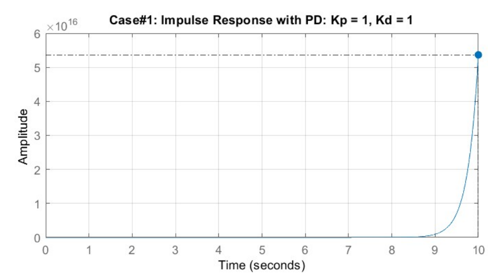
Day 9 – Compare the result

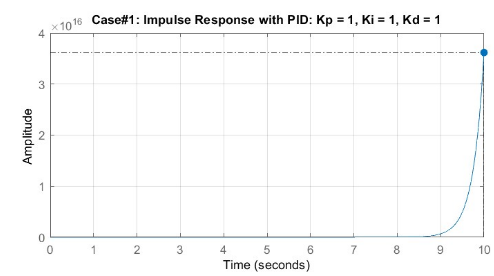
Comparing the various cases of PD and PID controller:

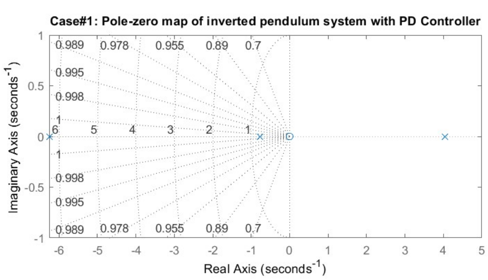
Combination of K_p, K_d, K_i:

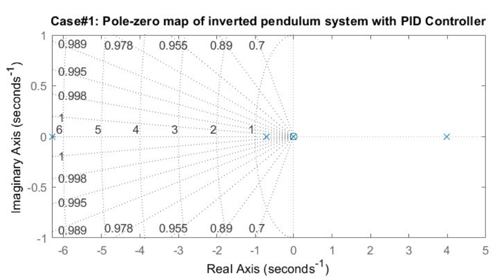
	PD controller		PID controller		
Cases	**K_p**	**K_d**	**K_p**	**Ki**	**K_d**
Case 1	1	1	1	1	1
Case 2	10	1	10	1	1
Case 3	100	1	100	1	1
Case 4	100	10	100	10	1
Case 5	100	20	100	1	10
Case 6	100	25	100	10	30

<u>Case 1:</u>

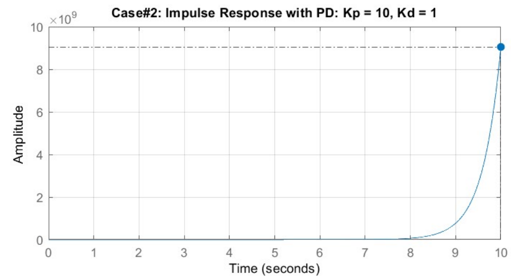


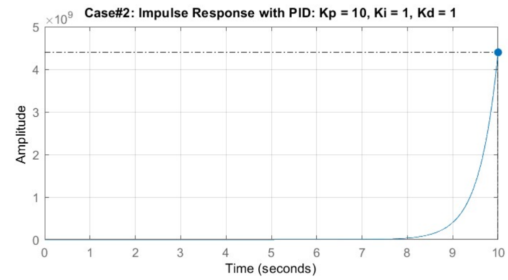


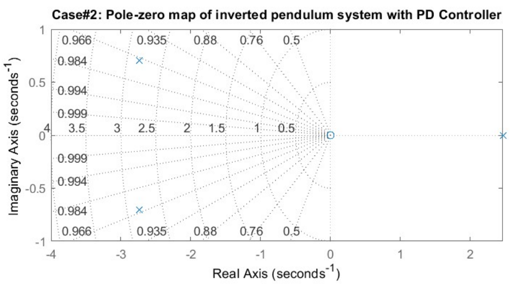


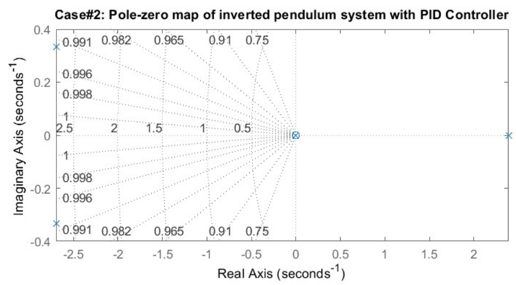


Case 2:

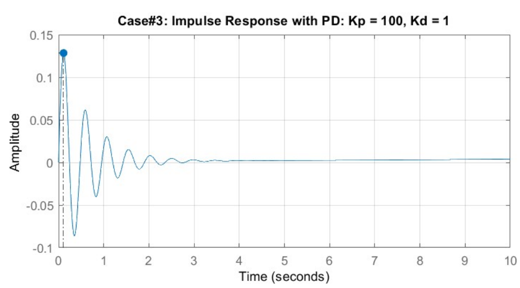

Case#2: Impulse Response with PD: Kp = 10, Kd = 1
Amplitude
Time (seconds)

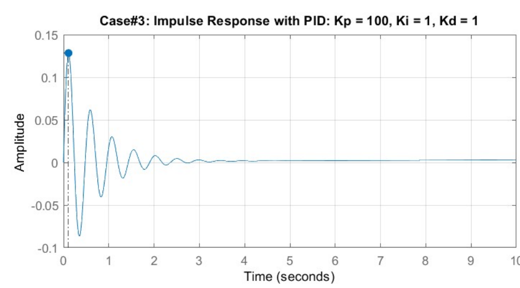

Case#2: Impulse Response with PID: Kp = 10, Ki = 1, Kd = 1
Amplitude
Time (seconds)

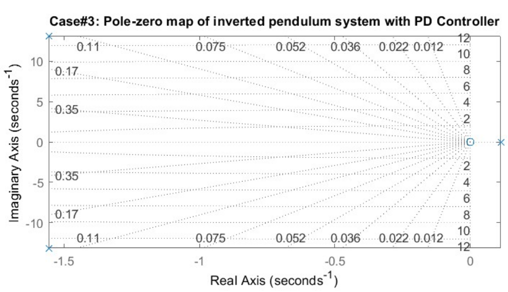

Case#2: Pole-zero map of inverted pendulum system with PD Controller
Imaginary Axis (seconds^{-1})
Real Axis (seconds^{-1})

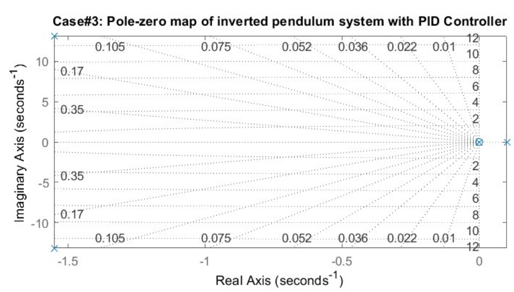

Case#2: Pole-zero map of inverted pendulum system with PID Controller
Imaginary Axis (seconds^{-1})
Real Axis (seconds^{-1})

Case 3:

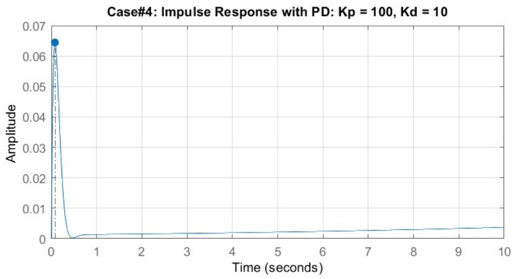

Case#3: Impulse Response with PD: Kp = 100, Kd = 1
Amplitude
Time (seconds)

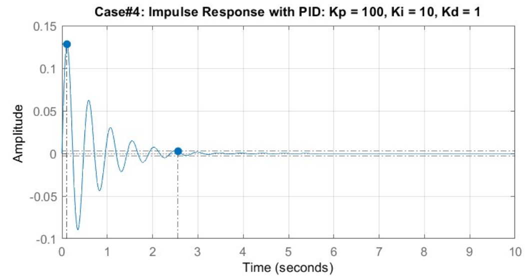

Case#3: Impulse Response with PID: Kp = 100, Ki = 1, Kd = 1
Amplitude
Time (seconds)

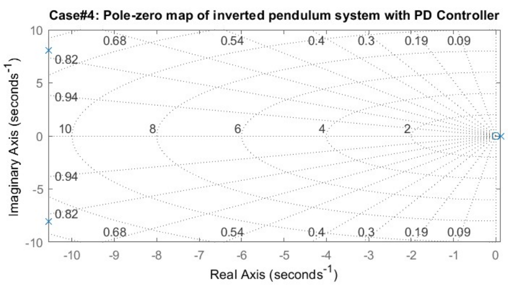

Case#3: Pole-zero map of inverted pendulum system with PD Controller
Imaginary Axis (seconds^{-1})
Real Axis (seconds^{-1})

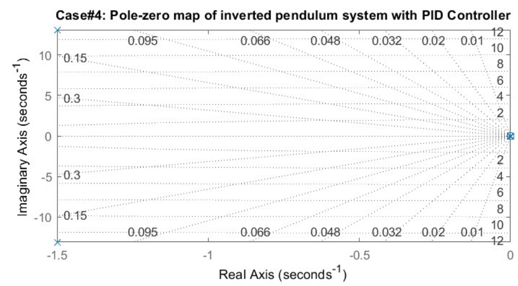

Case#3: Pole-zero map of inverted pendulum system with PID Controller
Imaginary Axis (seconds^{-1})
Real Axis (seconds^{-1})

Case 4:

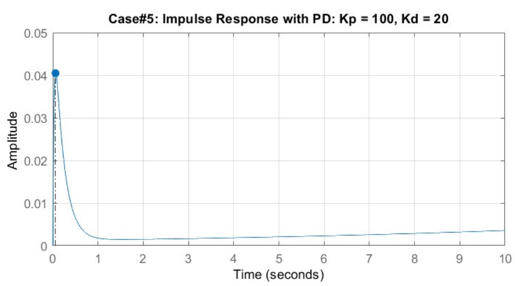

Case#4: Impulse Response with PD: Kp = 100, Kd = 10
Amplitude
Time (seconds)

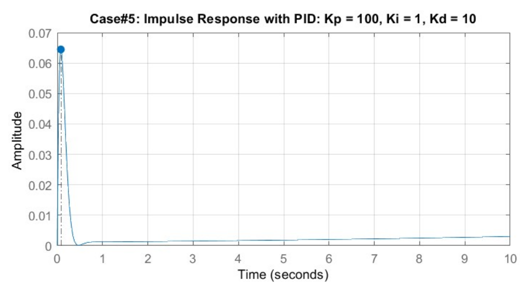

Case#4: Impulse Response with PID: Kp = 100, Ki = 10, Kd = 1
Amplitude
Time (seconds)

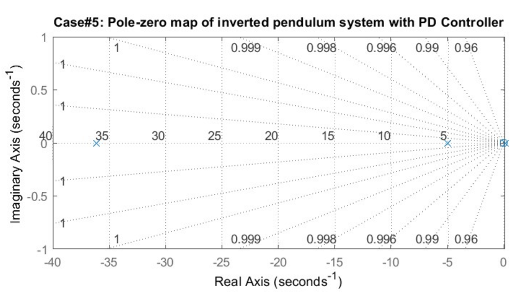

Case#4: Pole-zero map of inverted pendulum system with PD Controller
Imaginary Axis (seconds^{-1})
Real Axis (seconds^{-1})

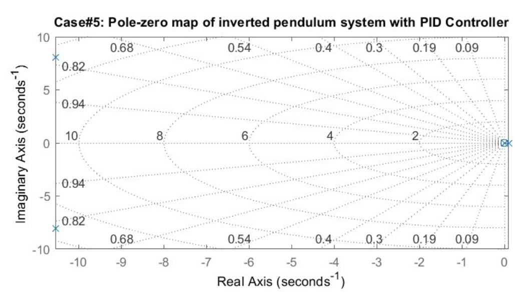

Case#4: Pole-zero map of inverted pendulum system with PID Controller
Imaginary Axis (seconds^{-1})
Real Axis (seconds^{-1})

Case 5:

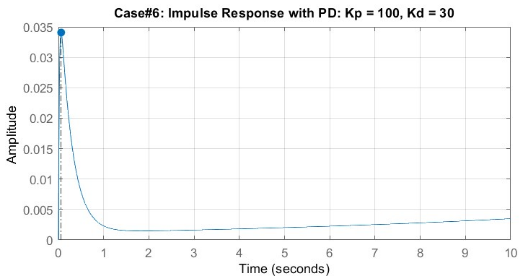

Case#5: Impulse Response with PD: Kp = 100, Kd = 20
Amplitude
Time (seconds)

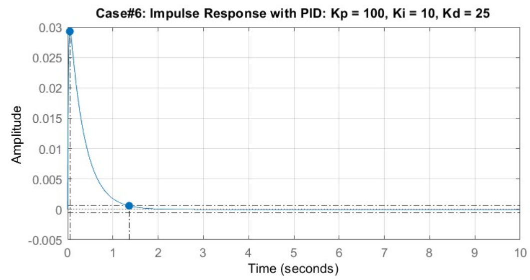

Case#5: Impulse Response with PID: Kp = 100, Ki = 1, Kd = 10
Amplitude
Time (seconds)

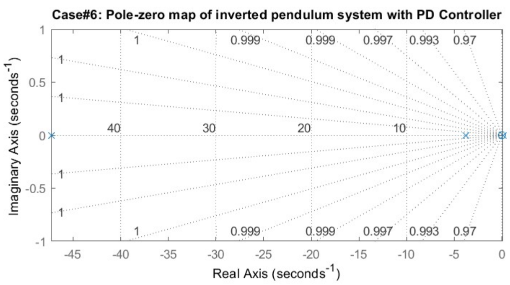

Case#5: Pole-zero map of inverted pendulum system with PD Controller
Imaginary Axis (seconds^{-1})
Real Axis (seconds^{-1})

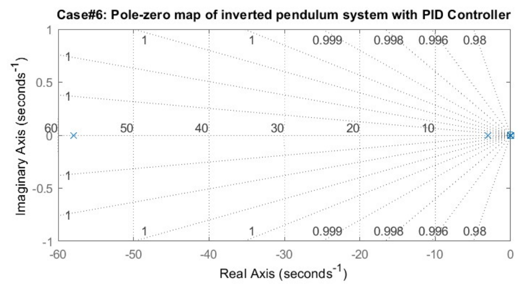

Case#5: Pole-zero map of inverted pendulum system with PID Controller
Imaginary Axis (seconds^{-1})
Real Axis (seconds^{-1})

Case 6:









Conclusion/Outcomes:

- On comparing the PD and PID controller being used for stabilizing the inverted pendulum system, the PID controller is the best option and is the best to stabilize the system as studied above.
- The PD controller also make the impulse response stable, but one pole is left in the RHP of the s-plane and hence this makes the system unstable.
- On using the PID controller, the integral part of the PID controller shifts that one pole in the RHP of the s-plane to the LHP.
- *Case #6* i.e., $K_p = 100$, $K_i = 10$, $K_d = 25$ is the best and the optimum case in tuning the PID controller for the system, since beyond $K_i > 10$ will make the response to move below the 0 line, and also increasing the K_p more will increase oscillations in the system. Increasing K_d more will increase the overshot, which is not desired.