Answer the following questions:

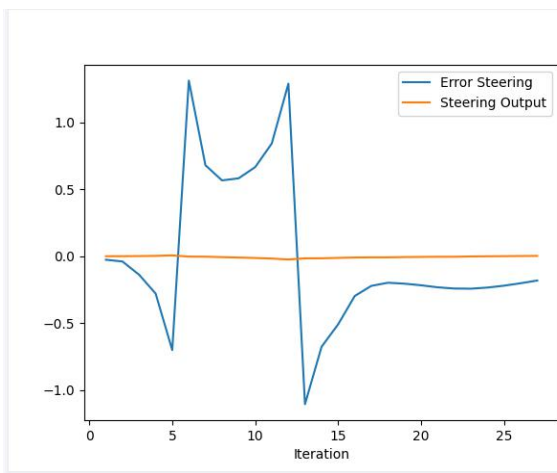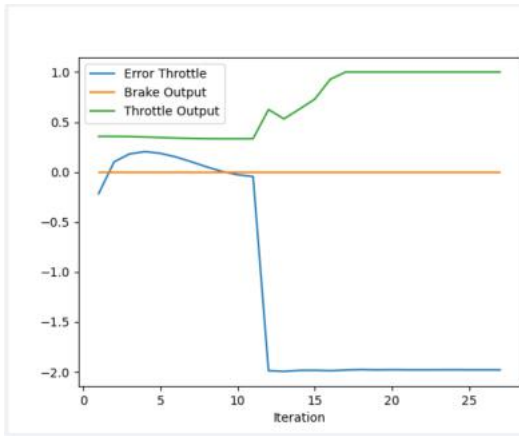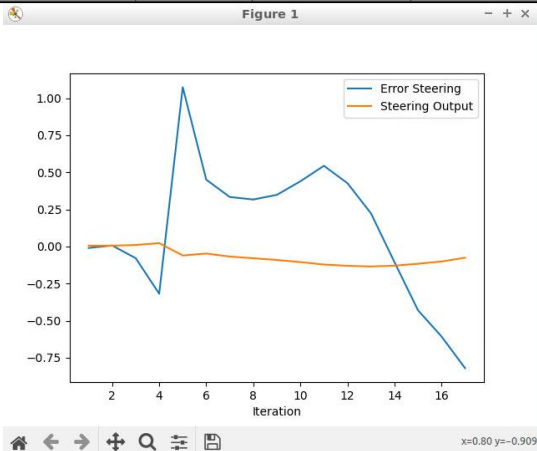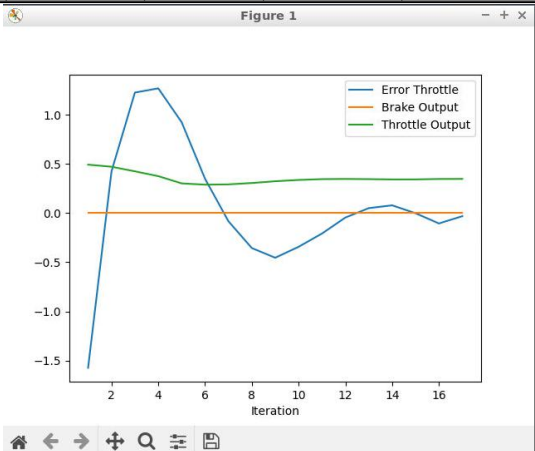**- Add the plots to your report and explain them (describe what you see)**

I tested various combinations of of the parameters for steering and throttle. Below is a table to summary some of the test results.
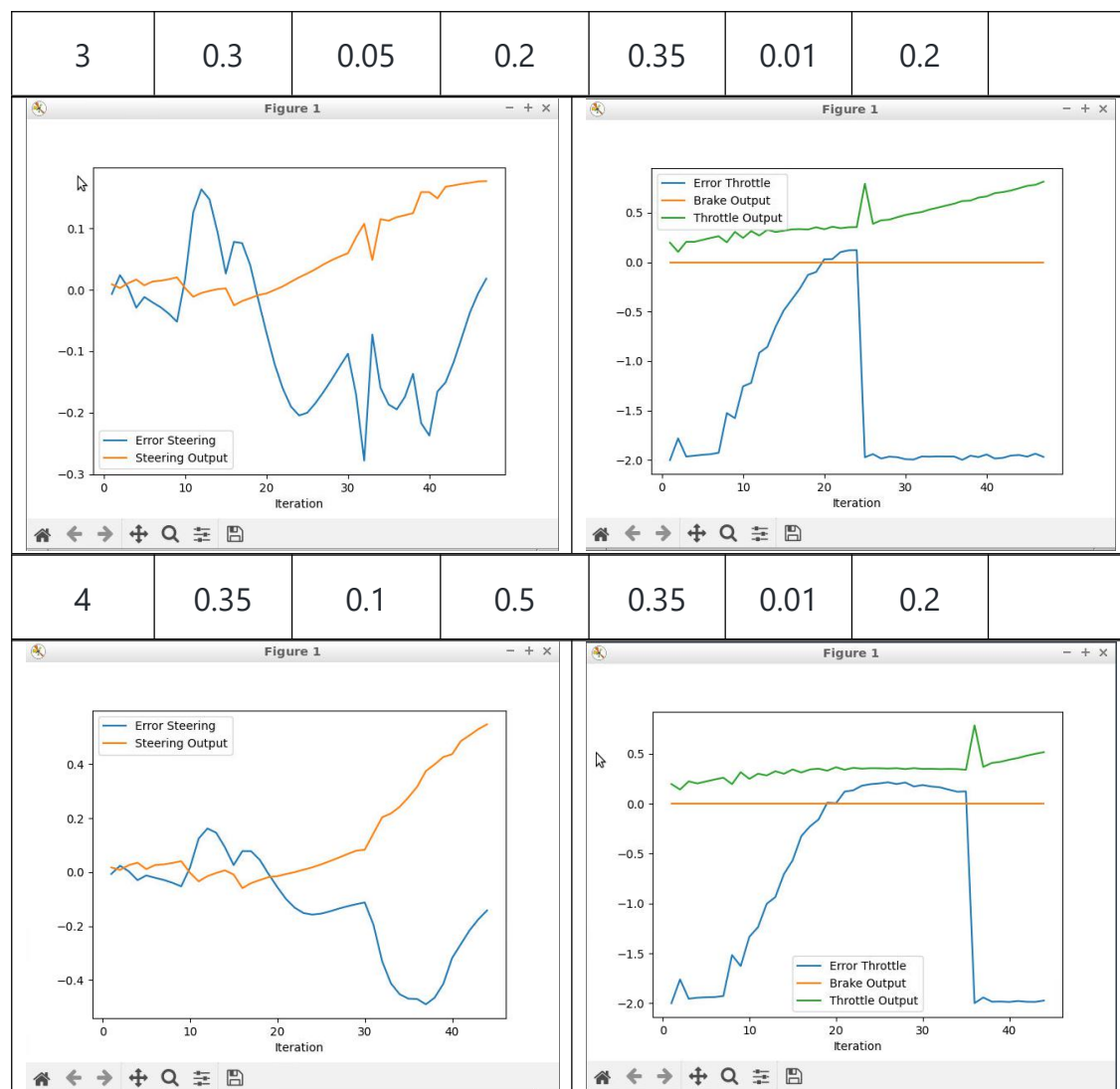
#1: as a initial test, the vehicle crashed to the wall on the right after about 10 iterations.
#2: increased the parameters, the vehicle is able to pass the stopped car from left, but went to far and turned to the left.
#3: the vehicle wasn't able to pass the stopped car in front and hit the car.
#4: this is so far the most successful run, the vehicle is able to pass the stopped car.

	Steering			Throttle			
TEST	KP	KI	KD	KP	KI	KD	Notes
1	0.1	0.005	0.001	0.2	0.05	0.1	
2	0.2	0.03	0.02	0.182	0.04	0.002	

3	0.3	0.05	0.2	0.35	0.01	0.2	

4	0.35	0.1	0.5	0.35	0.01	0.2	

- What is the effect of the PID according to the plots, how each part of the PID affects the control command?

1. Increasing Kp (proportional gain) has the effect of proportionally increasing the control signal for the same level of error. Kp tends to lower steady-state error

2. The derivative term Kd adds the ability to "anticipate" error. this anticipation tends to add damping to the system, thereby decreasing overshoot.

3. The addition of an integral term to the controller (Ki) tends to help reduce steady-state error. It helps when there is a persistent and steady error. A drawback of the integral term, however, is that it can make the system more sluggish

- How would you design a way to automatically tune the PID parameters?

The course discussed about using Twiddle algorithm to automatically tune the parameters.

- PID controller is a model free controller, i.e. it does not use a model of the car. Could you explain the pros and cons of this type of controller?

The PID controller is widely accepted in industrial control field, mainly because its functional simplicity and robust performance on a variety of operation conditions. However, it also has its

limitations: it's a feedback control system with constant parameters. It doesn't have knowledge about the process and its performance is reactive.

- (Optional) What would you do to improve the PID controller?
Increasing the frequency so the feedback is more in-time to improve its performance.