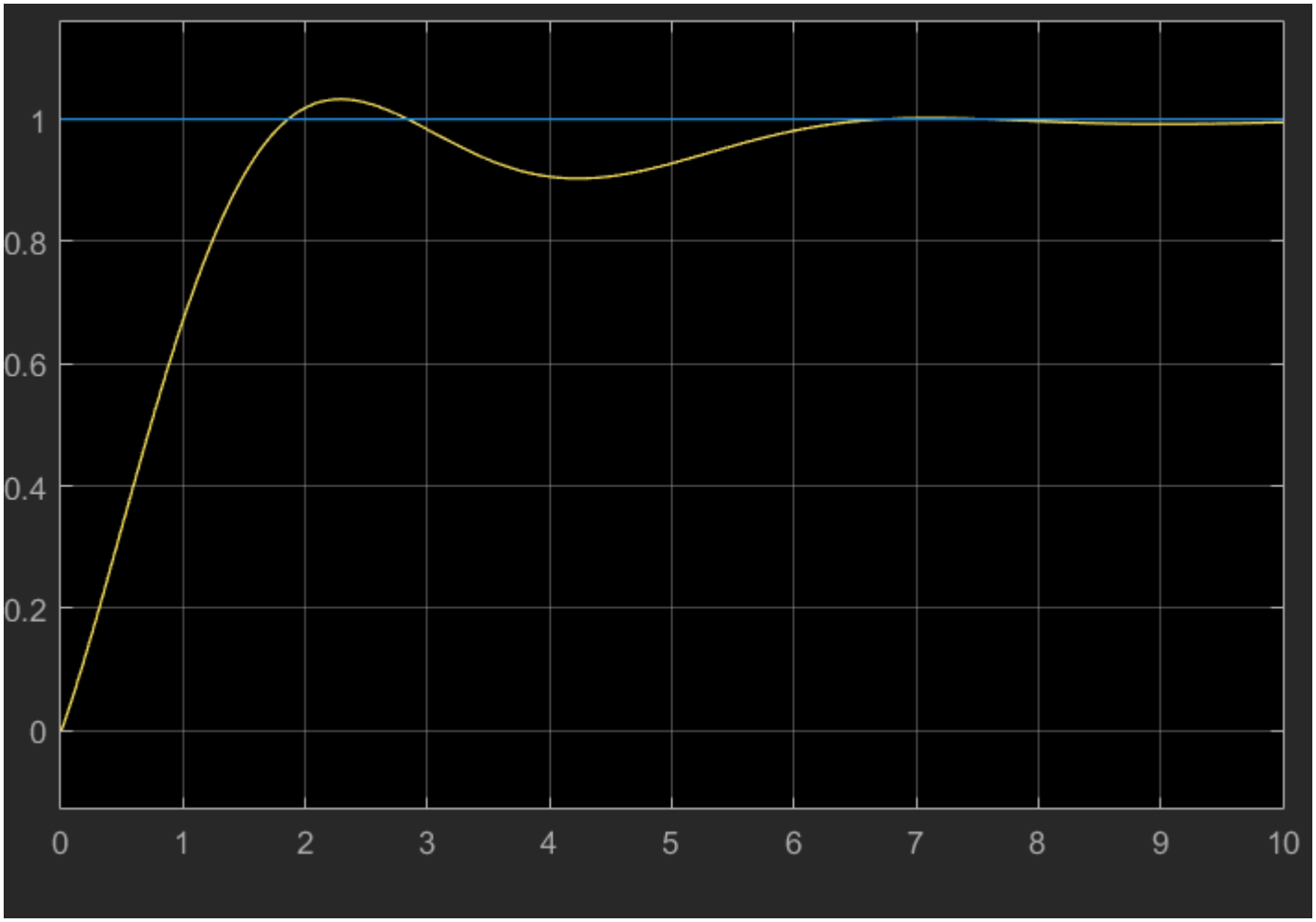
Used inbuilt pid tuner

Figure 1:

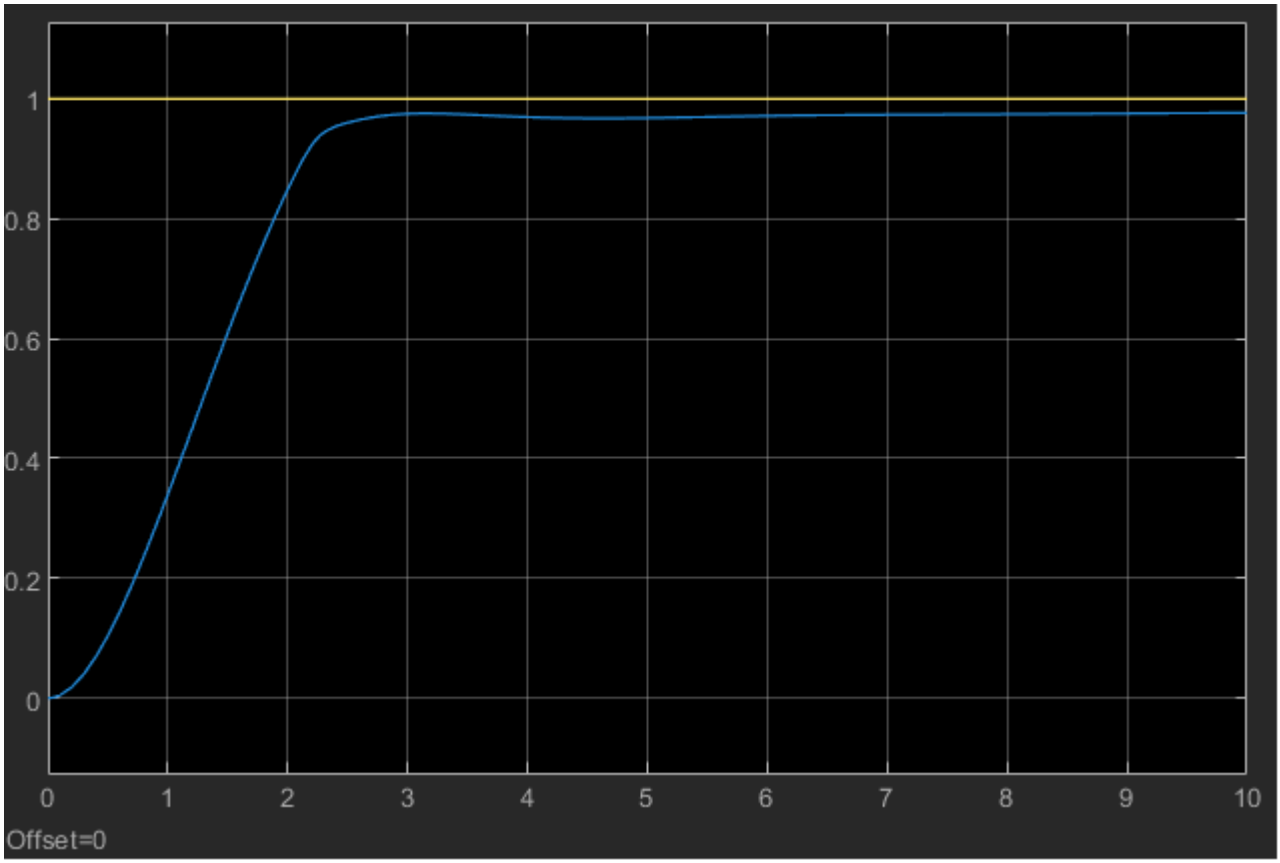


This figure demonstrates the response of the nonlinear mass-spring-damper system when controlled using a conventional PID tuner. The PID parameters were manually tuned to achieve stable performance. While the system settles around the target setpoint, there is noticeable overshoot and oscillation in the transient phase. The conventional tuner lacks adaptability, making it less effective in responding to changes in system dynamics or varying external inputs.

Used trained RLtd3 agent for pid tuning

First trail

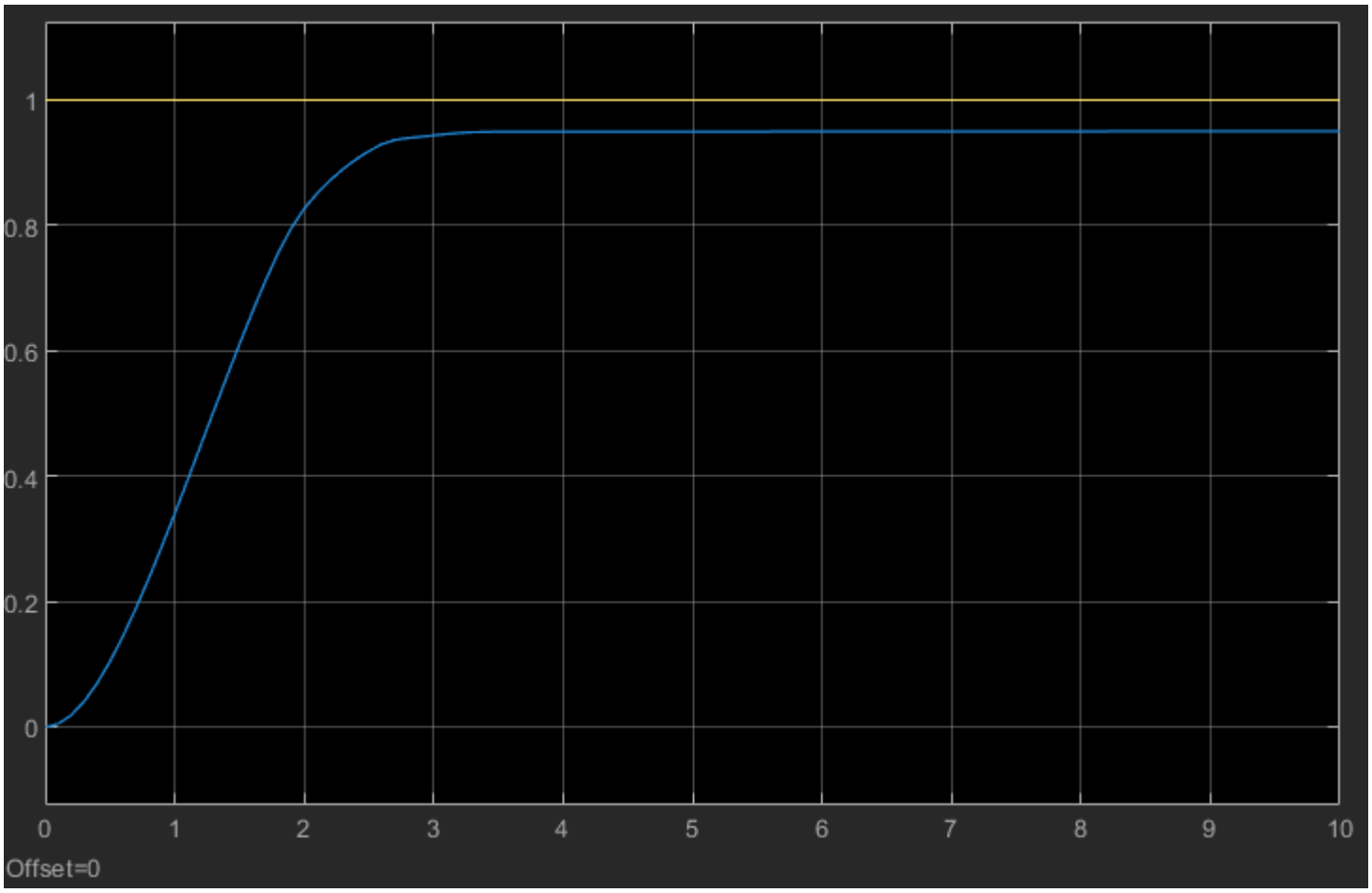
Figure 2: used trained td3rl agent in constant 1 input



This figure shows the initial performance of the TD3-RL agent controlling the nonlinear system. The agent was trained with a constant input and was able to reduce oscillations significantly compared to the conventional PID controller. However, the response shows that the agent is still learning to reach the target setpoint effectively, and further fine-tuning is required to improve performance.

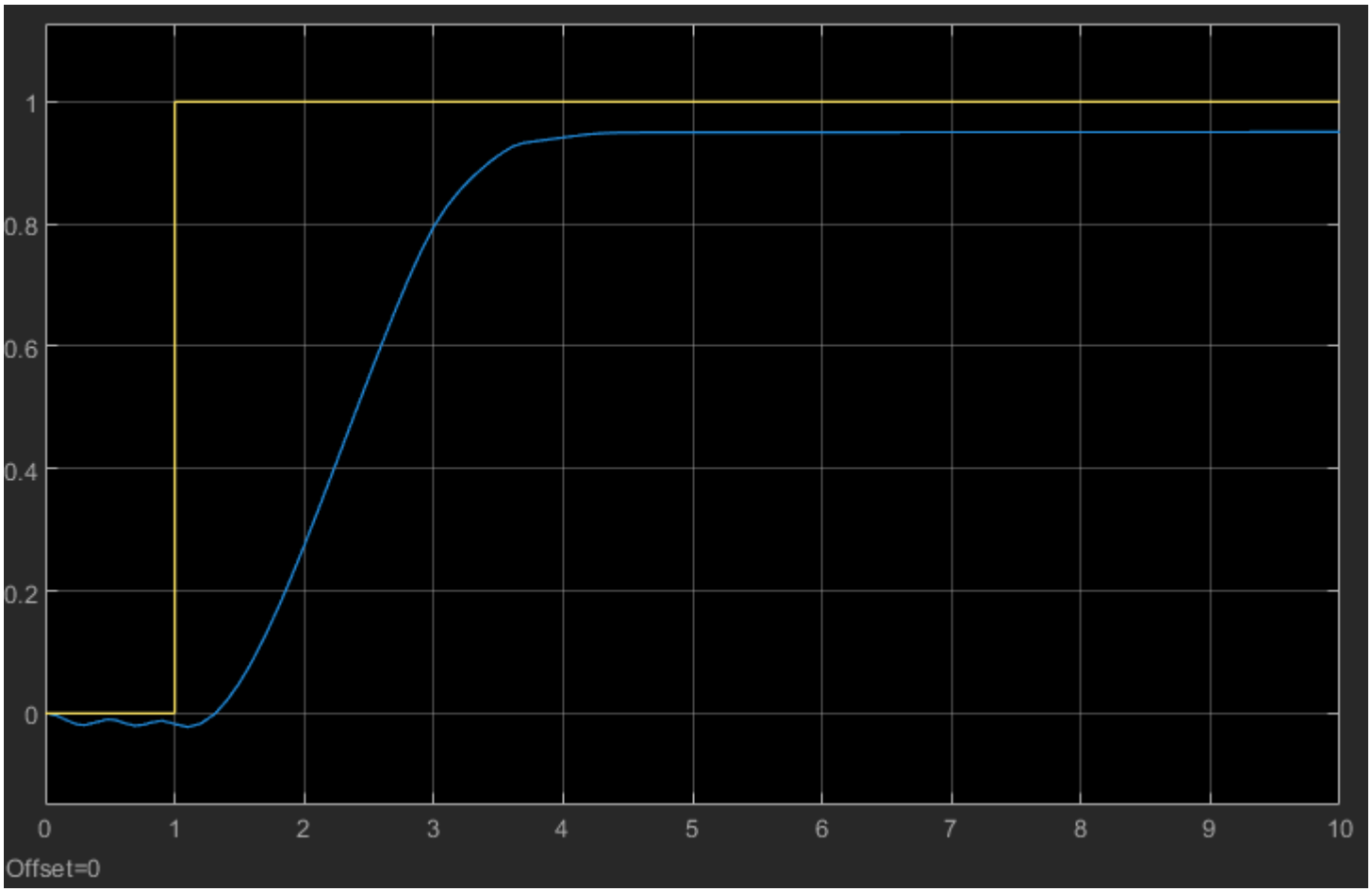
Second try

Figure 3: used trained td3rl agent in constant 1 input



After additional training, the TD3-RL agent demonstrates improved performance. The agent achieves better stability around the target setpoint with minimal overshoot and quicker settling time compared to the initial simulation. This figure highlights the adaptability of the TD3 algorithm in learning optimal control strategies for the nonlinear system.

Figure 4: used trained td3rl agent in step input also



This figure illustrates the step response of the system when controlled by the fully trained TD3-RL agent. The agent effectively tracks step changes in the target input, showcasing minimal overshoot, fast settling, and smooth transitions. This performance demonstrates the ability of the RL-based PID controller to handle dynamic changes in setpoints, outperforming conventional PID methods in terms of adaptability and precision.

Conclusion for Figures:

The four figures collectively highlight the progression and effectiveness of the TD3-RL agent in controlling a nonlinear mass-spring-damper system. Initially, the conventional PID controller shows stable but less adaptive performance with noticeable overshoot and slower settling time. As the TD3-RL agent trains and fine-tunes its strategy, the results demonstrate significant improvements, including reduced overshoot, faster settling time, and smooth tracking of step inputs. The final trained agent outperforms the conventional PID controller, showcasing the advantages of reinforcement learning in dynamic and nonlinear control tasks.