

Project 1 Report - ME155C/ECE147C

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Abstract

1 Introduction

2 System Identification

2.1 Process to be controlled

The process we are controlling is a two cart system connected by a spring. The system is driven by a motor that's given a voltage V [Volt], which produces a force F [N] applied to the first cart with mass m_1 [kg], and the second cart with mass m_2 [kg] is connected to the first cart via a spring with spring constant k [N/m]. In this system, x_1 [m] is the position of the first cart, and x_2 [m] is the position of the second cart. The control input is the voltage $u := V$ [Volt] applied to the motor, and the measured output is the position $y := x_2$ [m] of the second cart.

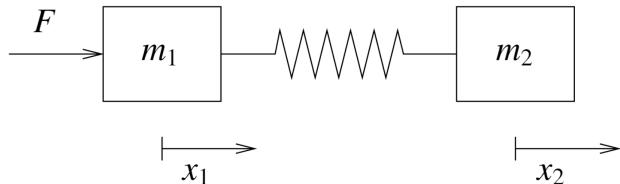


Figure 1: Two cart system

2.2 Non-Parametric Identification

The non-parametric identification method used was sine-wave testing in conjunction with the correleation method. This strategy consists of applying sinusoidal inputs at distinct frequencies to calculate the magnitude and phase of the frequency response at that frequency from the output of the system.

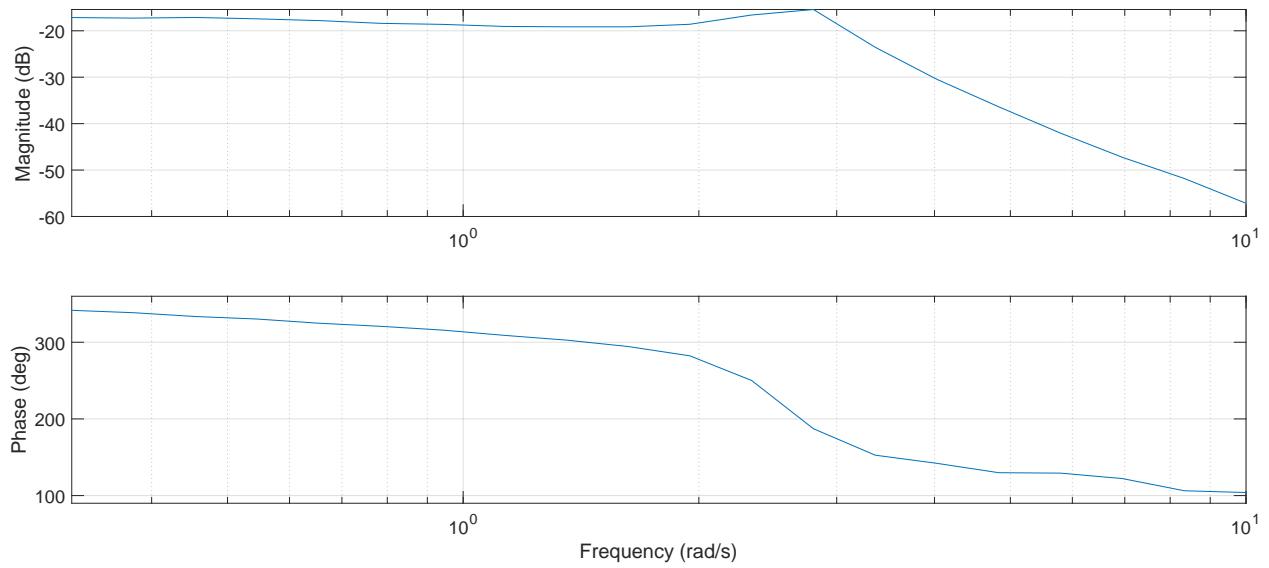


Figure 2: Bode plot of the identified system using non-parametric identification

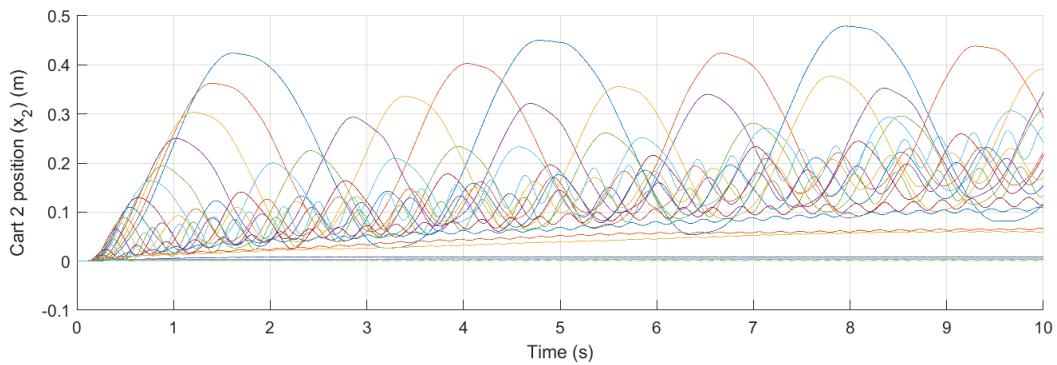


Figure 3: Output signals of all experiments for parametric identification

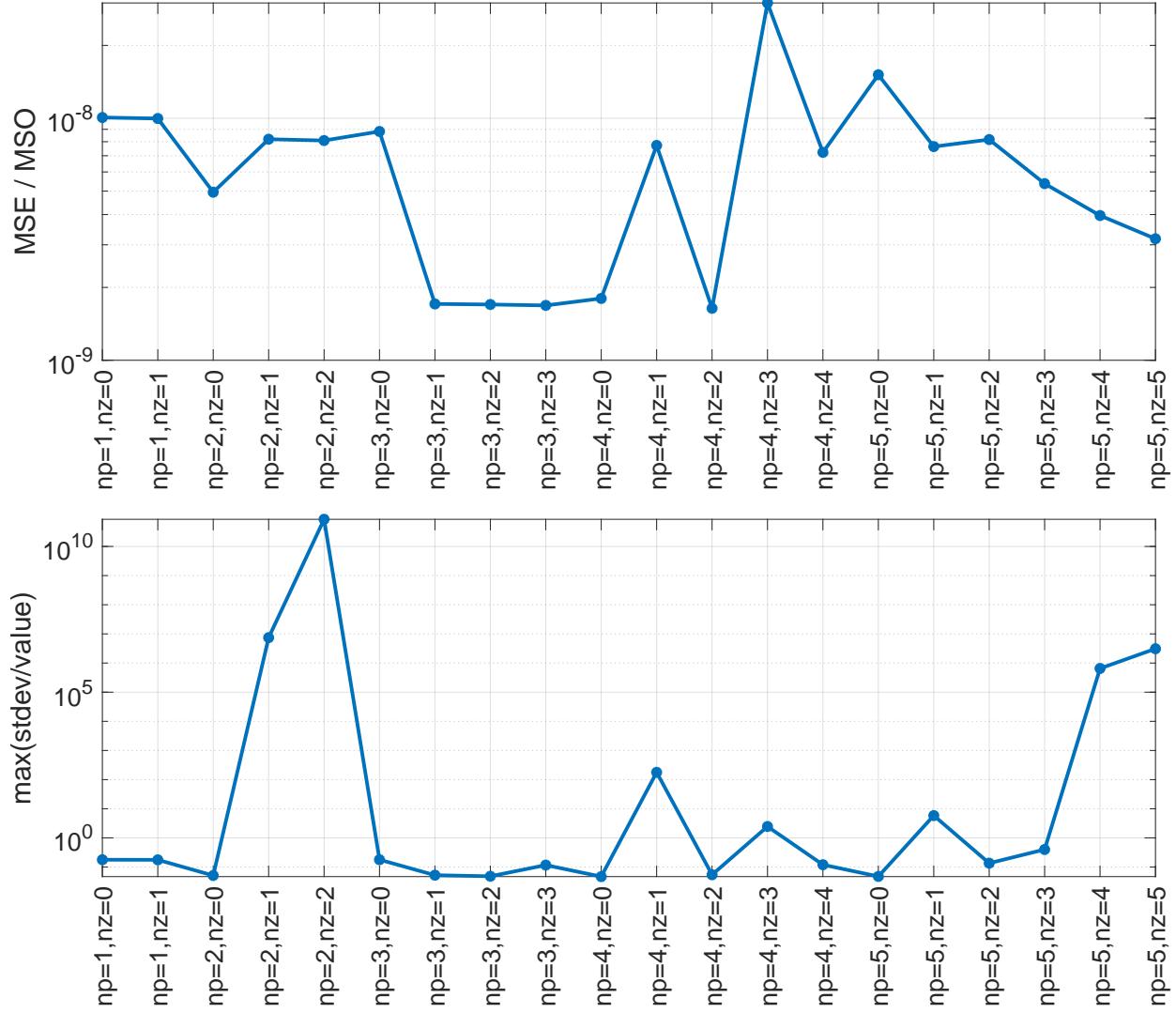


Figure 4: Normalized MSE and worst parameter standard deviation for different model orders

2.3 Parametric Identification

3 Controller Design

3.1 Design Methodology

3.2 Simulation Results

4 Closed-loop Testing

4.1 Step Response Experiments

4.2 Closed-loop Frequency Response

5 Conclusions and Future Work

References

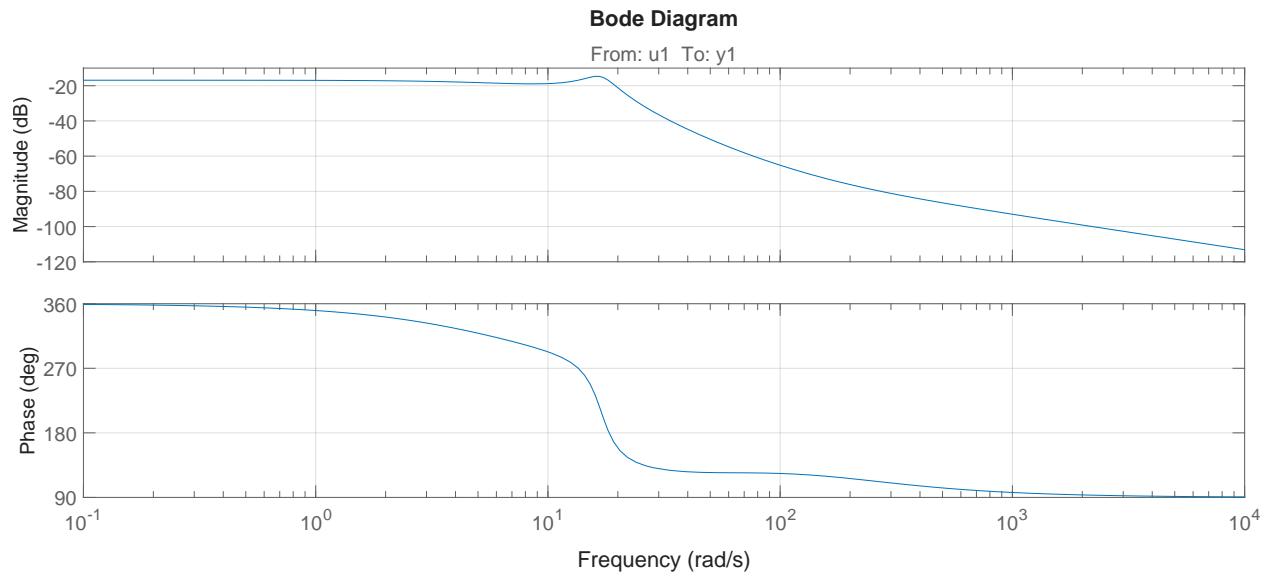


Figure 5: Bode plot of the identified system using parametric identification

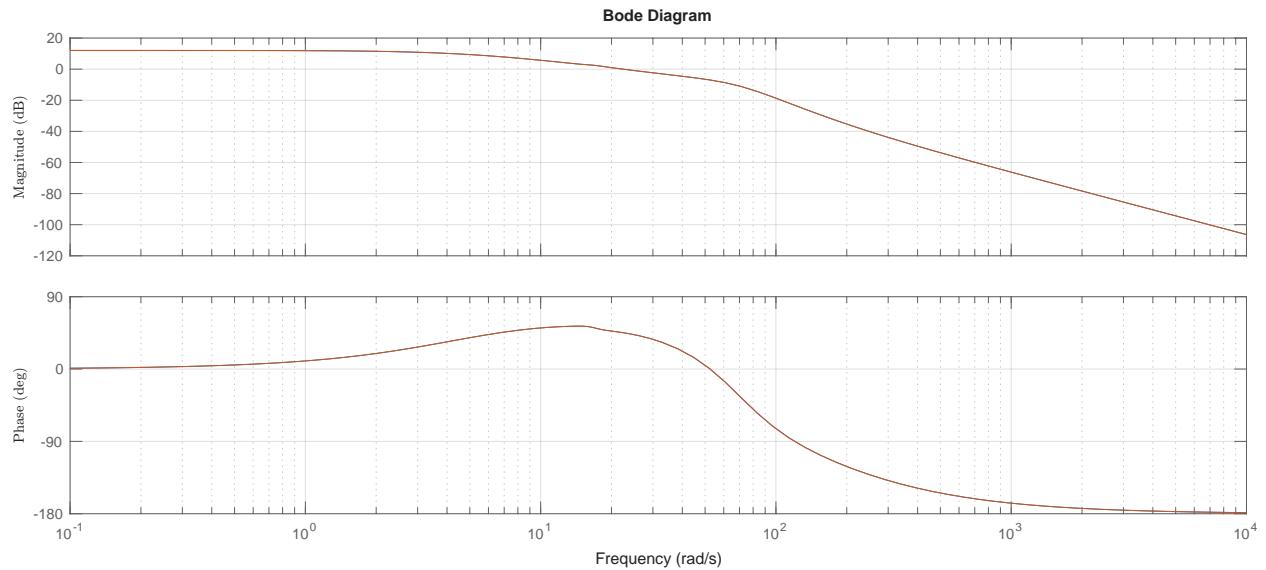


Figure 6: Bode plot of complementary sensitivity function of simulated controller

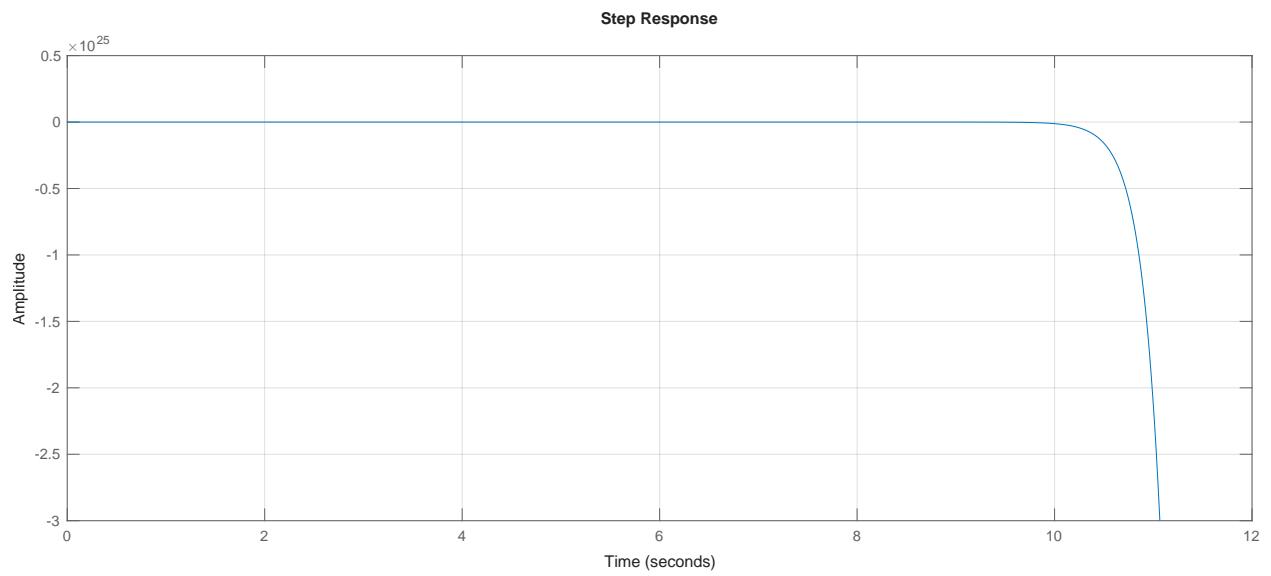


Figure 7: Simulated closed-loop step response

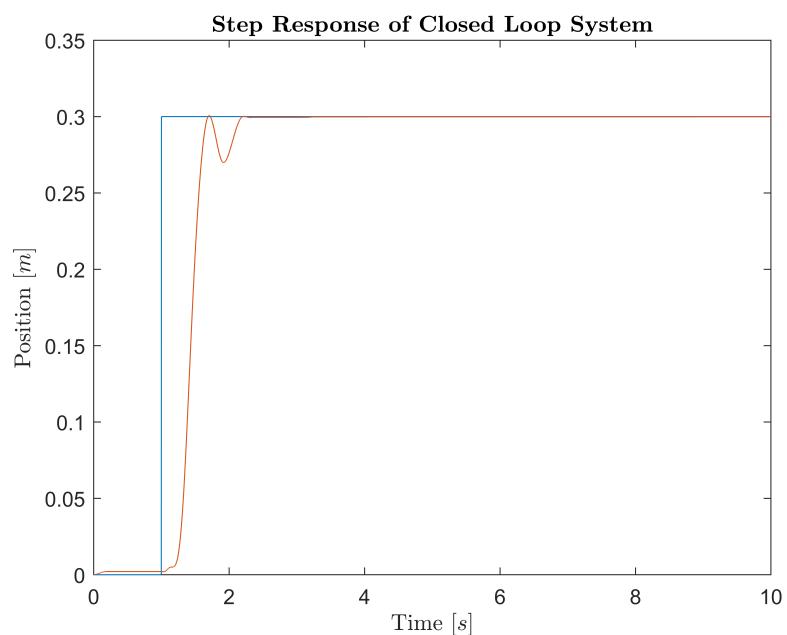


Figure 8: Closed-loop step response

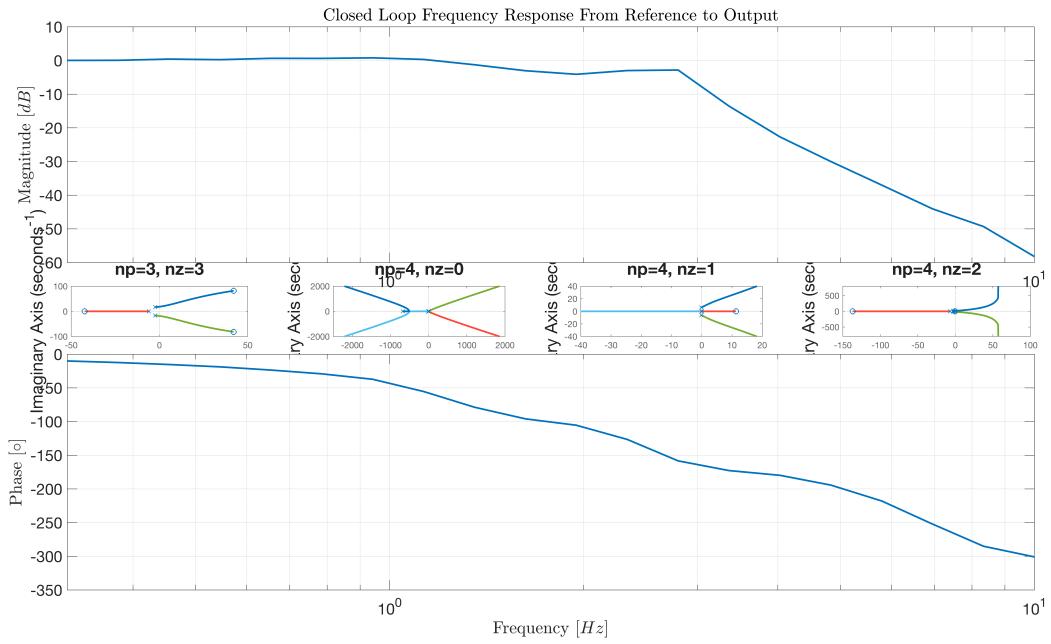


Figure 9: Closed-loop frequency response of the transfer function from reference to output

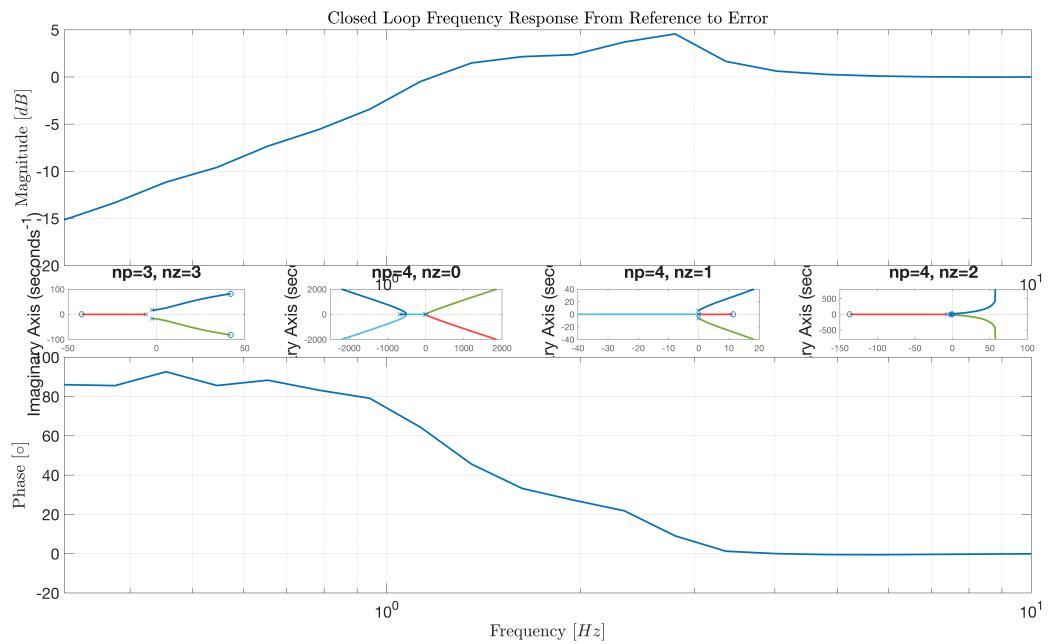


Figure 10: Closed-loop frequency response of the transfer function from reference to error