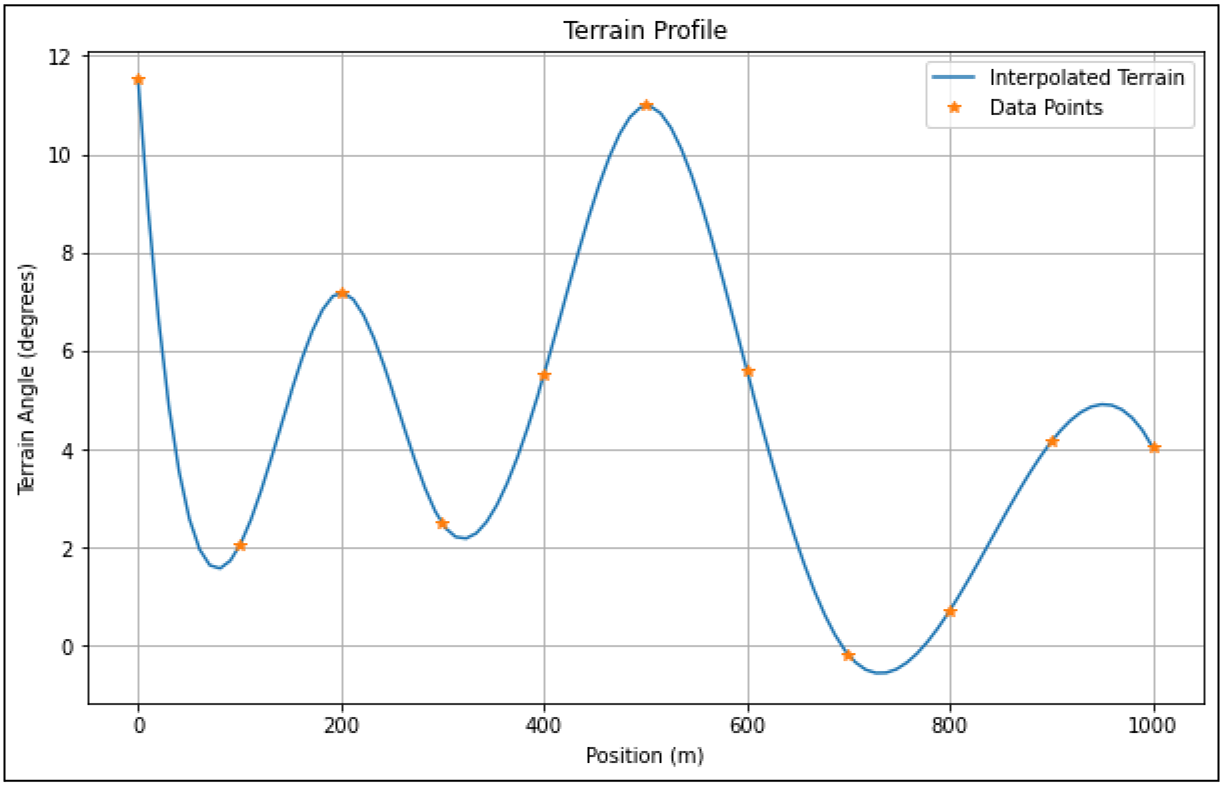
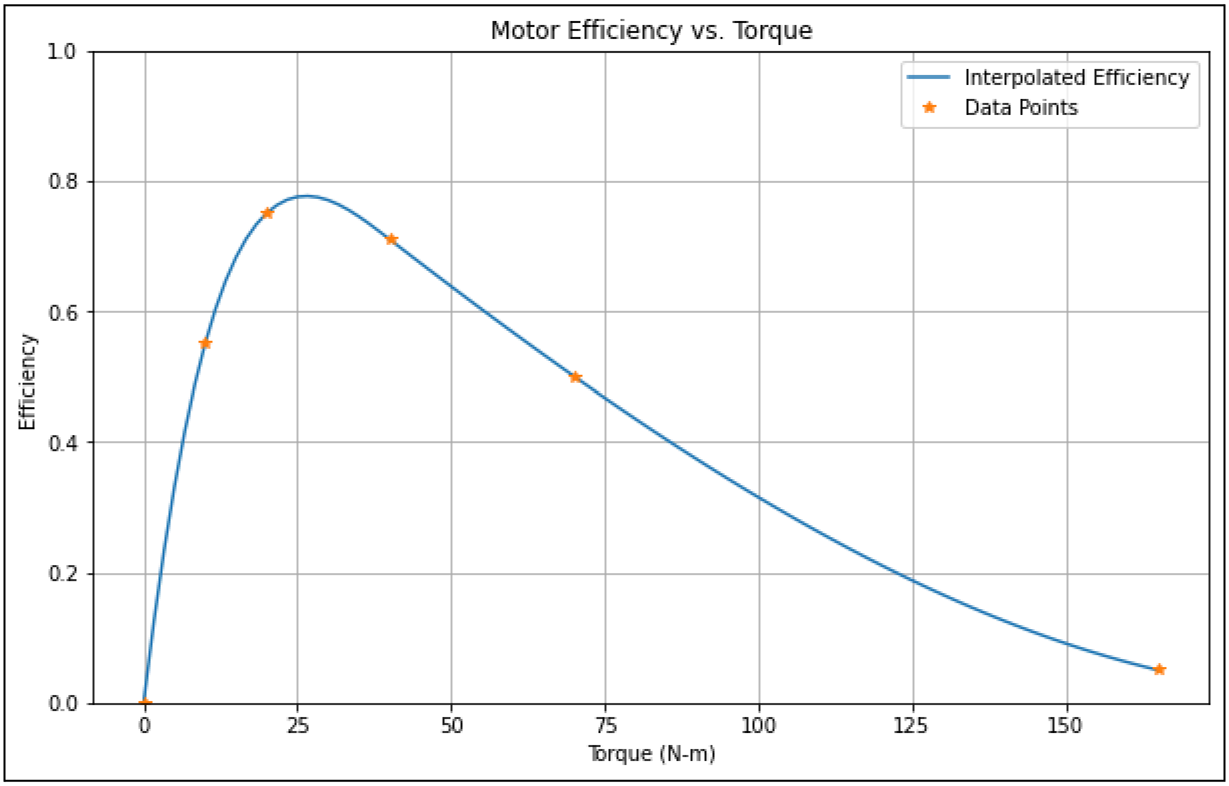
Task 2:



Experiment_Visualization Curve

The terrain profile generated through cubic spline interpolation exhibits smooth characteristics throughout the entire path. The graph shows that the blue interpolated line transitions naturally between the data points (marked by orange stars) without any jarring changes or breaks. This smoothness is from using cubic polynomials between points, which ensures continuous slopes and curvatures at the transitions. Additionally, the curve maintains accuracy to our input data, as evidenced by the interpolated line passing exactly through each orange star marker. This smooth behavior makes sense for modeling real-world terrain since actual landscapes typically don't have abrupt elevation changes.

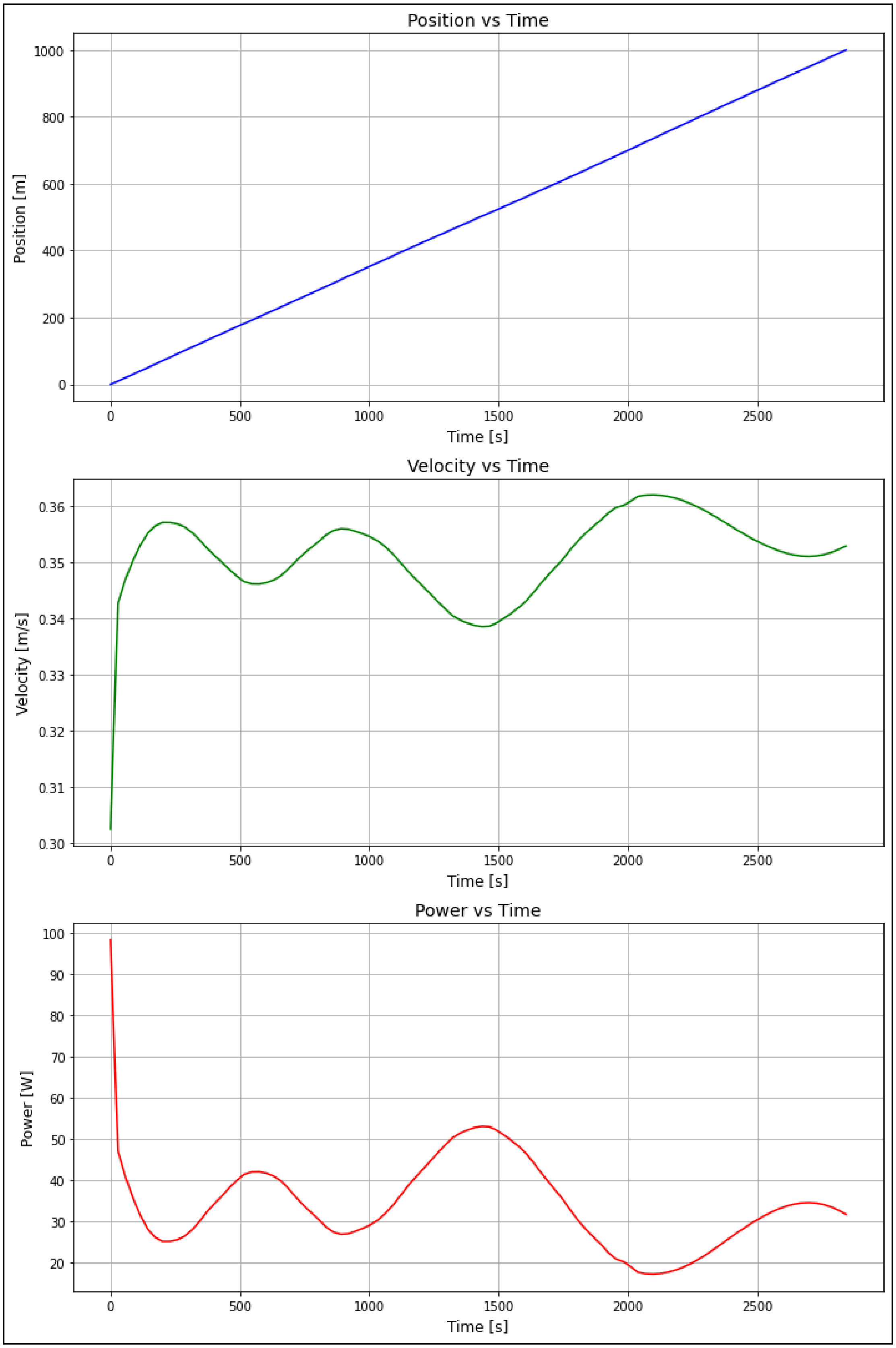
Task 5:



Efficiency_Visualization Curve

This motor efficiency curve shares a similar overall shape with Figure 2 from the handout - starting at zero, rising to a peak, then declining - though it operates at a much higher torque range. The curve is smooth throughout due to the cubic spline interpolation used to connect the data points. The interpolated line passes exactly through all six data points (marked with stars), which is a key property of cubic spline interpolation.

Task 8:



Position vs Time
Position [m]
1000
800
600
400
200
0
0
500
1000
1500
2000
2500
Time [s]
Velocity vs Time
Velocity [m/s]
0.36
0.35
0.34
0.33
0.32
0.31
0.30
0
500
1000
1500
2000
2500
Time [s]
Power vs Time
Power [W]
100
90
80
70
60
50
40
30
20
0
500
1000
1500
2000
2500
Time [s]

(a) Position vs Time: The position-time graph shows a slightly non-linear relationship. While there is an overall upward trend, the slope (which represents velocity) varies over time rather than being constant. This nonlinearity occurs because the rover's velocity changes as it encounters different terrain angles, requiring different amounts of power and resulting in varying speeds across the trajectory.

(b) Velocity-Power Relationship: Looking at the velocity and power plots, there's a clear correlation - when the rover requires more power (shown by spikes in the power graph), there are corresponding changes in velocity. The relationship appears inverse in many cases - when the rover encounters situations requiring more power (likely uphill sections), the velocity tends to decrease slightly. This makes physical sense as the rover needs to expend more energy to maintain motion against gravity on inclines, resulting in slightly reduced velocity.

(c) Velocity Profile and Terrain: The velocity shows periodic variations between approximately 0.34-0.36 m/s, which likely corresponds to changes in terrain elevation. The dips in velocity (around t=1500s) suggest encounters with uphill sections where the rover must work harder against gravity, while slight increases in velocity may correspond to downhill or level sections where less power is required to maintain motion.

(d) Velocity Smoothness: The velocity graph shows smooth transitions rather than abrupt changes. This smoothness is due to two factors:
1. The terrain profile was interpolated using cubic splines, creating smooth transitions between terrain points
2. The rover's inertia and motor characteristics prevent instantaneous velocity changes, leading to gradual transitions as terrain conditions change

Rover Telemetry Data

Variable	**Value**
completion_time	2842.92 s
distance_traveled	1000 m
max_velocity	0.36 m/s
average_velocity	0.35 m/s
battery_energy	1094725.05 J
batt_energy_per_distance	1094.725 J/m

Task 9:

During Experiment 1, the battery energy used is 1,094.725 kJ. This is greater than the energy provided by the Lithium Iron Phosphate battery pack, as this batter only provides 907.2 kJ. Therefore, no, the rover can not complete the case defined by Experiment 1 with the 0.9072e6 J Lithium Iron Phosphate battery pack. There is not sufficient energy capacity to handle the demands shown in the simulation. We arrived at this conclusion by analyzing the output of Experiment 1.