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EECS 304 Spring 2012

Frequency Domain Design Project

# Introduction

In this project, we were given a plant representing the yaw control system of a wind turbine. The system, which had the transfer function

had to be controlled with two different controller topologies to achieve 2% settling in 2 seconds from a step response with less than 60% overshoot. The first topology was a two-pole, two-filter design. The second topology was a PID controller with a built-in low pass filter.

# Methodology

For the two-pole, two-zero controller, I used MatLab's rltool and manually moved the poles and zeros until the root locus showed that it would be possible to achieve a fast controller with relatively high damping. I then selected a gain using the root locus.

For the PID controller, I began with the "optimal" PID controller generated by rltool. I found that this controller was more conservative than necessary, and tweaked the gains to make a more aggressive controller that would bring the output to with 2% in 2 seconds.

# Results

## 2 Pole/2 Zero Controller



Root locus With Poles and Zeros Open Loop Bode Diagram with Margins



Closed loop Bode plot (BW = ~4 rad/s)









## PID Controller



Root locus With Poles and Zeros Open Loop Bode Diagram with Margins



Closed Loop Bode plot (BW = ~2.5 rad/sec)









# Comments and Conclusions

These two controllers achieved very different results, even though both satisfied the design requirements. The two-pole, two-zero controller was a higher bandwidth controller, so it had a faster rise time and a faster recovery from step disturbance. However, this came at the cost of much more energy wasted by high actuator efforts, particularly when noise was added to the system. The PID controller was much slower (increasing the gain could have made it faster), but used much less energy in the form of actuator effort. It rejected higher frequency noise, which caused it to use much less actuator effort when noise was added to the system. The PID controller performs worse at ramp tracking, but that is also not specified in the system specifications. Over all, given the performance of these two controllers, I would base my choice on additional information about the characteristics of the noise in the system. Both fulfill the design parameters. Although the two pole / two zero controller is faster, the extra speed probably doesn't matter.