ME 51500 Orbital Mechanics / ME I5800 Trajectories and Orbits
Fall 2023 Design Project

Artemis 2, scheduled to be launched by the end of 2024, will carry a crew of 4 on a trip around the moon. This will be the first crewed lunar mission in over 50 years.

The Orion spacecraft will be launched from Pad 39B at the Kennedy Space Center atop a Space Launch System (SLS) rocket and placed into an earth parking orbit. The actual mission plan is quite complicated (see https://www.nasa.gov/image-article/artemis-ii-map-2/) but for simplicity we will consider the following mission profile. After a 3-hour systems checkout period in the parking orbit, the Interim Cryogenic Propulsion Stage (ICPS) will be fired placing the spacecraft on a trajectory toward the moon. For safety reasons, the vehicle will follow a "free-return" trajectory meaning that once placed on this trajectory, the spacecraft will be able to swing around the moon and return to earth without having to perform additional burns. Such a trajectory is shown in the figure below.

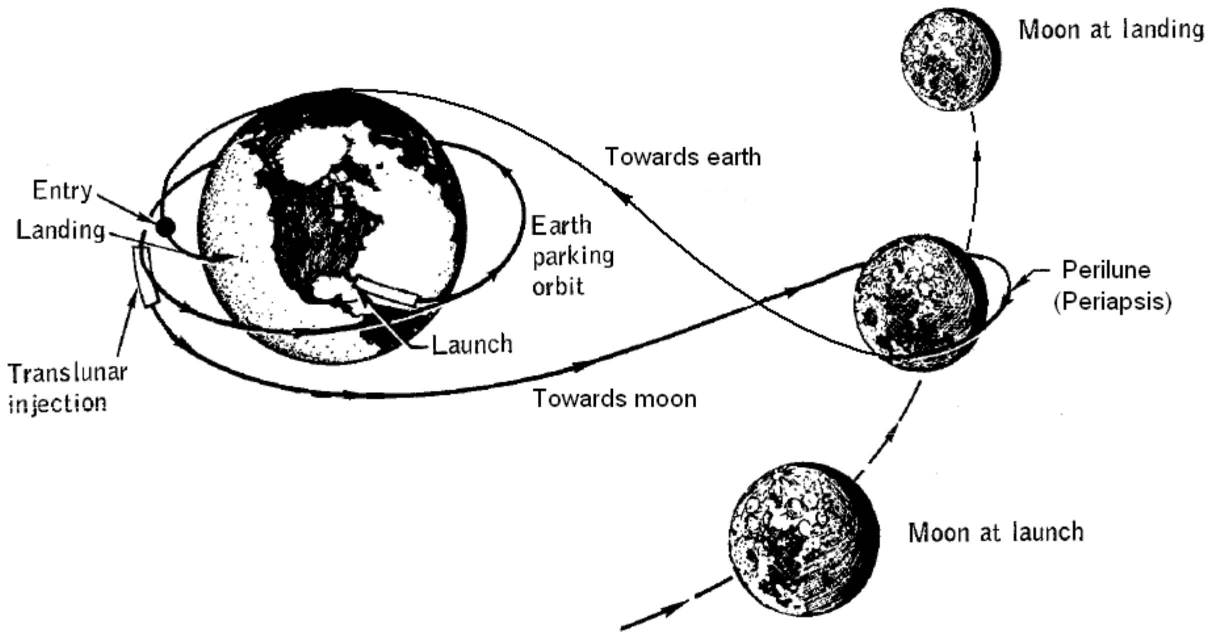

Figure 1. Circumlunar free-return trajectory. (https://en.wikipedia.org/wiki/Free-return_trajectory)

The mission constraints are minimization of fuel consumption, achieving a perilune altitude no closer than 100 km and accomplishing the entire mission in 14 days or less. In your report, you should give details of the earth parking orbit you selected (with reasoning why you selected this orbit), the translunar injection burn, (the ΔV and orientation of the spacecraft required for the burn), the time the spacecraft reaches its closest approach to the moon, and the time it takes the spacecraft to return to earth. Your report should include a timeline in table form listing Mission Elapsed Time (MET) and a description of each scheduled event. The timeline should start with launch, include the time the spacecraft spends in the earth parking orbit, the time of the translunar injection burn, the time the spacecraft reaches its closest approach to the moon, and end with the time of splashdown back on earth. You should try to get realistic values for any parameters you need, list any simplifying assumptions made, and include all programs and calculations used for your analysis. You may use GMAT, Matlab or any other software you wish to simulate the trajectory.

Please note that this is an open-ended design problem with many possible solutions. Therefore, **NO TWO PAPERS SHOULD LOOK ALIKE. Papers bearing any resemblance to each other will receive a grade of *negative 100%*.** It is therefore better not to submit anything at all than to submit work which has been copied. Papers will be graded on originality, presentation and evidence of the thought process used in arriving at your final design. The report must be typewritten, except for equations and hand calculations which can be clearly handwritten. Please e-mail an electronic copy of your report in Word format (required) and a hard copy (if you want a graded copy returned) no later than 5:00 PM, Monday, December 11th. The report will count 10% of your final grade.