Team 03: Zachary, Michael, Jayden

6.1 Coding

Question 1:

We had you define the acceleration due to gravity as a field in a structure that you had to pass as an input argument to several functions. Instead, we could have had you type the value for the constant, 3.72 m/s^2, directly in those functions. Do you believe there is an advantage to how we had you do it? Explain. Would you have done it differently? Explain why or why not.

By defining the acceleration due to gravity as a field in a structure you would have to pass as an input argument to several functions, coding and functionality of our code become more effective. By defining gravity in this way, it becomes easy to change gravity depending on if the rover is tested on other planets. For instance, if the rover was tested on mars, earth, and the moon gravity would be changed within define_rover instead of having to input a constant throughout the whole program in inputs. By doing this you not only reduce the amount of work required to update the rover when testing it on other planets but also the possibility of human error when changing gravity throughout the program or forgetting to change the value altogether, which would be a critical mistake.

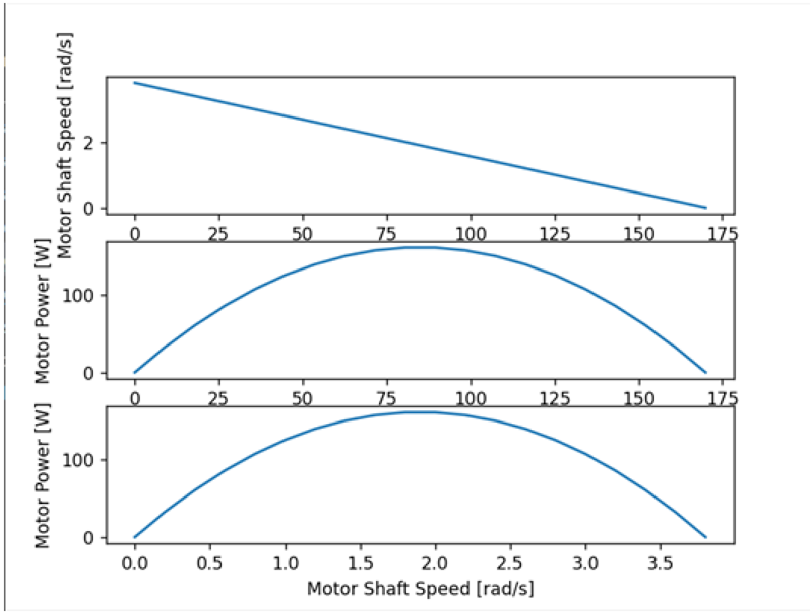
Question 2:

What happens if you try to call F_gravity using a terrain slope of 110 degrees? Is this desirable behavior? Explain why you think this.

If one tries to call F_gravity using a terrain slope of 110 degrees an except statement would return that the terrain degree would be larger than the permitted -75 to 75 degree threshold. The reason for this desirable behavior is that the rover has limitations on what terrain it can navigate. For these reasons the rover would have difficulty traveling on slopes that are not within the threshold of -75 to 75 degrees. Therefore, in order to maintain the structural integrity of the rover, which is navigating at a location where it must be self-sufficient, the rover should not exceed these limits so that it does not break.

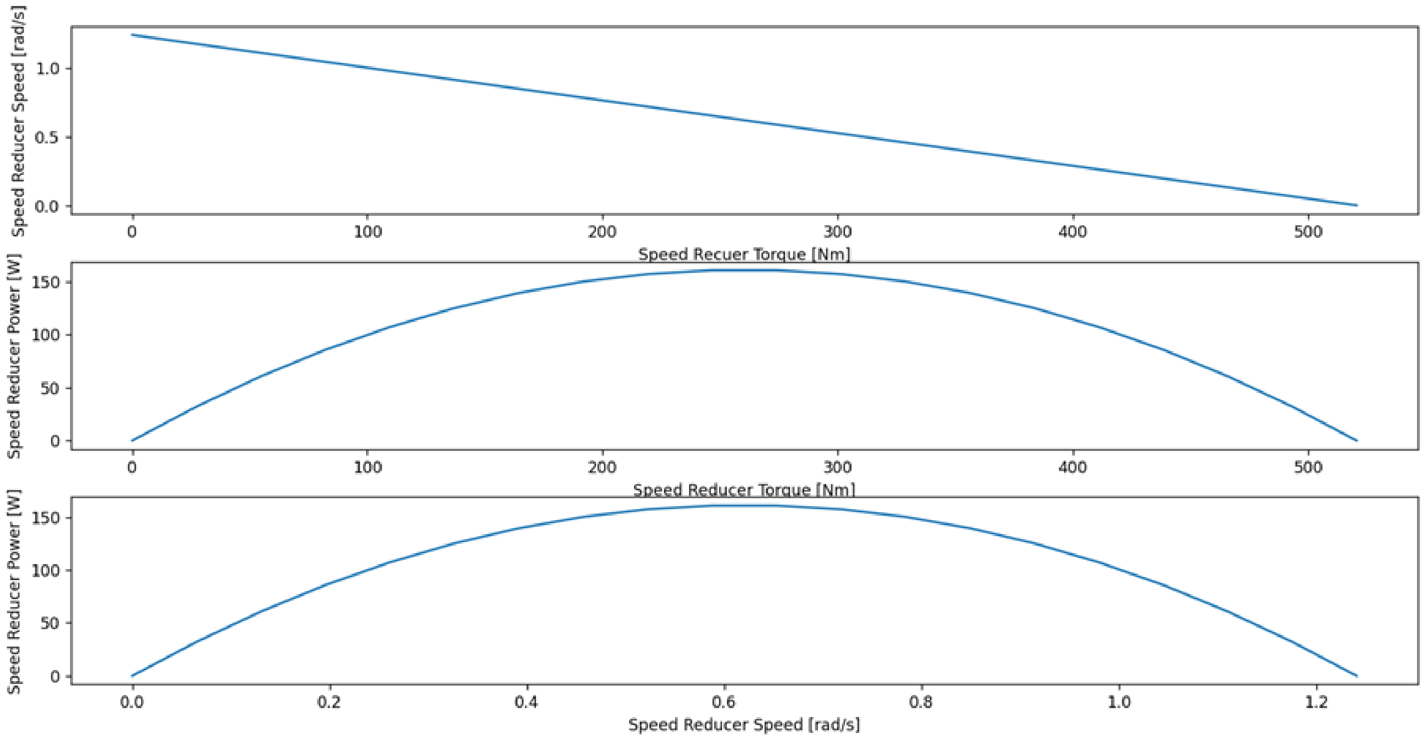
6.2 Motor and Speed Reducer Behavior

Question 3: The maximum power output of a single motor is about 27 Watts, this occurs at a speed of about 1.8 rad/s



Question 4:

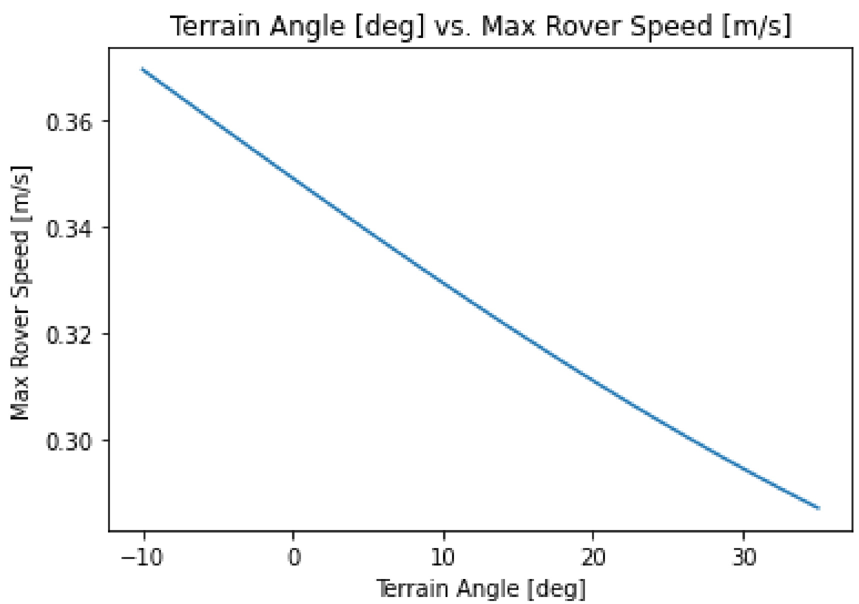
The speed reducer does not have an effect on the maximum power output of the system. Though it can be seen that the same power is achieved at around .62 rad/s



6.3 Rover Behavior

Question 5:

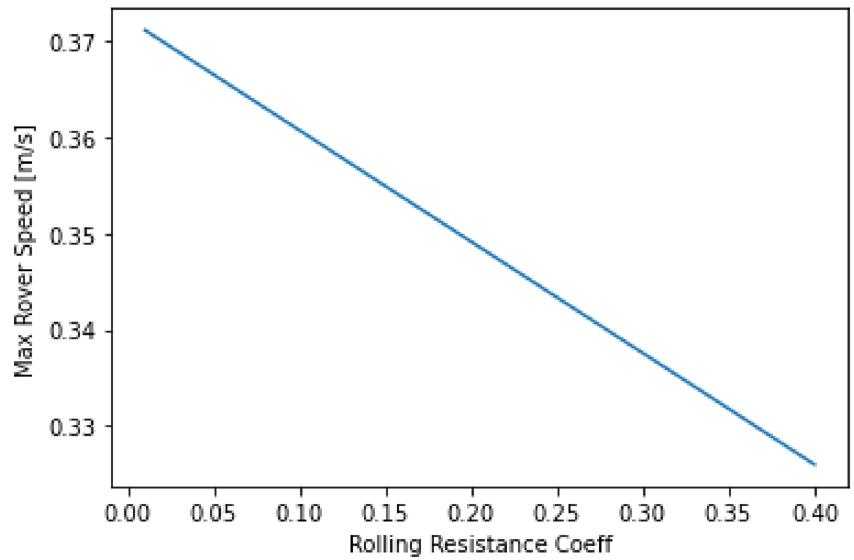
Examine the graph you generated using analysis_terain_slope.py. (Provide the graph in your response for reference.) Explain the trend you observe. Does it make sense physically? Why or why not? Please be precise. For example, if the graph appears linear or nonlinear, can you explain why it should be the way you observed? Refer back to the rover model and how slope impacts rover behavior.



As seen in the above graph, the trend appears to be non-linear. This is due to the fact that as the terrain angle increases in value the Maximum Rover Speed decreases as less energy goes towards the kinetic energy for the rover's speed but towards the gravitational potential energy of the inclination. Due to kinetic energy being a non-linear parabolic, while gravitational potential energy is linear, the total energy is conserved. For this reason, there is not a linear proportionality between the height achieved and the decrease in the maximum rover speed.

Question 6:

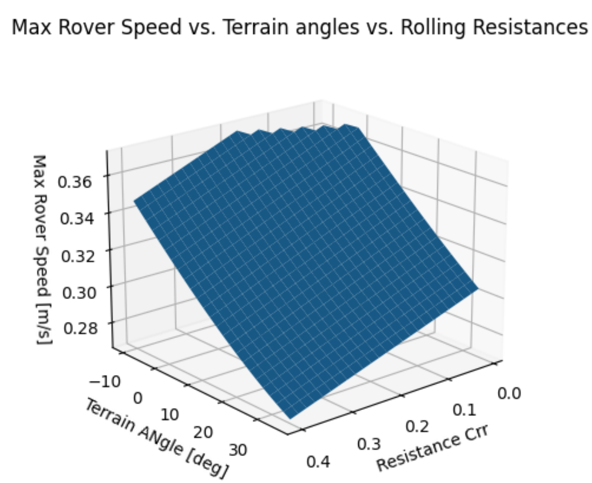
Examine the graph you generated using analysis_rolling_resistance.py. (Provide the graph in your response for reference.) Explain the trend you observe. Does it make sense physically? Why or why not? Please be precise. For example, if the graph appears linear or nonlinear, can you explain why it should be the way you observed? Refer back to the rover model and how the coefficient of rolling resistance impacts rover behavior.



The graph displayed above that represents a relationship between the Maximum Rover Speed and Rolling Resistance Coefficient appears to be linear. Therefore, there is a direct proportionality between the rolling Resistance Coefficient and the Maximum Rover Speed. This relationship is observed since the increase of the dynamic frictional force will not accelerate the rover, under the assumption that the rover is in equilibrium. The result of this increase of the dynamic frictional force will decrease the terminal velocity since when summing the forces in the direction of motion there will not be any acceleration due the frictional forces eventually equaling the output forces of the drivetrain. Therefore, the result is a linear graph.

Question 7:

Examine the surface plot you generated using analysis_combined_terrain.py (Provide the graph in your response for reference.) What does this graph tell you about the physical conditions under which it is appropriate to operate the rover? Based on what you observe, which factor, terrain slope or coefficient of rolling resistance, is the dominant consideration in how fast the rover can travel? Please explain your reasoning.



The above graph represents the relationship and impact of the Rolling Resistance and Terrain Angle on the Maximum Rover Speed. As displayed above, the maximum rover speed increases with the decrease in both the terrain angle and rolling resistance. Moreover, there is a noticeably more drastic difference in the maximum rover speed due to the impact of the terrain angle as opposed to the coefficient of rolling resistance. Another analysis can be drawn from the model in which the rover won’t travel on a decreasing slope without friction. This relationship is recognized when viewing the slopes of separate graphs, such as the Maximum Rover Speed vs. Terrain Angle Curve and the Maximum Rover Speed vs. Resistance Crr Curve.