conditions within specified limits), comments on the reasonableness of the results, comparisons to other sources, if any.
4. Clear and concise conclusions statement: Statement of what was done and what was learned from this project.
5. Clarity and organization of the final report and presentation

Bonus points: Additional points will be awarded to reports that include one or more of the following:

1. Examination of non-parabolic trajectories or trajectories that do not match those found in the literature review; discussion of pros, cons, and feasibility of such trajectories.
2. Research-based or quantitative discussion of constraints on the trajectories that can be used (e.g. angles of ascent and descent, aircraft speeds, human endurance to acceleration and deceleration)
3. Research- or simulation-based suggestions on if and how trajectories may be improved (i.e. longer durations of weightlessness) with different aircraft characteristics.
4. Other related aspects relevant to the topic (should be discussed with instructor).