

ME 256 – Homework 3

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1. Q1: Comparison Plots for True and Nominal Plants with Varying Damping

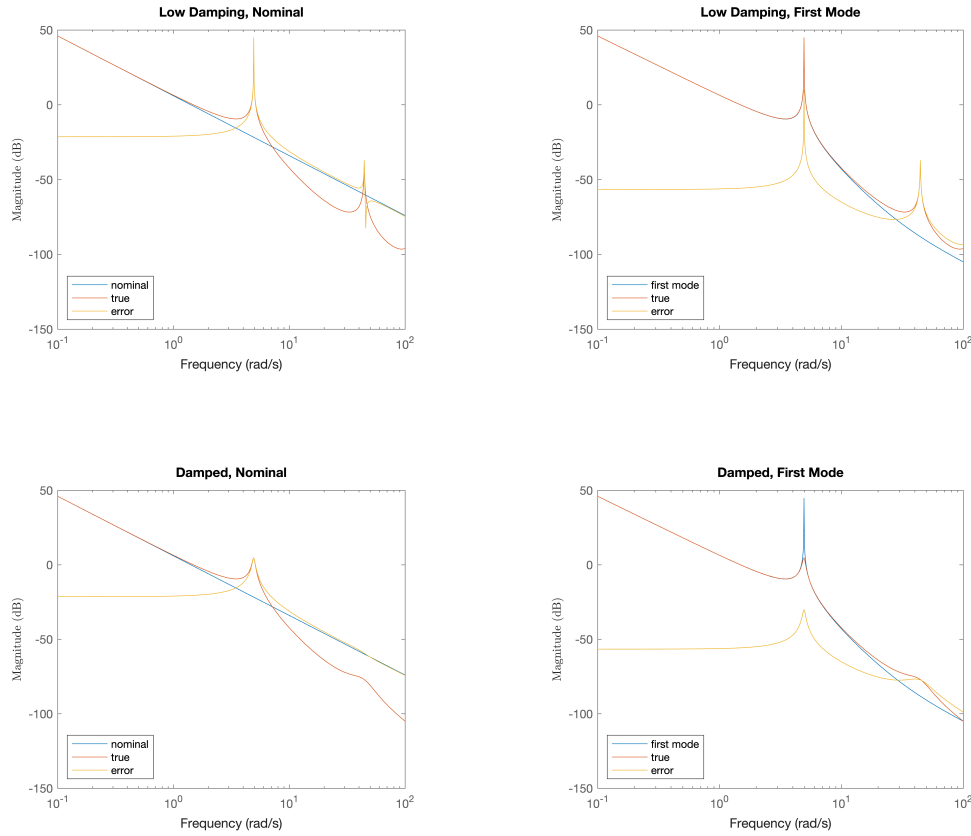


Figure 1: The nominal, the true, and the relative error system Bode plots together for comparison.

2. Q2/Q3: Step Responses: Nominal vs. True Plant

The 'good' controller achieves a settling time of about 2 seconds on the nominal plant. The plot also shows the response of the later designed 'robust' controller which has a much slower settling time.

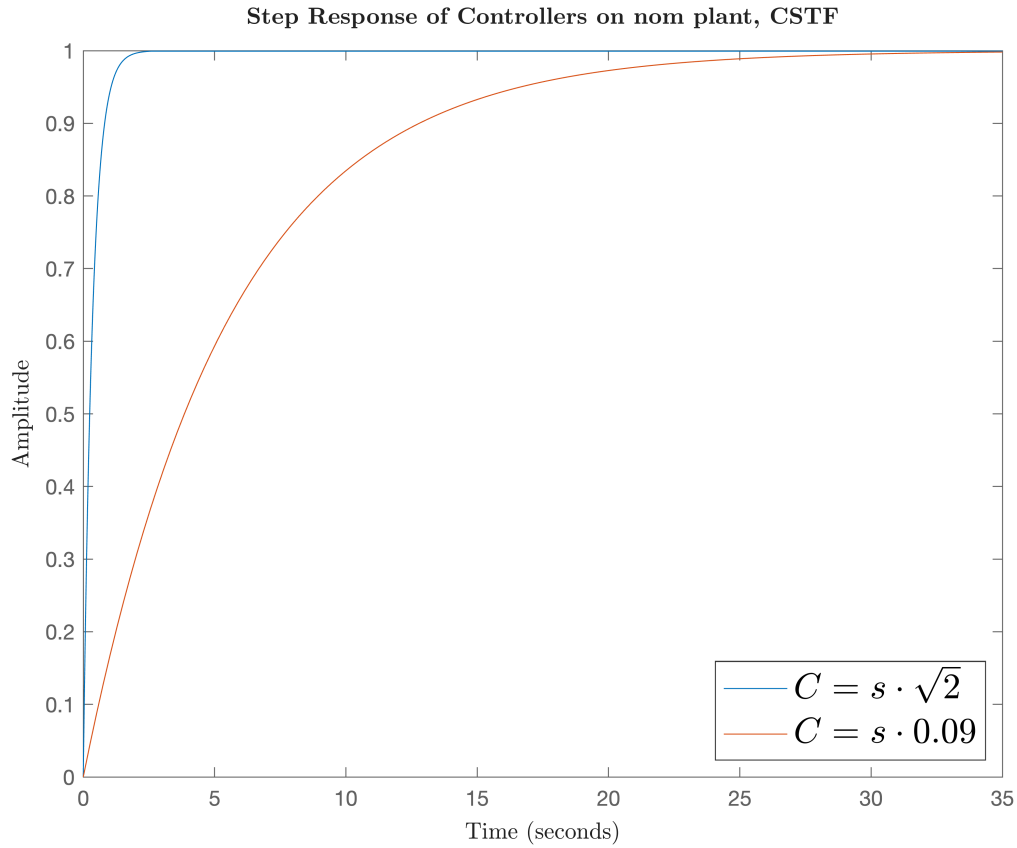


Figure 2: Step response of the nominal closed-loop system.

We see that the 'good' controller is unstable while the 'robust' one at least visually looks to have Lyapunov Stability.

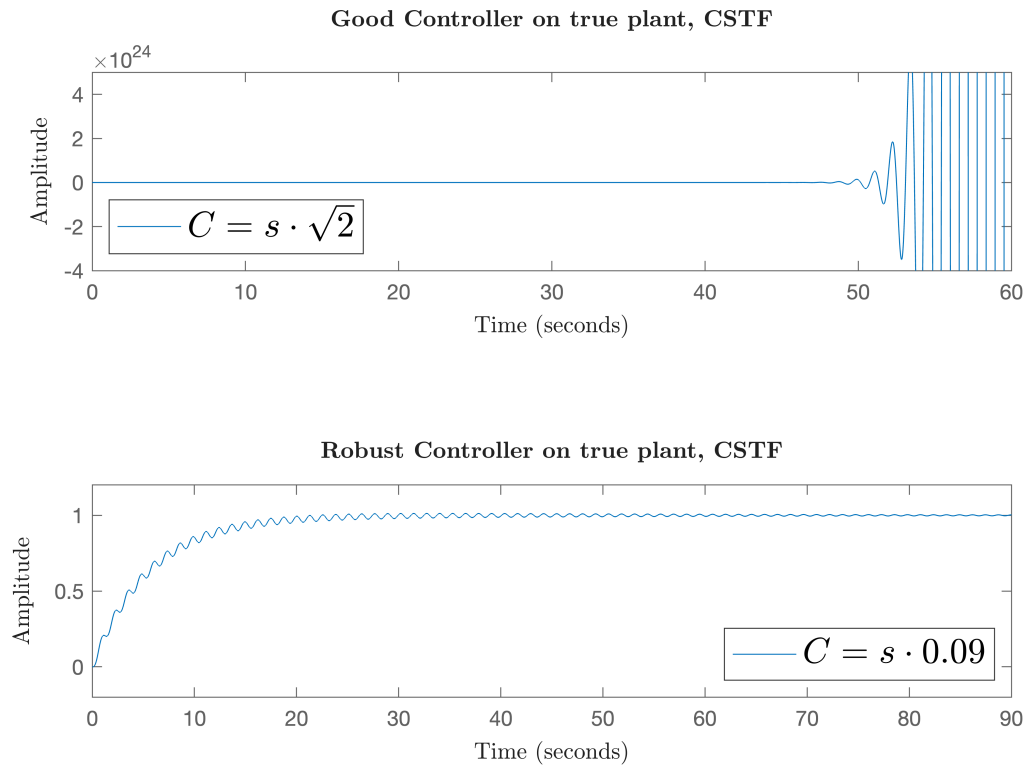


Figure 3: Step response of the true plant with designed controller.

3. Q3: Closed-Loop Sensitivity and Performance

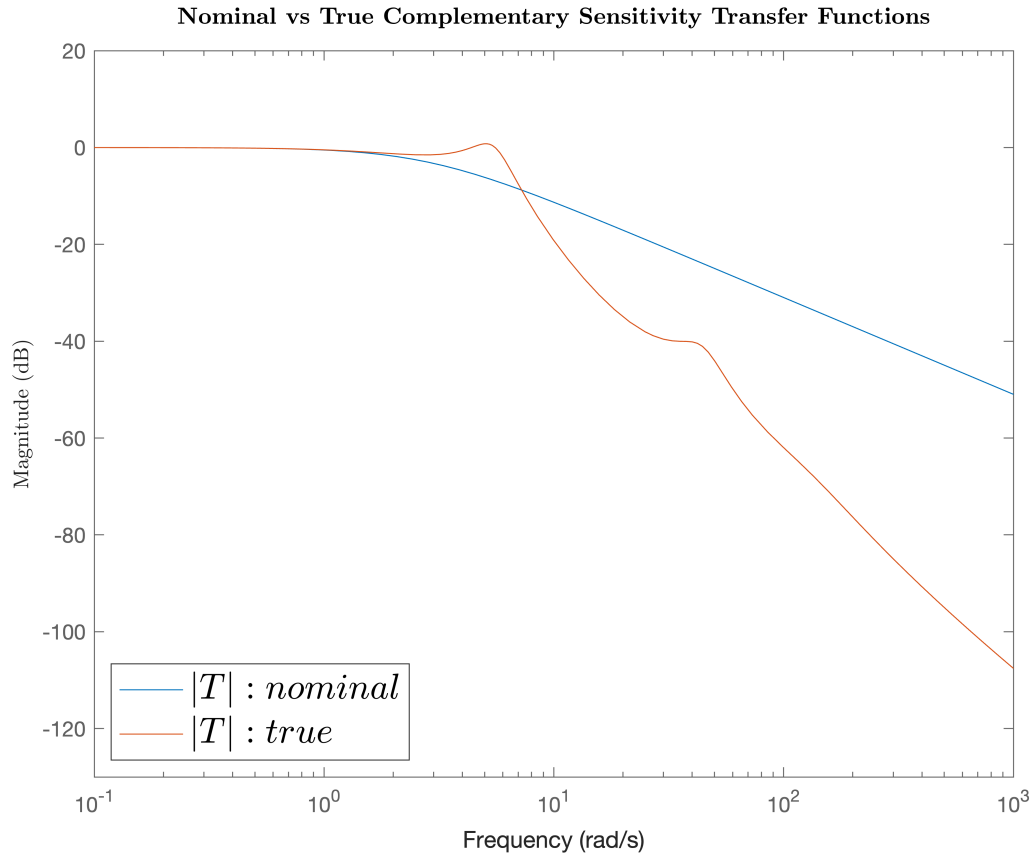


Figure 4: Complementary sensitivity transfer functions for various controllers.

4. Q3: Weighting and Controller Design

Here, a transfer function:

$$W_0 = \frac{80 \cdot s + 1}{8 \cdot s^2 + 3 \cdot s + 200}$$

is chosen to find a slightly conservative bound on the nominal plant with multiplicative uncertainty to cover the true plant behavior.

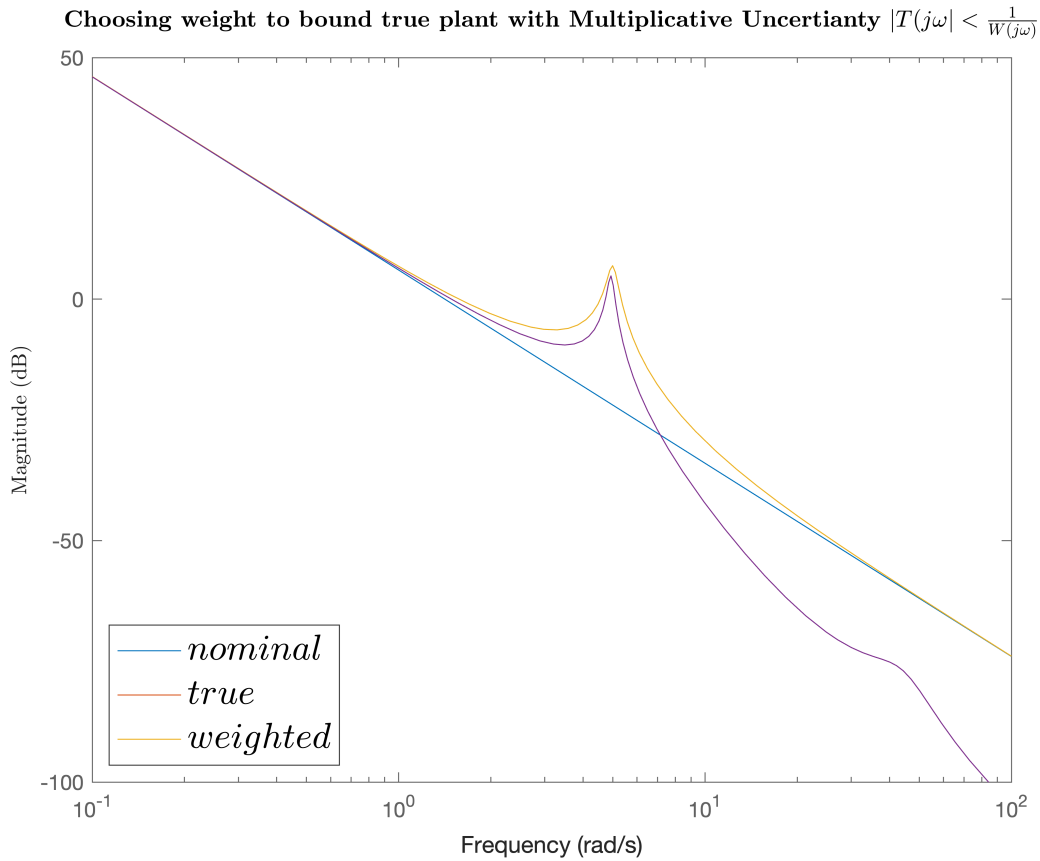


Figure 5: Weighted plant used in controller synthesis.

Steady state tracking will be gone after around 10 Hz since the weighted plant becomes very conservative with, staying with the nominal as frequency increases. A guess would be 8 Hz for 1 % tracking accuracy.

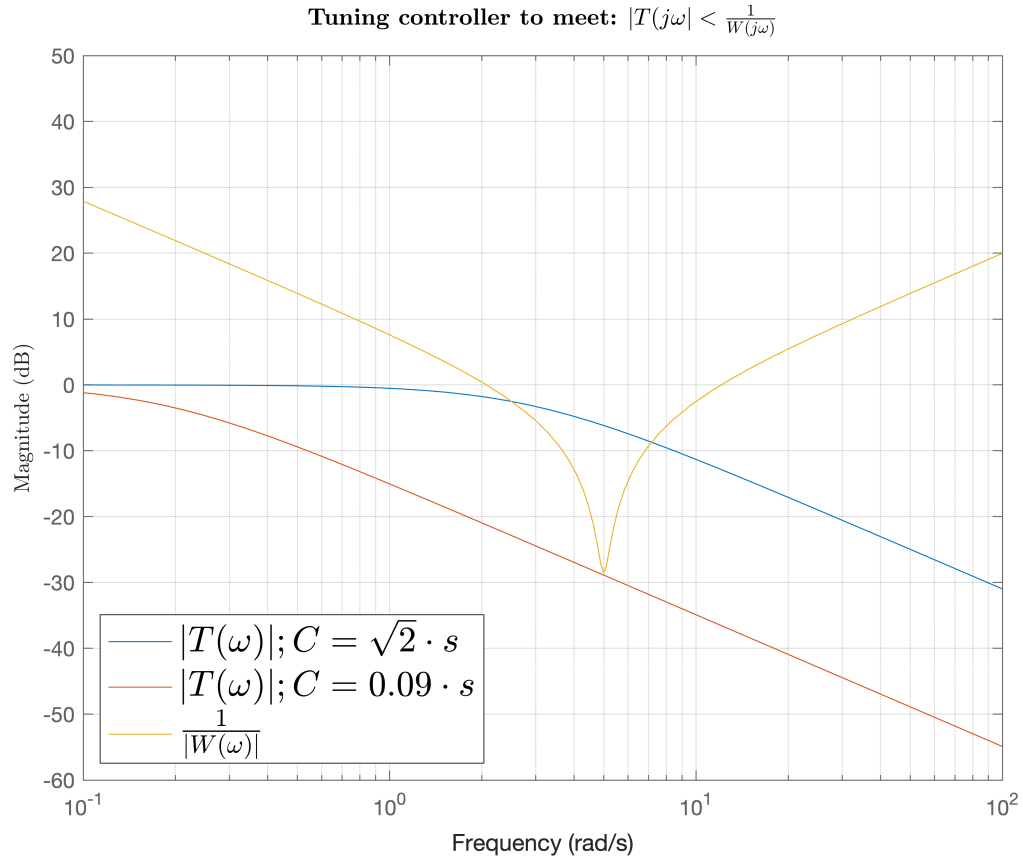


Figure 6: Conditions for robust performance and stability.

The 'good' controller chosen for the nominal plant does not meet the bound for robust stability, so the gain is decreased to meet the conditions. This controller is used in the previous plots.