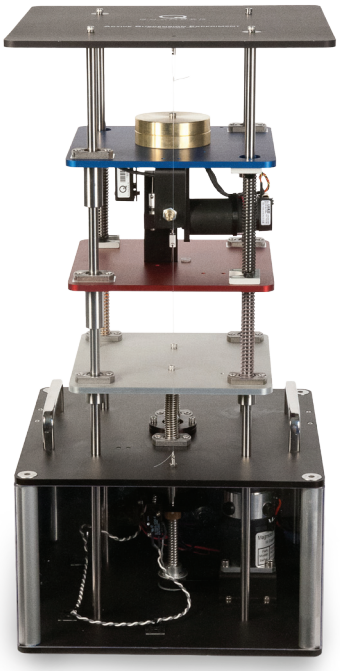
ACTIVE SUSPENSION

The Active Suspension is an ideal platform to teach active control challenges for a quarter-car model. This plant setup offers senior mechanical engineering students unique, hands-on learning relevant to today's automotive industry.



System specifications on reverse page.

BRING MODERN VEHICLE DESIGN TO YOUR LAB

The Active Suspension experiment teaches cutting-edge technology that has brought a new generation of vehicles to life. Active suspension technology is used in the automotive industry to continuously control the vertical movement of the vechicle wheel using an actively-controlled actuator placed on the suspension axis. Similar technologies have also been used in train bogies to improve the curving behavior of the train and the decreased acceleration perceived by the passenger.

HOW IT WORKS

The Active Suspension consists of three masses, or plates. Each mass slides along stainless steel shafts using linear bearings and is supported by a set of springs, as shown in Figure1. The upper mass (blue) represents the vehicle body supported above the suspension, also known as the sprung mass. The middle mass (red) corresponds to one of the vehicle's tires, or the unsprung mass. Finally, the bottom (silver) mass simulates the road. The upper mass is connected to a high-quality DC motor through a capstan to emulate an active suspension system that can dynamically compensate for the motions introduced by the road. The lower plate is driven by a powerful DC motor connected to a lead screw and cable transmission system. It is used to simulate different road profiles. Students can tune the supplied controller or design their own controllers to optimize the various suspension performance parameters which include:

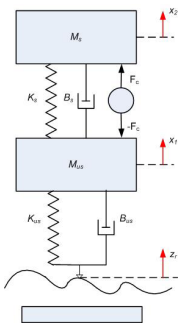


Figure 1.
Double Mass-Spring-Damper students use to model the Active Suspension System.

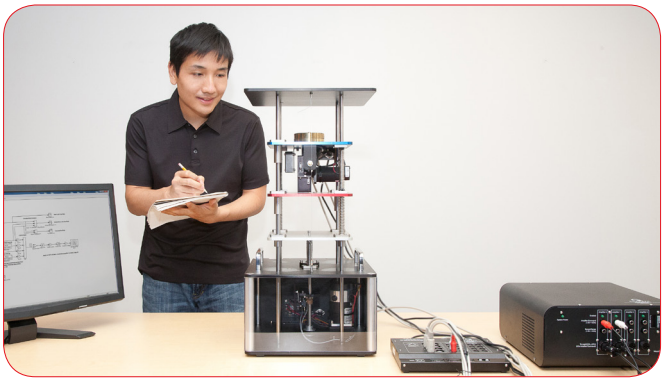
Ride Comfort - is related to vehicle body motion sensed by the passengers. It can be measured using either the accelerometer that is mounted on the top plate, or the encoder (for a direct position measurement).

Suspension Travel - refers to relative displacement between the vehicle body and the tire and is constrained within an allowable range of motion. This can be measured using the suspension encoder that is mounted on the capstan.

Road Handling - is associated with the contact forces between the road surface and the vehicle tires and depends on tire deflection. Tire deflection is the relative displacement between the tire and the road and it can be measured using all the encoders.

ACTIVE SUSPENSION WORKSTATION COMPONENTS

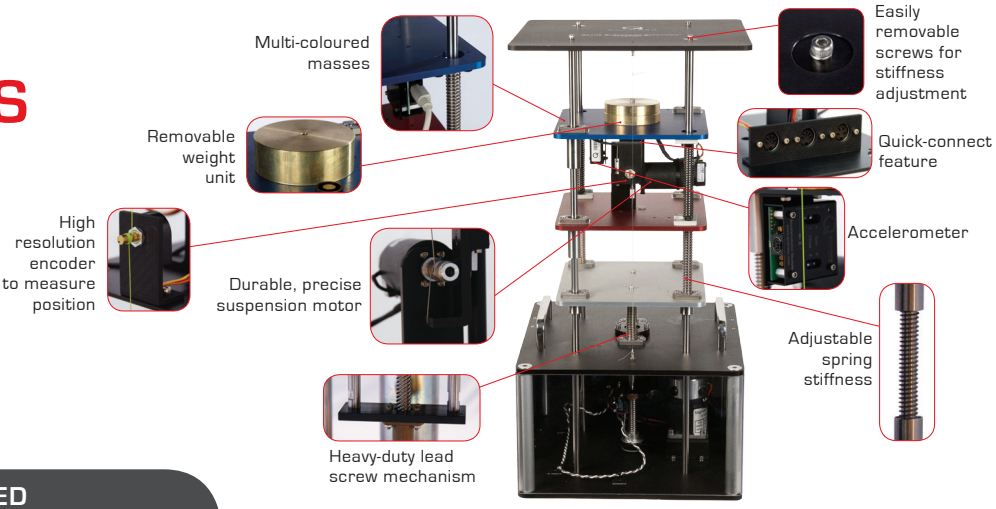
Active Suspension plant
Q8-USB data acquisition device
AMPAQ-L2 linear current amplifier
QUARC real-time control software for MATLAB®/Simulink®
Laboratory Guide, User Manual, and Quick Start Guide (provided in digital format)
Sample pre-built controllers and complete dynamic model



Active Suspension workstation

SYSTEM SPECIFICATIONS

Active Suspension



CURRICULUM TOPICS PROVIDED

- Double mass, spring, damper system analysis
- Industry-relevant control requirements (ride comfort, suspension travel, road handling)
- Derivation of dynamic model
- State space representation
- System transfer functions
- Open-loop system analysis
- Time domain and frequency-domain open-loop and closed-loop system identification
- Full-state/two state feedback LQR control design(with real-time control parameter tuning)
- Full-state/two state feedback LQR controller (with real-time control/ observer parameter tuning)
- Observer design

FEATURES

- Heavy-duty and robust machine components
- Three high resolution encoders used to measure positions of bottom and top masses as well as suspension deflection
- 226 W MICROMO brushless DC motor connected to capstan for active suspension control
- 70 W Magmotor brushed DC motor connected to belt-drive mechanism for road actuation
- Adjustable weight and spring stiffness
- Accelerometer measurements as sensory input
- Responsive belt-drive mechanism to simulate the road suface
- Accelerometer mounted on top plate to measure vehicle body acceleration
- Multi-coloured masses for distinction (vehicle body in blue, vehicle wheel in red and the road suface in silver)
- Limit switch and protection circuit
- Fully documented system models and parameters
- Open architecture

DEVICE SPECIFICATION

Dimensions – W x L x H	30.5 cm x 30.5 cm x 61 cm
Total mass	15 kg
Range of motion	±22 mm (road), ±19 mm (tire), ±25.4 mm (car)
Position resolution	0.002mm/count (road), 0.005 mm/count (tire), 0.009mm/count (body
Stiffness	adjustable from 0.4 to 2 N/mm
Excitation frequency	up to 15 Hz
Resonant frequency	Configurable between 2 to 6 Hz
Accelerometer sensitivity	9.81 m/Vs^2

COMPLETE WORKSTATION COMPONENTS

Plant	Active Suspension
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 and Laboratory Guide
Real-time targets	Microsoft Windows® and NI CompactRIO
Data acquisition devices	Quanser QPID/QPIDe, Q8-USB, or NI CompactRIO with two Quanser Q1-cRIO modules
Amplifier	Quanser AMPAQ-L2 multi-channel linear current 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.