I Introduction

For the coding parts, numpy and matplotlib are the ones in charge of plotting the graphs and getting the necessary values.

For example, we found gravitational potential using formula 1 which was provided ,and then to graph it we use every point from -1.5 * the distance to the moon (Dm) to 1.5* Dm, and graph the resulting answer. The code in part 1.1 shows the user-made function of Gravitational Potential and fig 1.2 is the plotting of the function. Where X is 10^5 points starting from 0 ending at 1.5 * Dm, and fig 1.3 is a color plot showing how strong the gravitational potential is if Earth is at the coordinates 0,0 however all graphs from now on will have the points used range from -1,5* Dm to 1.5Dm.

II The gravitational potential of the Earth-Moon system

This part is the same as the one discussed in part 1 except with the addition of the moon in order to more accurately estimate the Gravitational potential. As you can see in the image, it is different from 1.3 because up and to the right of the earth you can see a light (the moon). In order to add the moon we found the gravitational potential of both the earth and the moon and added their absolute values up resulting in fig 2.1. Fig 2.2 is the same in theory except it instead uses circular waves called “levels” in order to show a different perspective of the same Gravity Waves

III The gravitational force of the Earth-Moon system

For this part we first made a user defined function that took in 2 separate masses and their respective coordinates. Using formula 2 and through a bit of algebra, it returned the X and Y components of the force. Fig 3.2 is a scatter plot of thee in force the previously made Earth, moon system will exert on the Apollo 11 command module. 3.2 is particularly tricky because in order to account for all the points, we needed to use a for-loop and constantly add the X components of the forces of the moon and the earth.

IV Projected performance of the Saturn

Part 4.1 calculates the burn time T through the use of formula 5 which gives 157.7 seconds. Part 4.2 uses formula 3 in order to calculate delta V, the change in the rocket's velocity. This user defined function requires the Time T, Wet mass, Dry mass, Burn rate, Velocity of the Exhaust, and the gravitational acceleration g. Finally we take the definite integral from 0 to time T in order to find the height. For this we use the function quad which gives 74.1 km

V Stage 1 V Discussion and Future Work

In order to complete this, several approximations were used such as: The Earth and Moon were treated as point masses when they are not, we do not calculate the atmospheric drag or any type of weather conditions or external variables on Saturn V, and we assumed that the burn rate and velocity were constants when in reality they would be constantly changing. These are the reasons why although the calculations were close (157 seconds instead of 160, and 74 km instead of 70 km) they were not as precise as we wanted. More functions and conditions would need to be taken into effect.