COUPLED TANKS

The Coupled Tanks system is a re-configurable process control experiment that enables students to perform a wide array of modeling and control-related laboratories.

GIVE STUDENTS CONTROL OF A REAL-WORLD APPLICATION

Liquid level control is common in many industries, such as pulp and paper mills, petro-chemical plants, and water treatment facilities.

HOW IT WORKS

Designed in association with Prof. Karl Åström and Prof. Karl Henrik Johansson, the Coupled Tanks system consists of a single pump with two tanks. Each tank is instrumented with a pressure sensor to measure the water level. The pump drives the water from the bottom basin up to the top of the system. Depending on how the outflow valves are configured, the water then flows to the top tank, bottom tank, or both. The rate of flow can also be changed using outflow orifices with different diameters. The ability to direct water flow, together with variable outflow orifices allows for several interesting Single Input Single Output (SISO) configurations. Further, two or more Coupled Tanks can be combined together for Multiple Input Multiple Output (MIMO) experiments. Unique issues involving fluid dynamics, pressure and time delays are effectively conveyed with this system. The Coupled Tanks can be configured into three experiments of varying difficulty, giving a variety of modeling and control laboratory challenges.

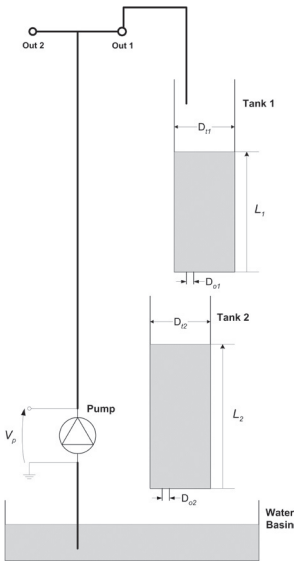
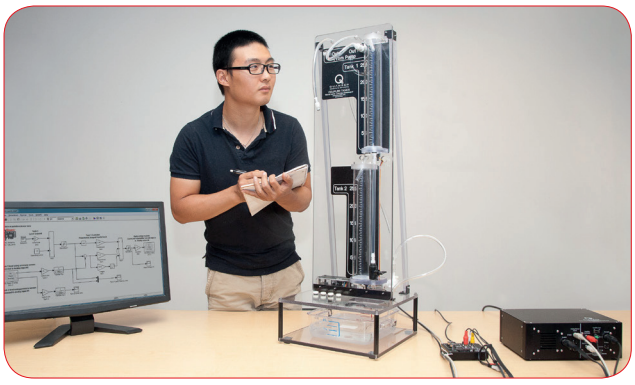


Figure1.
The courseware prompts students to experiment with this Coupled Tanks configuration to learn how to control water level in Tank 2.

System specifications on reverse page.

COUPLED TANKS WORKSTATION COMPONENTS

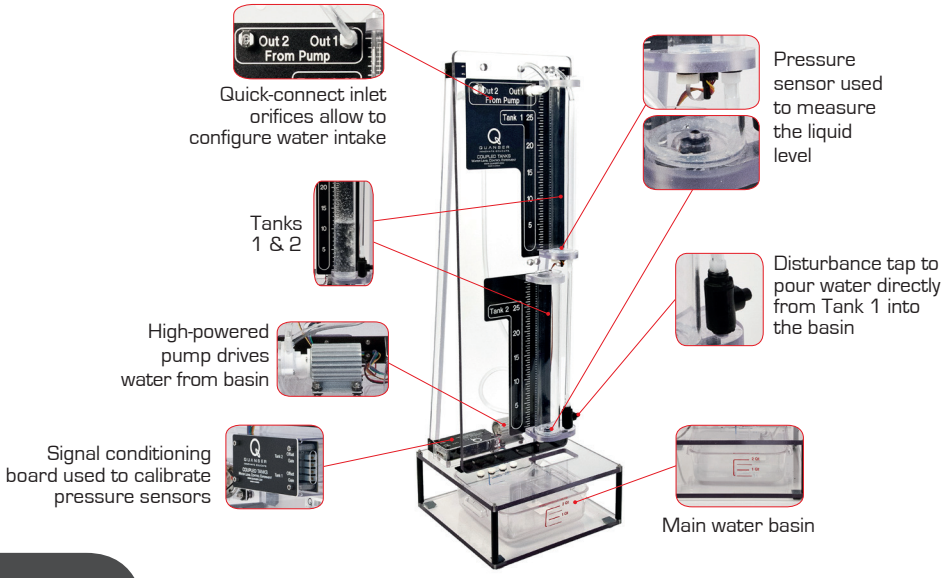
Coupled Tanks plant
Q2-USB data acquisition device
VoltPAQ-X1 linear voltage amplifier
QUARC real-time control software for MATLAB®/Simulink®
Instructor and Student Workbooks, User Manual, and Quick Start Guide (provided in digital format)
Sample pre-built controllers and complete dynamic model



Coupled Tanks workstation

SYSTEM SPECIFICATIONS

Coupled Tanks



CURRICULUM TOPICS PROVIDED

- Derivation of dynamic model from first-principles
- Transfer function representation
- Linearization
- Level control
- PID
- Feed-forward
- Control parameter tuning

FEATURES

- Overall frame constructed from solid Plexiglas
- Two tanks and single pump design
- Pressure / level sensors on each tank
- Re-configurable water flow pump and tanks
- Drain tap allows water from top tank to pour directly into basin
- Three sizes for outflow orifices supplied (small, medium, and large)
- Pressure sensors can be calibrated (using gain and offset knobs)
- Fully compatible with MATLAB®/Simulink® and LabVIEW™
- Easy-connect cable and connectors
- Fully documented system model and parameters provided for MATLAB®/Simulink®, LabVIEW™ and Maple™
- Open architecture design, allows users to design their own controller

DEVICE SPECIFICATIONS

Device mass	6.6 kg
Frame dimensions – H x W x L	30.5 cm x 30.5 cm x 91.5 cm
Pump flow constant	3.3 $cm^3/(V.s)$
Pressure sensor sensitivity	6.1 cm/V
Pressure sensor range	0 to 6.89 kPa
Tank height	30 cm
Tank inside diameter	4.45 cm
Small outflow orifice diameter	0.32 cm
Medium outflow orifice diameter	0.48 cm
Large outflow orifice diameter	0.56 cm

COMPLETE WORKSTATION COMPONENTS

Plant	Coupled Tanks
Control design environment	Quanser QUARC® add-on for MATLAB®/Simulink® Quanser Rapid Control Prototyping (RCP) Toolkit® add-on for NI LabVIEW™
Documentation	Quick Start Guide, User Manual, Instructor and Student Workbooks
Real-time targets	Microsoft Windows® and NI CompactRIO
Data acquisition devices	Quanser Q2-USB, Q8-USB, QPID/QPIDe or NI CompactRIO with two Quanser Q1-cRIO modules
Amplifier	Quanser VoltPAQ-X1 linear voltage amplifier

The linear state space model and a sample controller(s) are supplied

About Quanser:
Quanser is the world leader in education and research for real-time control design and implementation. We specialize in outfitting engineering control laboratories to help universities captivate the brightest minds, motivate them to success and produce graduates with industry-relevant skills. Universities worldwide implement Quanser's open architecture control solutions, industry-relevant curriculum and cutting-edge work stations to teach Introductory, Intermediate or Advanced controls to students in Electrical, Mechanical, Mechatronics, Robotics, Aerospace, Civil, and various other engineering disciplines.