LAB REPORT

Lab 4: Control Design Using the Root Locus

Lab Date: 2018/11/14

Submission Date: 2018/11/19

Prelab: 1 marks

Lab Report: 4 marks

Lab Work: 5 marks

Name	Student Number
Yixuan Liu	1003238793
Chenhong Qiu	1002939840

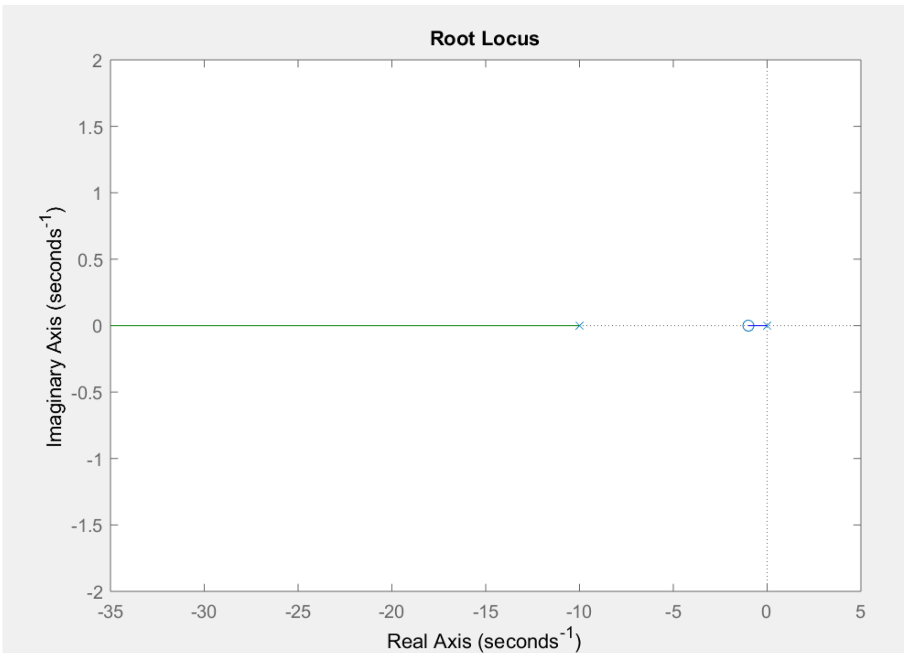
4.1 Identification of model parameters

(0.25 mark) Estimated parameters are: a = 1.57   b = 10

4.2.1 Controller design using Matlab, Part1

(0.25 mark) Root locus plot when TI = 1.

Using the plot, prove that there doesn't exist K>0 such that the closed-loop system has two poles on the real axis with real part<-20.

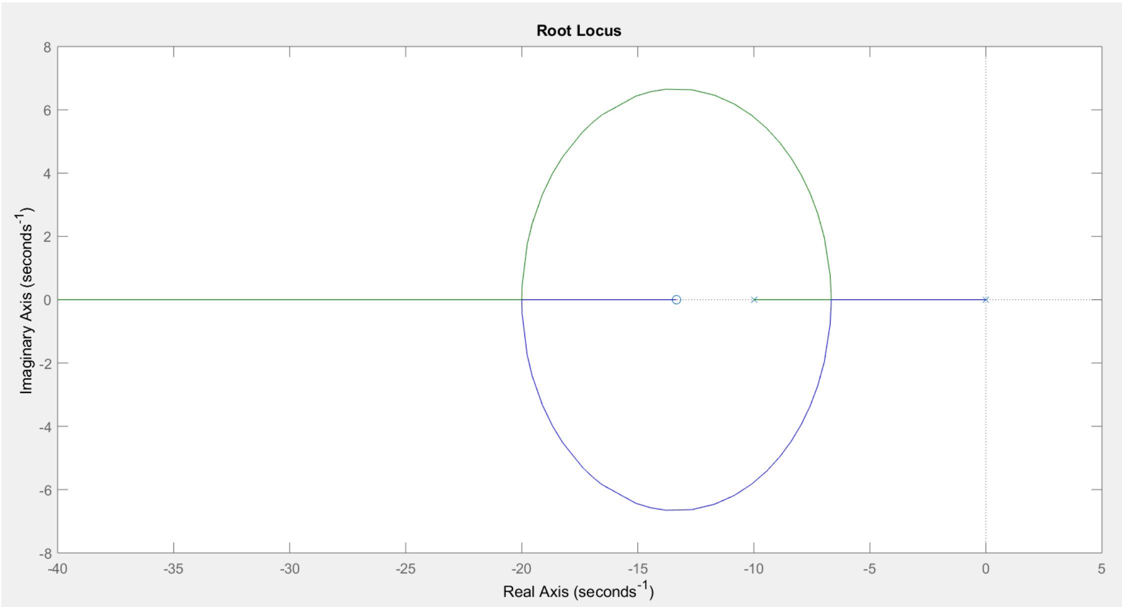


In the figure, one pole is located at s=0, the other is located at s=-10. Both poles are on the real axis with real part < -20.

(0.25 mark) Value of TI and K for which the closed-loop system has two poles at S = -20,

TI = 0.075   K = 19.1

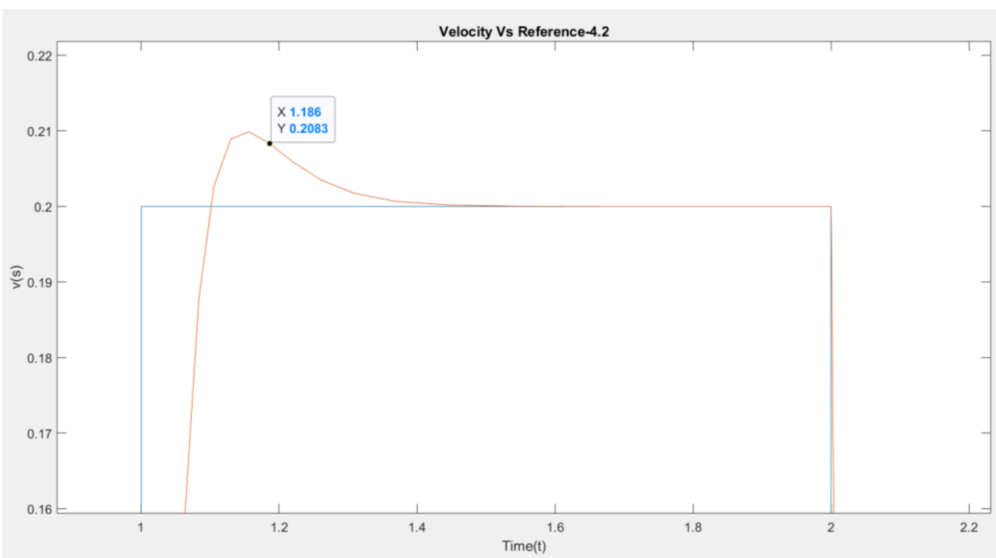
(0.25 mark) Root locus plot for the value of TI you just found.



4.2.2 Controller design using Matlab, Part2

(0.25 mark) Plot showing one period of the simulation output (with proper labels).

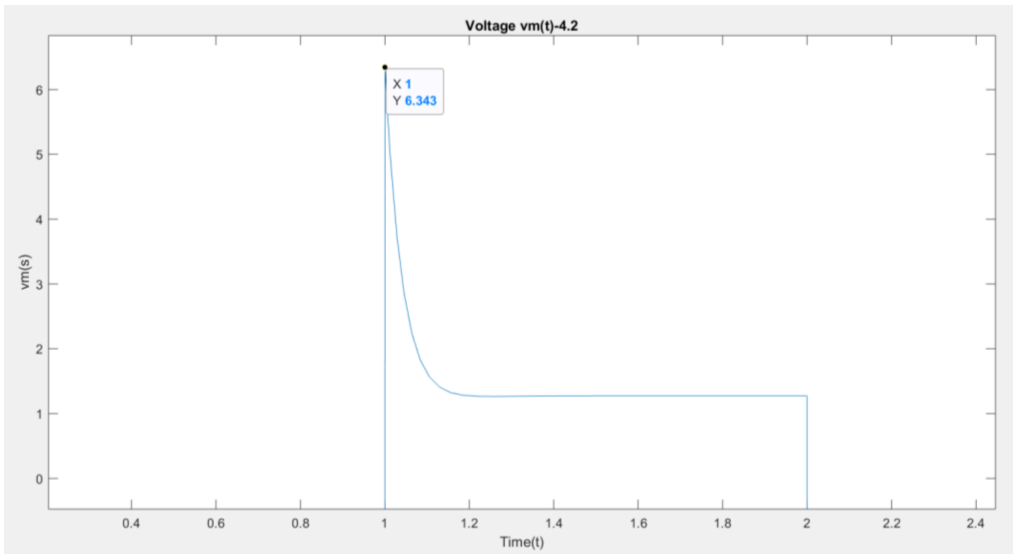
What is the estimated value of the settling time: Ts = 0.186s (we observe the second cycle)



(0.25 mark) Plot showing the control input voltage Vm(t) (with proper labels).

What is the peak value of Vm(t) ?

Vm(t) = 6.343v



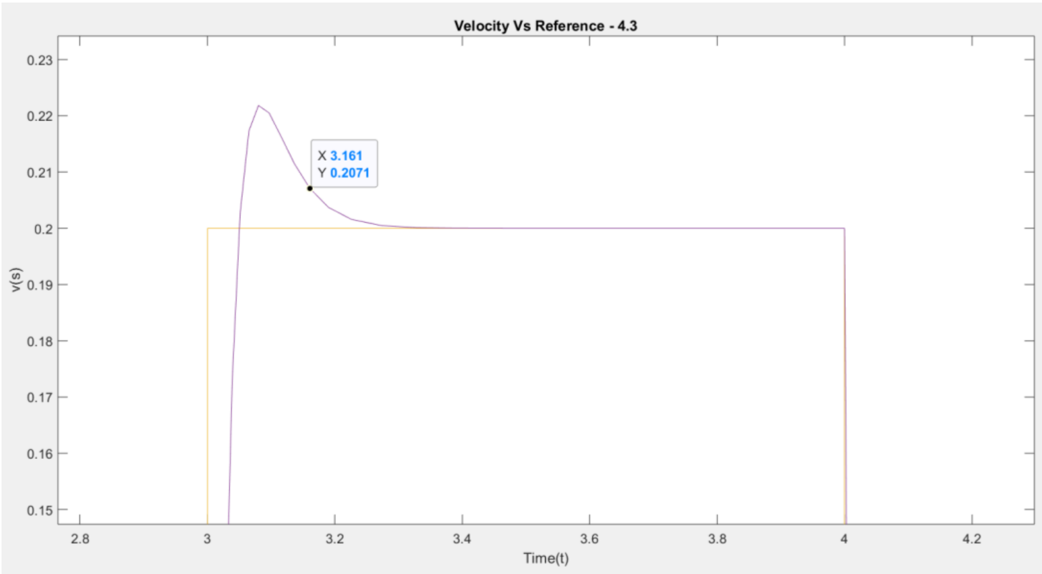
4.2.3 Controller design using Matlab, Part3

(0.25 mark) Value of TI and K for the more aggressive controller (S = -30)

TI = 0.0555 K = 31.9

(0.25 mark) Plot showing one period of the simulation output (with proper labels).

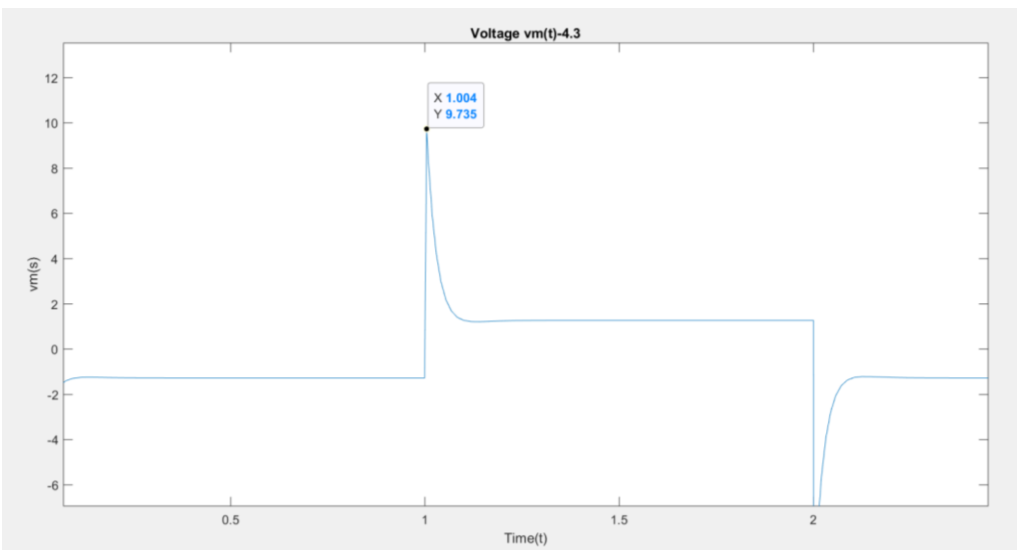
What is the estimated value of the settling time: Ts = 0.161s (we observe the fourth cycle)



(0.25 mark) Plot showing the control input voltage Vm(t) (with proper labels).

What is the peak value of Vm(t) ?

Vm(t) = 9.735v



(0.75 mark) Compare the performance of the two controller you designed earlier.

How do settling time and overshoots compare? How about maximum value of Vm(t)?

The normal controller: Ts = 0.186s, Vm = 6.343v < 11.75v

The aggressive controller: Ts = 0.161s, Vm = 9.735v < 11.75v

For aggressive controller, settling time is smaller and maximum voltage is larger than the normal one.

Which controller is best suited to meet the specifications?

According to Vm = 9.735v < 11.75v, it meets SPEC5. Besides, the aggressive controller has smaller settling time. Thus the the aggressive controller is the best suited to meet the specification.

What is the cause of the differences between the two controllers?

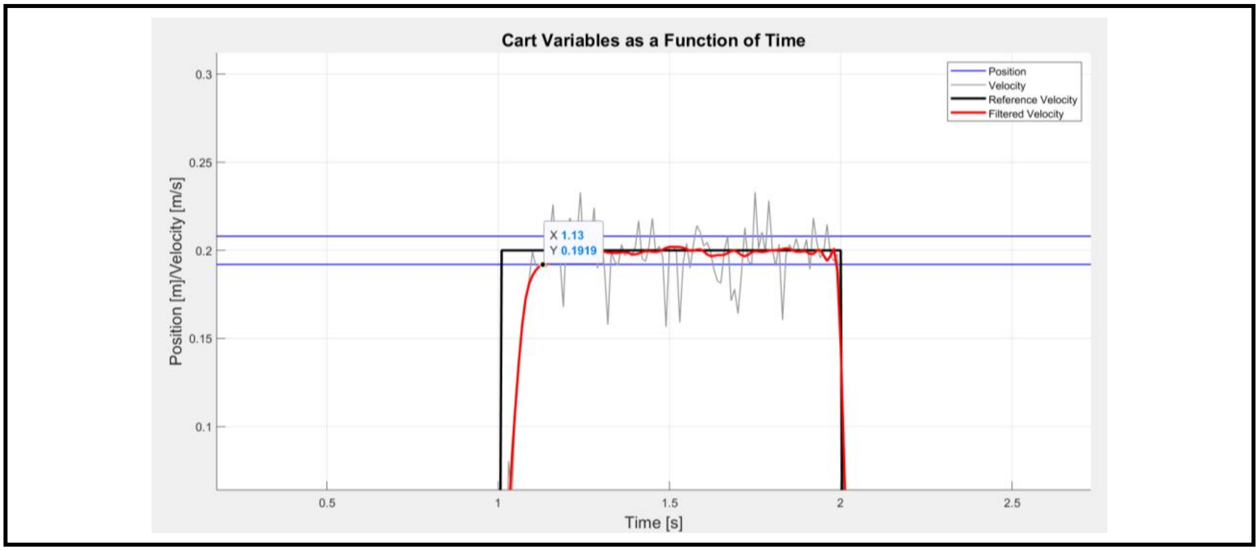
The aggressive controller has smaller settling time, larger overshoot, and larger peak voltage. Cart with aggressive controller is faster, and it needs less time to settle and be in steady state after changing direction of movement.

4.3 Controller Implementation

(0.5 mark) Normal controller, with no disturbance:

Plot showing actual cart speed V(t) and reference r(t) (with proper labels).

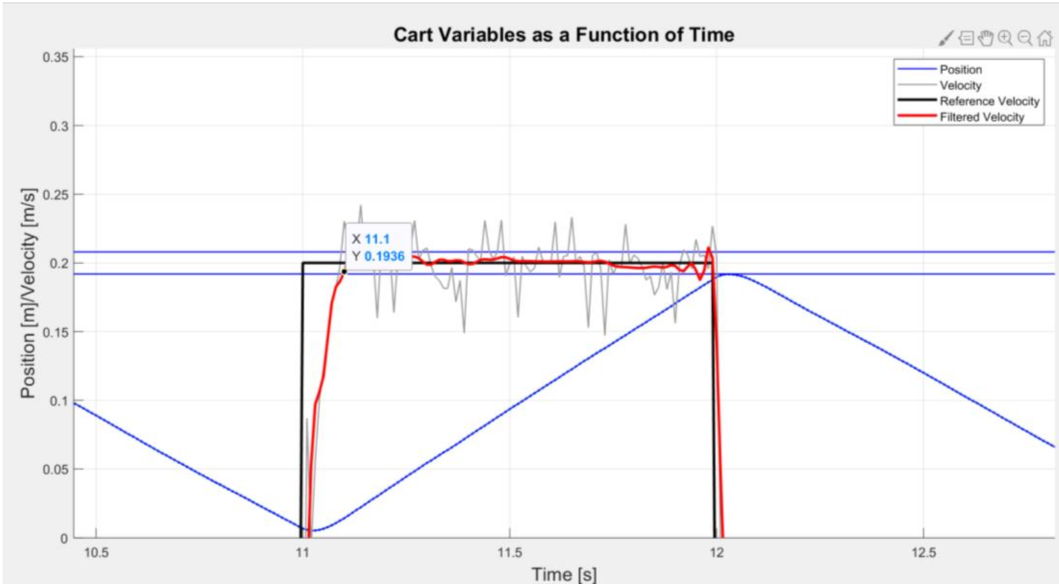
What is the estimated value of the settling time: Ts = 0.13s



(0.5 mark) Normal controller, when cart is tilted:

Plot showing actual cart speed V(t) and reference r(t) (with proper labels).

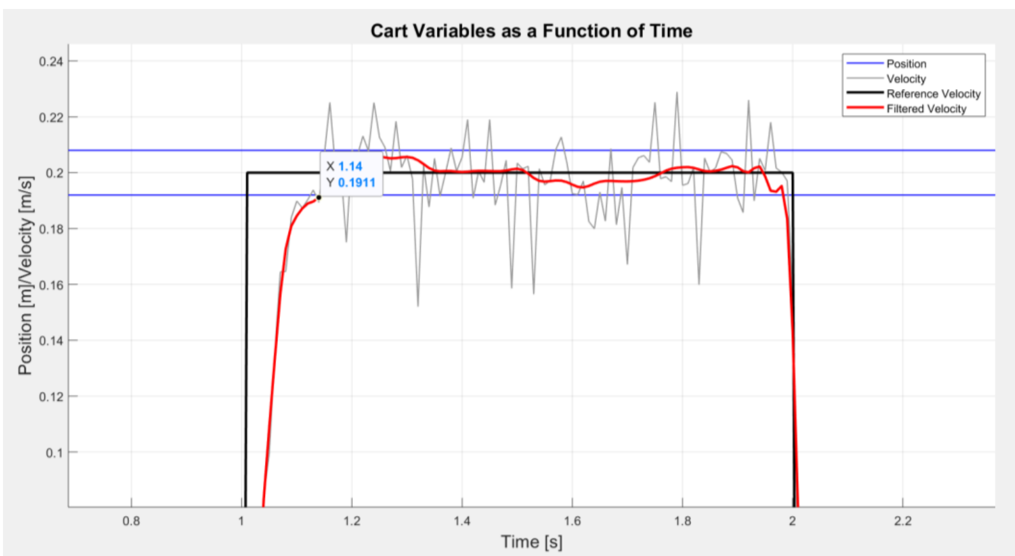
What is the estimated value of the settling time: Ts = 0.1s



(0.5 mark) Aggressive controller, with no disturbance:

Plot showing actual cart speed V(t) and reference r(t) (with proper labels).

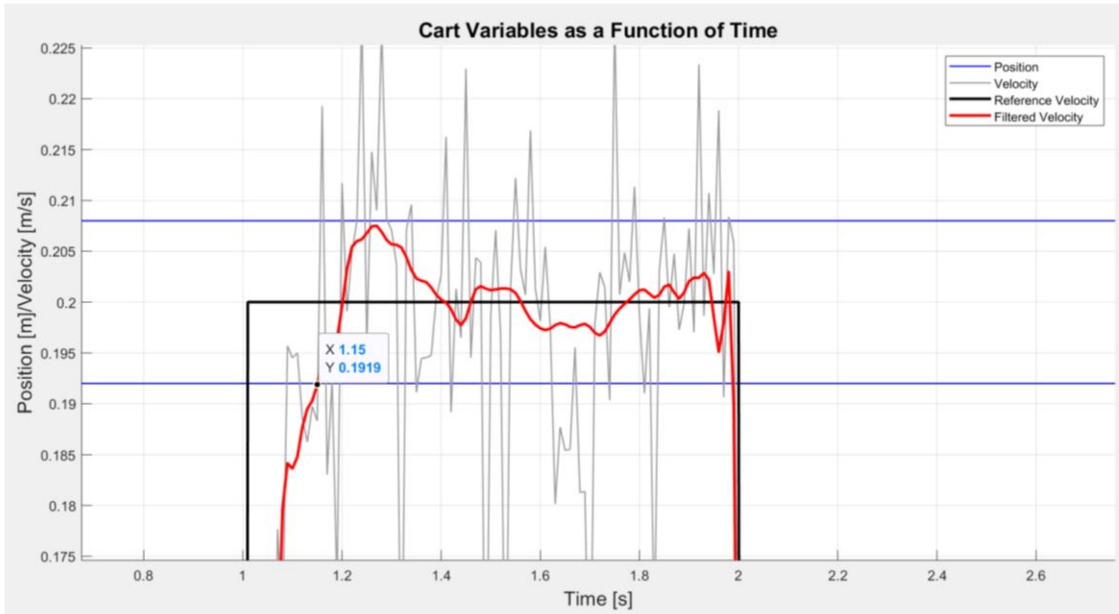
What is the estimated value of the settling time: Ts = 0.14s



(0.5 mark) Aggressive controller, when cart is tilted:

Plot showing actual cart speed V(t) and reference r(t) (with proper labels).

What is the estimated value of the settling time: Ts = 0.15s


Cart Variables as a Function of Time
Position [m]/Velocity [m/s]
Time [s]
Position
Velocity
Reference Velocity
Filtered Velocity
X 1.15
Y 0.1919
0.225
0.22
0.215
0.21
0.205
0.2
0.195
0.19
0.185
0.18
0.175
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6