Phase-Lead Compensation of a Rotational Rigid-Body System*

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Abstract

The objective of this lab is to use frequency domain techniques to design a phase-lead compensator for a rigid, rotational disk. The controller will be designed and implemented in LabVIEW using the Simulation Module and Control Design Toolkit.

1 Phase-Lead Compensation of a Rotational Rigid-Body System

1.1 Objectives

1. Use frequency domain techniques to design a phase-lead compensator for a rigid, rotational disk.

1.2 Pre-Lab

1. Derive the equations of motion for the 1DOF rotational system that you will control in this lab. The plant configuration is shown below. The disk will be loaded with four $0.5kg$ brass weights placed at a distance $9.0cm$ from the center of rotation.

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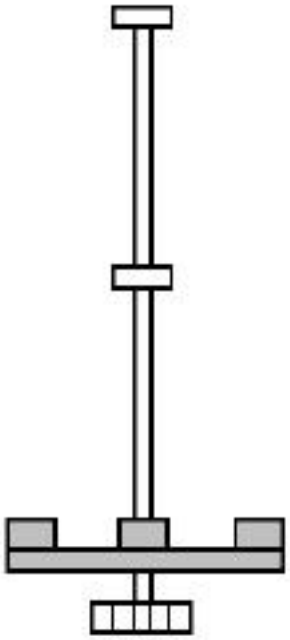

Figure 1: Rotational Rigid Body Plant Configuration

1. Design and simulate a phase-lead compensator that satisfies the following performance specifications:
   (a) Zero steady-state error to a step input.
   (b) Gain margin $\geq 15\,db$
   (c) Phase Margin $\geq 45^o$

1.3 Lab Procedure

1. Configure the plant for this experiment.
2. Code your phase-lead compensator into the control loop VI.
3. Perform a 3000 count step input, and save the plot.
4. Perform a ramp input with a velocity of 1000 counts/second and a dwell time of 3 seconds. Save the plot.

1.4 Post-Lab

1. What was the system's steady-state error to the ramp input? What would you expect it to be for a parabolic input?
2. Explain how gain margin and phase margin relate to a system's stability.