AE 146 Design Project
Part I Design Calculations
Due Friday May 23rd

Your design project will consist of two components: an orbit sequence design (Part I), and a rocket design (Part II). You will work in groups of three (11 groups total) – please come to see me if you are unable to find a partner. The total design project is to be presented to the class during the 10th week as a 10 minute PowerPoint presentation. You will turn in a copy of your slides for grading (on paper, not transparencies). Your presentation will consist of a formal report with several computer-generated plots. This document describes the Part I calculations, which are due on Friday May 23rd.

Your objective is to design the below rendezvous sequence. You may opt to minimize the time to rendezvous or the fuel needed (ΔV), please specify your choice.

This project includes an inclination change, orbit size change, rendezvous lead angle and timing calculations, and in-plane repositioning (twice). It is very challenging (Parts I and II combined constitute 20% of your total grade as a design in addition contributing to your homework score). It is recommended to take it seriously.

Specifications

1. You inject your space vehicle directly into a circular parking orbit of altitude 100 km. At burnout, your flight path angle is zero and your velocity is v_{bo}.
2. Even though you launched at the equator (line of nodes), you find that your orbit has an undesired 15-degree inclination in the geocentric frame and that your longitude of the ascending node, Ω, is 20^o. You will need to correct this inclination change so that you may rendezvous with a satellite in the equatorial plane. You need to decide if you should perform your plane change at 100 km altitude or at some other altitude.
3. Further, the satellite that you wish to rendezvous with is in GEO (35,860 km altitude with 0 degree inclination)
4. This target satellite was 40 degrees behind you at the time you entered your parking orbit of 100 km.
5. Your transfer(s) need not be a Hohmann, and you need not perform the maneuvers in the described sequence above (e.g., you can make an in-plane maneuver to 35,860 km and then perform your inclination maneuver, or you can split your inclination changes with altitude changes). You only need to justify your choice over other choices and make sure that you can achieve rendezvous.
6. You receive critical information (and hardware) from this satellite during rendezvous that you need to transfer to another satellite in GEO in order to prevent its catastrophic failure. The physical transfer will be remotely controlled with the use of robotic arms, and hence, you now need only to rendezvous with this second satellite that is 10 degrees in front of you, i.e., you need to perform in-orbit repositioning with $\Delta L=10^o$.
7. Finally, after making one complete orbit with this second satellite, you need to take your destined position in GEO, which is another 5^o ahead of this second satellite. Once this maneuver is accomplished, your mission is finished.

You will need to look specifically at the following issues:

a) investigate the total ΔV's for different schemes of changing the orbit plane, i.e., where the plane change maneuver should be initiated. DON'T JUST CHOOSE ONE SITUATION! INVESTIGATE SEVERAL AND JUSTIFY YOUR FINAL CHOICE!

b) investigate the different schemes for targeting below (i.e. find the total ΔV's and the total time required): Calculate the lead phase angle required for rendezvous. This will vary depending on the maneuvering that you have conducted prior to your final rendezvous maneuver. You need to keep track of the target satellite's position as you are performing your other maneuvers. Calculate the waiting time required before you achieve this phase relationship with the target satellite for various maneuvering scenarios.

Your final design choices will be used in Part II of the design project.

You will need to turn in your calculations (in homework format – not several loose sheets of paper with miscellaneous equations) and several neat graphs. They will be counted as a homework.

This is a group project, so you can either divide the responsibilities between each member of the group, or work as a team and each person do each part together. Either way, you will each receive the same score. If you divide the responsibilities, it is every member's responsibility to check their partners' work and make sure you agree with it.

Remember: DON'T JUST CHOOSE ONE SITUATION! INVESTIGATE SEVERAL SCENAIROS AND JUSTIFY YOUR FINAL CHOICE WITH SOME CONVINCING REASONING.