ME 273 Spring Semester 2018
Project 2: Model of a Saturn V Rocket

Mission:

Your mission, should you choose to accept it, is to provide thorough answers/solutions for each of the exercises, and produce a detailed report. Also provide any code that you used to produce the results shown in your report. It is imperative that the code you include be commented in detail with your own, original content. Detailed comments are the main way to uniquely identify your individual effort. Please embed a description of the solutions to each exercise, all graphs and other visual aids, and your computer code into the live script format in MATLAB.

Project Exercises

Exercise 1

Your first mission is to build a computational model of a Saturn V rocket that includes the effect of burning the fuel in all three rocket stages. Remember to include detailed comments in your simulation program. Relevant data for the stages of a Saturn V rocket is provided in Table 1. More detailed information on the Saturn V rocket can be found at https://en.wikipedia.org/wiki/Saturn_V. Launch your rocket from rest in a direction that points radially outward from the center of the Earth (straight up), and maintain this orientation throughout the rocket's motion. Provide a detailed assessment of the accuracy of your rocket model? By now, you should be able to demonstrate in detail how you determine a sufficiently small value of Δt to ensure an accurate solution. Produce graphs of the altitude, velocity, and acceleration of the rocket as a function of time from the instant the rocket was launched until the instant the third stage has been jettisoned.

NOTE: Build the model such that the time between prior stage jettisoning and current stage ignition is about 3-4 seconds.

	T (N)	v_e (m/s)	empty mass (kg)	fully fueled mass (kg)
stage 1	34×10^6	2,580	131,000	2,300,000
stage 2	5×10^6	4,130	36,000	480,000
stage 3	1×10^6	4,130	11,000	119,000
payload	-	-	-	52,000 kg

Table 1: Saturn V Data

Exercise 2

The average distance from the Earth to the Moon is 384,403 km. Use your model to determine what happens to the rocket after all the fuel in the three stages has been burned, and the stages have been jettisoned. Does your rocket make it to a distance of 384,403 km from the Earth? Provide a detailed description of the behavior of your model.

Exercise 3

If you did not make it to the Moon (this is a hint for the result of Exercise 2), can you account for what's missing from the model, even though in the model you have used the correct Saturn V parameters provided by NASA? The answer to this question may require some significant investigation/thinking on your part. Again, provide detailed answers/analysis to this question.

Exercise 4

WARNING: Do not read the following until you have completed Exercise 3; otherwise, it may short-circuit your educational experience.

Starting from the rocket's parking orbit (third stage not completely empty-hopefully you have discovered what the parking orbit is in researching your answer to Exercise 3), produce a detailed *pseudocode* for modeling the trans-lunar injection maneuver. Include the gravitational influence of the Moon in your pseudocode, i.e. the Earth, the Moon, and the rocket are all interacting via the gravitational force. You are not expected to produce a working code for the trans-lunar injection, but you could try it if you have time and sufficient interest. Hint: If you decide to try to produce the code for the trans-lunar injection, keep it constrained to a 2D problem.