

# Qube-Servo 3

## Pendulum Interfacing & Inertia

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**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 CE

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

## Pendulum Interfacing & Inertia

### Why explore Pendulum Interfacing & Inertia?

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Accurate representation of conventions in the pendulum model is essential to ensure correct hardware behavior. For instance, positive rotations of the pendulum should yield positive angle readings from the encoders, and applying positive voltages to the motor should produce positive rotations. Misalignment with these conventions can lead to system instability.

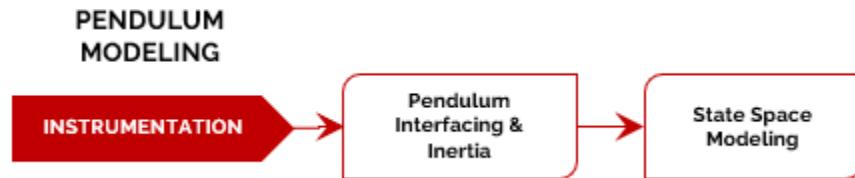
To be able to successfully model the pendulum, we also need to be able to understand its moment of inertia. This parameter can be determined analytically when pendulum parameters are known or experimentally when they are not, offering flexibility in the approach to system modeling.

## Background

This lab will help you set proper conventions of the pendulum position to be able to successfully balance it in future labs. You will also understand how to compute the moment of inertia of the pendulum analytically and experimentally.

This lab is part of Pendulum Modeling skills progression of the Qube-Servo 3. This will help you familiarize yourself with the pendulum and how to model and use it.

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 – Modeling & IO → Pendulum Free Body Diagram (Pendulum Interfacing and Free Body Diagram sections)

## Getting started

Ensure you have completed the following labs

- SPo \_ Instrumentation Labs

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 pendulum attachment is set up and connected to the Qube-Servo 3 using the cable to the Encoder 1 port. Turn the plug to make sure the pendulum is centered around the front of the Qube at 0°. The resistance from the cable will help keep it in the desired position.
- If using the virtual Qube-Servo 3, make sure you have Quanser Interactive Labs open in the Qube 3 - Pendulum → Pendulum Workspace.
- **You have the Qube-Servo 3 User Manual.** It will be required to find relevant system information for some of the exercises.
- You are familiar with the basics of Simulink. See the [Simulink Onramp](#) for more help with getting started with Simulink.