Exercise 1 : Question 1

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For xdot = 2 m/s : Controllable and Observable.
For xdot = 5 m/s : Controllable and Observable.
For xdot = 8 m/s : Controllable and Observable.
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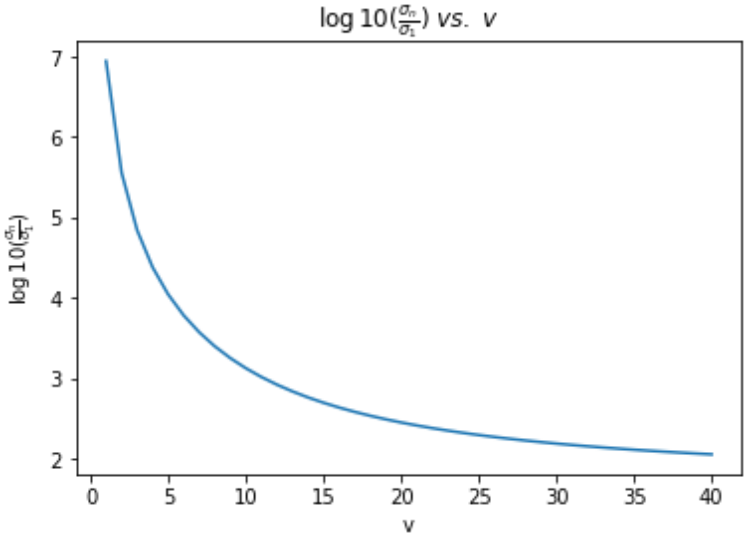
The system is controllable and observable for given longitudinal velocities (2, 5 and 8 m/s).

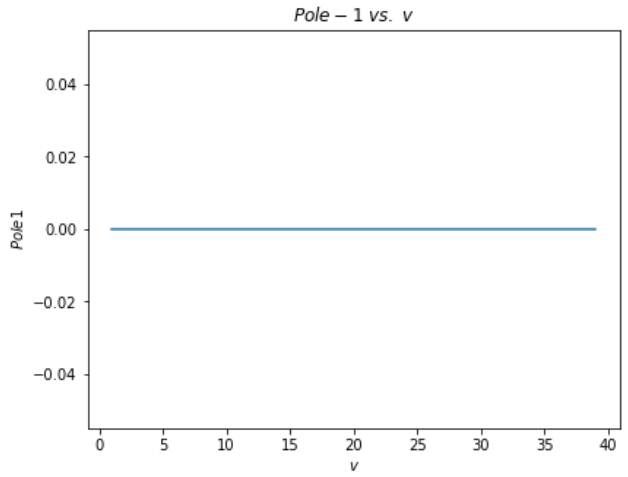
Exercise 1 : Question 2 (a)

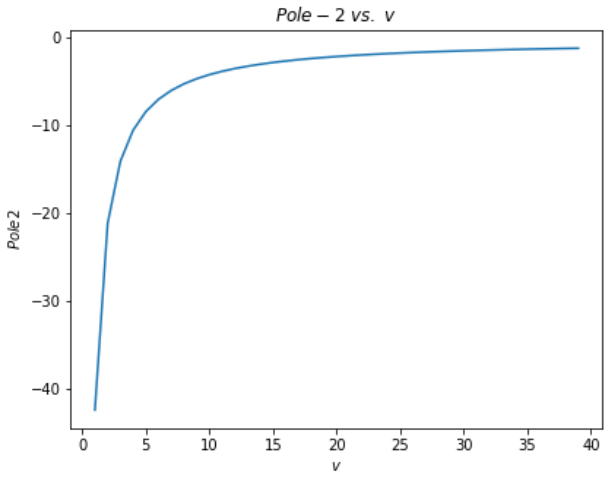


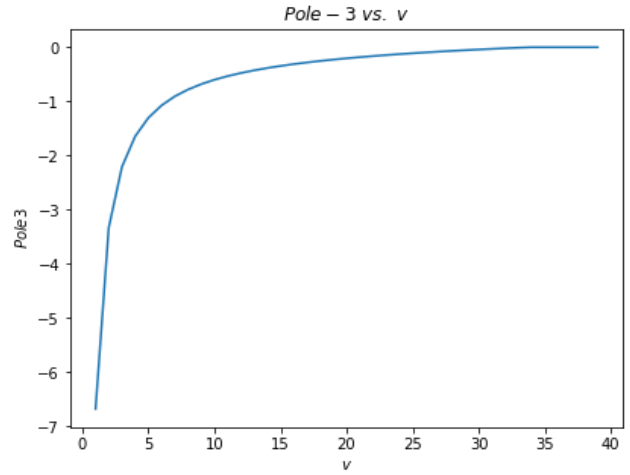
As the velocity increases from 1 to 40 m/s, the ratio of the largest singular value to the smallest singular values decreases. The curve represents the condition number of the P matrix. As the velocity increases, the condition number decreases indicating that the system becomes more well-conditioned (more accurate calculation of inverse and results).

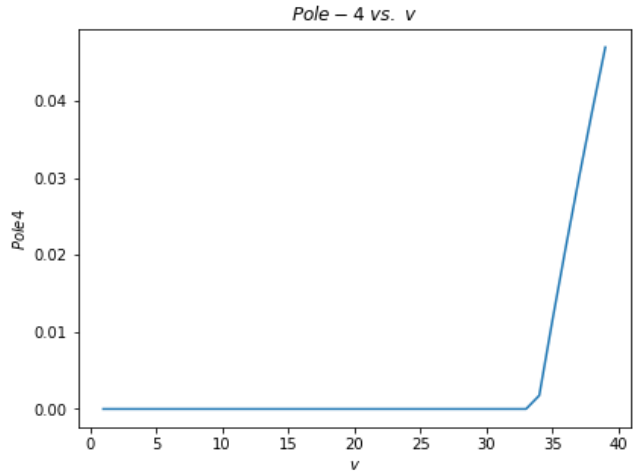
The **controllability** of the matrix improves as velocity increases, because the ratio becomes smaller, indicating the largest and smallest values are getting closer to each other (at the same time away from being 0).

Exercise 1 : Question 2 (b)







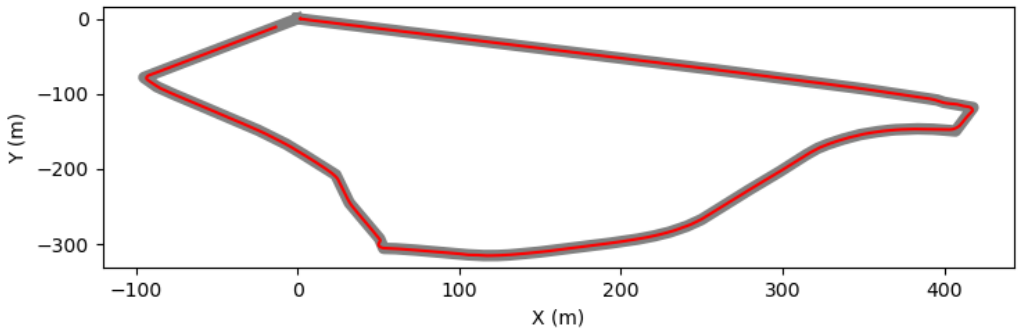


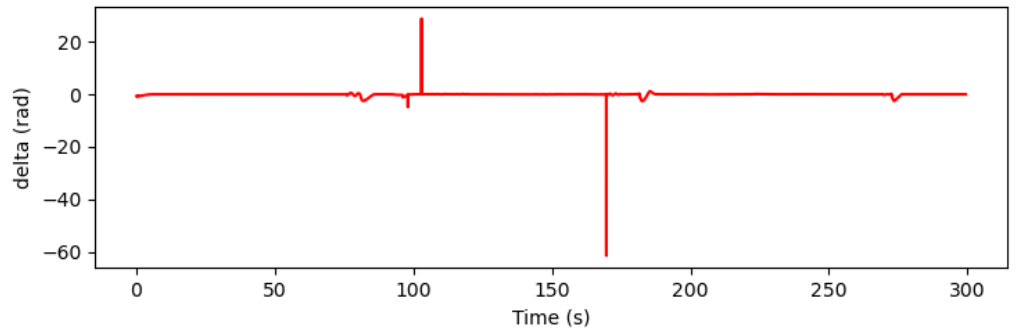
As the velocity increases from 1 to 40 m/s:

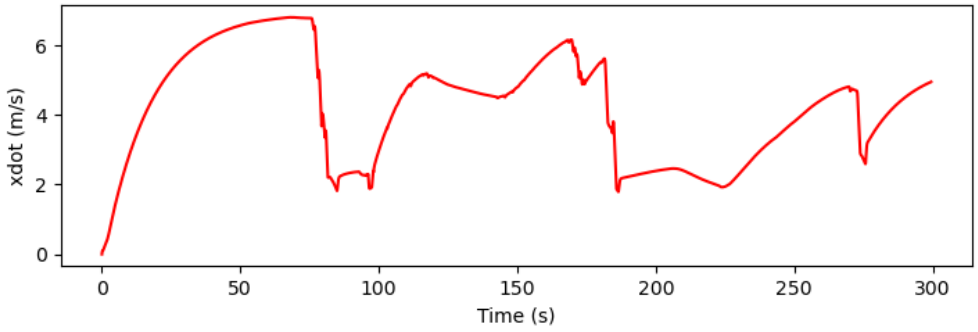
- Pole 1 – Remains constant, 0.
- Pole 2 – Increases from -40 towards 0
- Pole 3 – Increases from -7 towards 0
- Pole 4 – Remains nearly 0 till 33 m/s and then increases to become positive

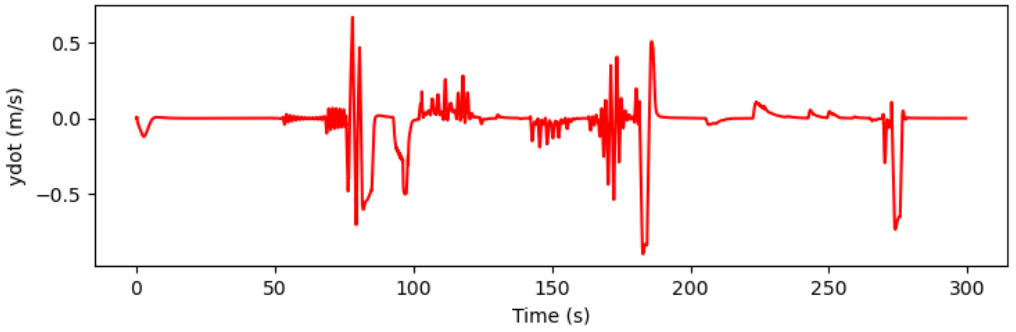
The systems is stable till a critical velocity of 33 m/s, but then as pole 4 becomes positive for velocities > 33 m/s, the system becomes unstable.

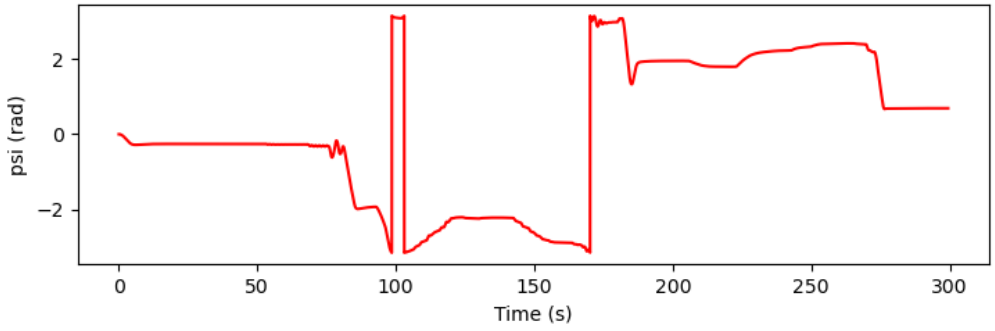
Exercise 2 : Plots

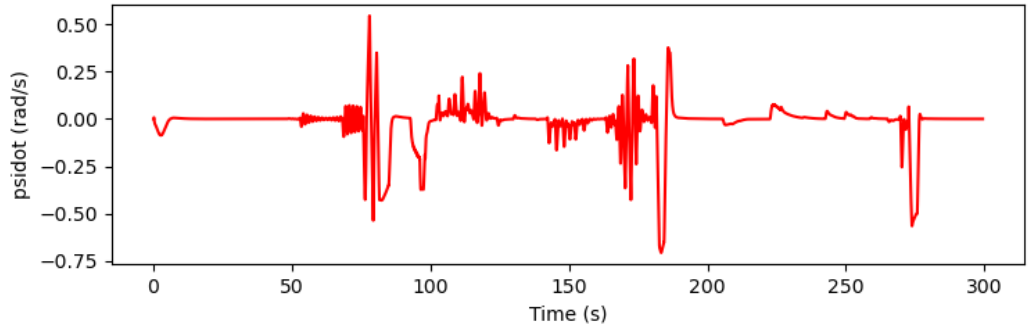


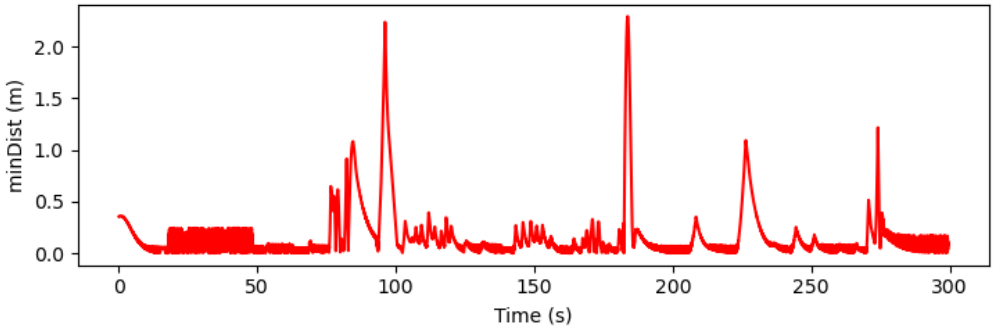


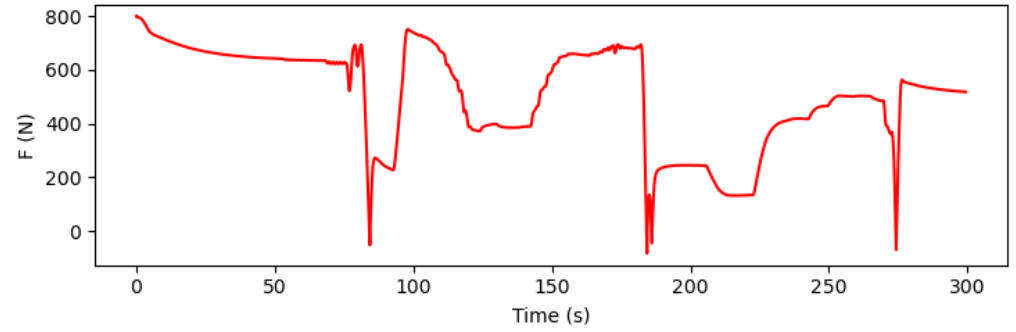












Exercise 2 : Evaluation Results