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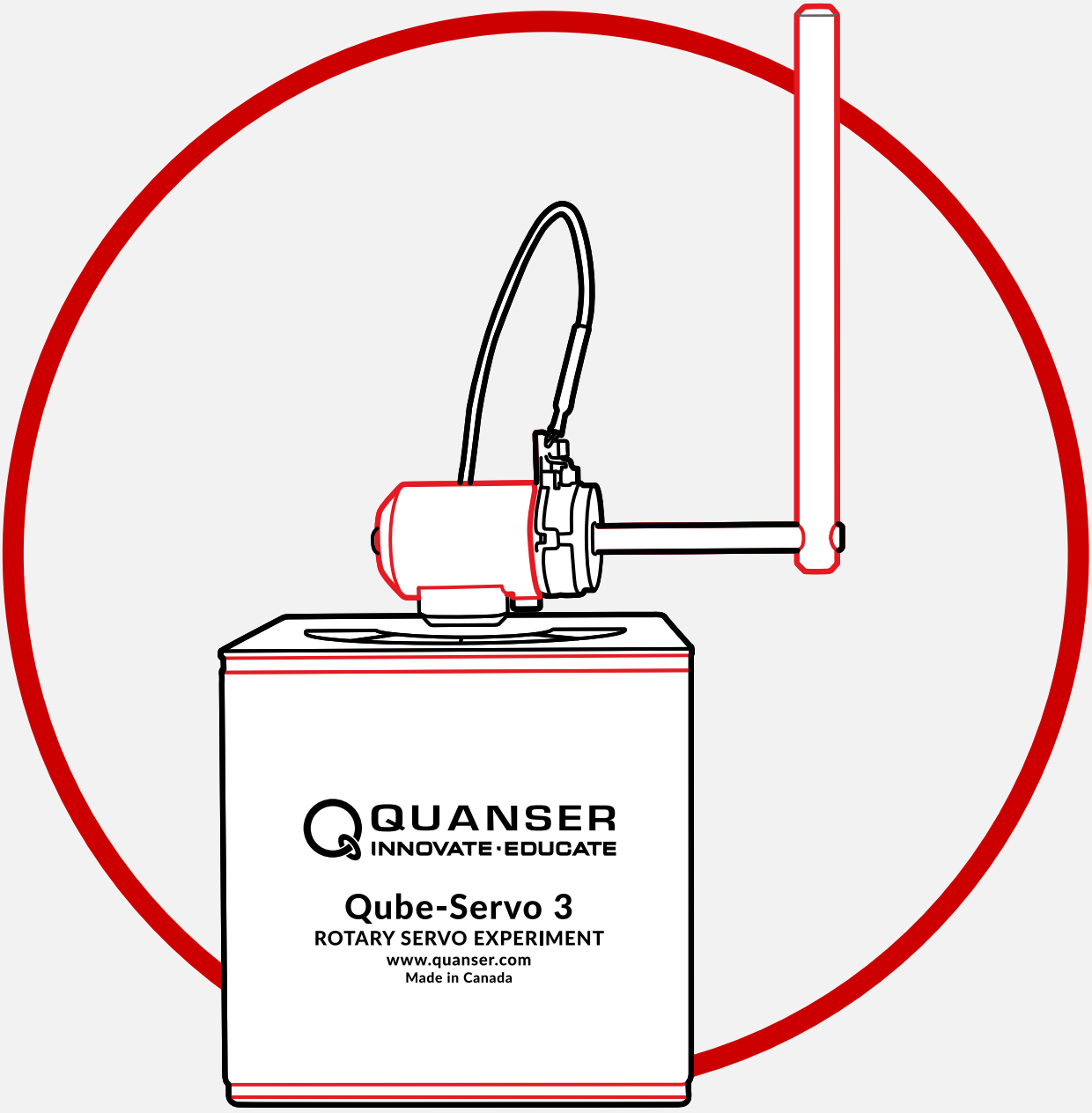


Qube-Servo 3

Lead Compensator

V1.2 – 27th February 2025

For more information on the solutions Quanser offers,
please visit the web site at: http://www.quanser.com

Quanser Consulting Inc.
119 Spy Court
Markham, Ontario
L3R 5H6, Canada

info@quanser.com
Phone : 19059403575
Fax : 19059403576
printed in Markham, Ontario.

Caution

This equipment is designed to be used for educational and research purposes and is not intended for use by the public. The user is responsible for ensuring that the equipment will be used by technically qualified personnel only. Users are responsible for certifying any modifications or additions they make to the default configuration.

FCC Notice This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

Industry Canada Notice This Class A digital apparatus complies with CAN ICES-3 (A). Cet appareil numérique de la classe A est conforme à la norme NMB-3 (A) du Canada.
Japan VCCI Notice This is a Class A product based on the standard of the Voluntary Control Council for Interference (VCCI). If this equipment is used in a domestic environment, radio interference may occur, in which case the user may be required to take corrective actions.

この装置は、クラス A 情報技術装置です。この装置を家庭環境で使用すると電波妨害を引き起こすことがあります。この場合には使用者が適切な対策を講ずるよう要求されることがあります。 VCCI-A

Waste Electrical and Electronic Equipment (WEEE)
This symbol indicates that waste products must be disposed of separately from municipal household waste, according to Directive 2012/19/EU of the European Parliament and the Council on waste electrical and electronic equipment (WEEE). All products at the end of their life cycle must be sent to a WEEE collection and recycling center. Proper WEEE disposal reduces the environmental impact and the risk to human health due to potentially hazardous substances used in such equipment. Your cooperation in proper WEEE disposal will contribute to the effective usage of natural resources.

电子信息产品污染控制管理办法 (中国 RoHS)

中国客户Quanser Consulting Inc. 关于关于限制在电子电气设备中使用某些有害成分的指令 (RoHS)。

CE Compliance

This product meets the essential requirements of applicable European Directives as follows:
- 2014/30/EU; Electromagnetic Compatibility Directive (EMC)

Warning: This is a Class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

Qube-Servo 3 – Application Guide

Lead Compensator

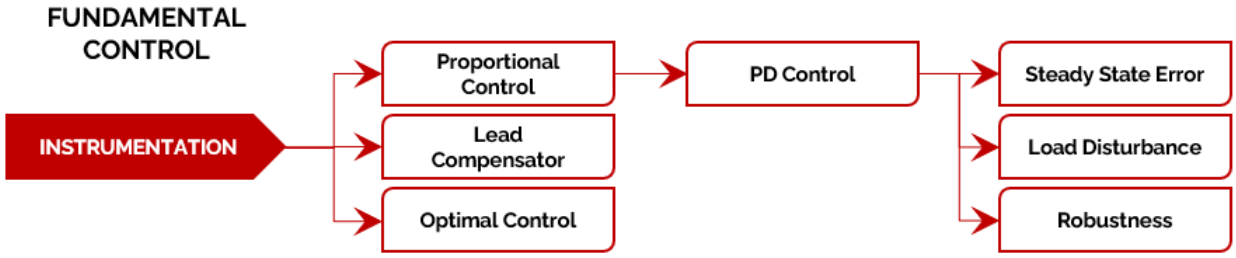
Why explore Lead Compensators?

PID controllers are often reliable in their performance, but certain applications may require the controller of a system to be extremely responsive and accurate. A lead compensator can improve the transient response and stability of a system. A lead compensator is essentially a PD controller and a filter combined, and it improves the response of a system by altering the phase margin and system bandwidth. These two parameters are used to affect the stability and speed of the resultant system response.

Background

This lab is part of the Fundamental Control skills progression of the Qube-Servo 3. It will give you hands-on experience in designing a lead compensator to control the speed of the DC motor on the Qube-Servo 3. A lead compensator is a PD controller and filter combined to yield better performance. The phase margin and gain crossover frequency are two important design parameters when designing a lead compensator. The phase margin is the amount of delay (or phase shift) that the system can withstand before becoming unstable. The higher the phase margin, the more stable the system and vice-versa. The gain crossover frequency relates to the bandwidth of the system. The higher the gain crossover frequency the smaller the peak time implying a faster system response.

The lab progression is as follows:



Prior to starting this lab, please review the following concept reviews (should be located in Documents/Quanser/4_concept_reviews/):

- Concept Review – Controls → PID Control (section For Qube-Servo/PD Position Control)
- Concept Review – Modeling & IO → Filtering
- Concept Review – Controls → Lead-lag compensators

Getting started

In this lab you will learn how to design a lead compensator using hand calculations to find the necessary gain and transfer function for a system. While you are performing the calculations, you will be developing a MATLAB script alongside the calculations so that you can perform quick iterations on your lead compensator design. Since lead compensator design is an iterative process, adjustments to your compensator will need to be made to achieve the performance requirements. Once the design is complete, the compensator will then be tested on the Qube-Servo 3 hardware to validate your design.

Ensure you have completed the following labs:

- **SP0 _ Instrumentation Labs**
- **Proportional Control**
- **PD Control**

- **Step Response Modelling**

Before you begin this lab, ensure that the following criteria are met:

- If using a physical Qube-Servo 3, make sure it has been setup and tested. See the Qube-Servo 3 Quick Start Guide for details on this step. Make sure the inertia disc load is attached to the Qube-Servo 3.
- If using the virtual Qube-Servo 3, make sure you have Quanser Interactive Labs open in the Qube 3 - DC Motor → Servo Workspace.
- You are familiar with the basics of Simulink. See the Simulink Onramp for more help with getting started with Simulink.