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Final Project - Team

Fall 2018

AME 457/557 – Orbital Mechanics and Space Flight

Due Friday, December 7, 2018 at 17:00 PM (MST)

This is a team project — ***collaboration with other teams is discouraged for this project****. It is permissible to use existing resources (computer programs/websites/books/notes) to check answers or help facilitate the solutions.* ***In any case, all collaboration and use of other resources must be properly acknowledged and described. Those who fail to adhere to this will receive a zero on the technical component of the project.***

Project Description . You are to develop software for orbital maintenance and transfer maneuvers, which will bring a satellite back to a nominal orbit after it has experienced perturbations from Earth's oblateness and atmospheric drag. The objective is to create an algorithm (e.g., MATLAB script files) that will implement a series of impulsive maneuvers that will bring the satellite back to a desired orbit.

The basis for this study is the Tiangong 1 Chinese Space Station. We will take the nominal orbit to be that at the observation epoch, and the impulsive maneuvers (to be designed by each team) are to be administered after a period of 30 days, during which time atmospheric drag has caused the initial orbit to contract and circularize, while Earth oblateness has rotated and precessed the orbital plane. You are to propagate Tiangong 1's orbit using codes previously developed (or those provided to you) for at least 30 days, and then implement the needed transfer maneuvers that will bring it back to the same orbital element set $(a, e, i, \Omega, \omega)$, where the actual position (dictated by f or M) is of no importance. The goal of this project is to minimize the total Δv needed to effect the transfer.

Input . The inputs to the software are:

1. For the orbit propagation part, you are to use the same inputs as before (with the correct B^*). Each team will use their own nominal set of orbital elements that were previously provided.
2. There are no other inputs. However, you may wish to code in the propagation time as an input, which influences the pre-transfer shape and orientation of the perturbed orbit (that is to be corrected with your maneuvers).

Output . The outputs to the software are:

1. The total cost of the sequence of maneuvers (in terms of total Δv).
2. Any other outputs that would demonstrate that your chosen sequence of maneuvers is fuel-optimal in some sense.

Structure . There is no specified structure, but your codes should be logical and all sub-functions should be called from a “main” program that also feeds in your specific inputs.

Final Poster . Present your results in a poster presentation format. Your poster should be similar to a a contractor’s presentation to a customer (e.g., SpaceX) that would serve as a “User’s Guide” for the orbital maintenance and transfer software, but also presents the TIANGONG 1 CHINESE SPACE STATION as a test case, with appropriate analysis provided. Your presentation should be self-contained, so that the reader can understand it without additional information not contained therein. It should be concise, thorough, clear, well organized, have good grammar, and provide sufficient technical background. It must be in PDF format and will be graded on these criteria:

- organization, presentation, and style (**30%**),
- technical merit and creativity (Does your code produce reasonable answers?! Did you demonstrate that your solution was optimal.) (**50%**),
- completeness (**20%**).

Technical Aspects . This is a design project, where you are to decide, based on the technical material presented in lecture, how to achieve the appropriate transfer. However, you might want to base your study not on a sequence of discrete maneuvers, but on a “Lambert solver”. This will more easily allow you to perform a parametric trade study, needed to show optimality.

Graduate Students . Graduate students are required to take the Lambert solver approach. You need not design your own Lambert algorithm, but can use open-source codes, which must be properly acknowledged.

Extra Credit (10 points) . Undergraduate teams who complete the “Graduate Student” task can receive up to 10 points of extra credit.

Important Note . You must submit your codes and poster in a single zip file (only one submission per group). All codes must be portable, must contain a main function that provides the inputs and calls the various subroutines. If they do not run properly on our machines, your technical scores will be docked 20% (that is, you are responsible for checking dependencies, paths, etc., to ensure portability). Finally, your slides must be converted into a single PDF file (PowerPoint or other formats will not be accepted), or you overall score will be docked 10%. Your code does not need to be appended to the PDF.