# Automatic Controls Laboratory

In this lab, students learn the practical aspects in the design and simulation of control systems, mechatronics, and thermodynamics.

This lab uses the state-of-the-art equipment from National Instruments. LabVIEW Control Design and Simulation Modules are integrated into the design of experiments with 4 trainer modules available for NI ELVIS. These modules provide components needed to set up controls design and simulation exercises.

## Major Equipment

- Vertical Take-Off and Landing (VTOL) Helicopter Board for NI ELVIS
- DC Motor Controls Board for NI ELVIS
- HVAC Board for NI ELVIS
- Rotary Inverted Pendulum Controls Board for NI ELVIS
- PCs running LabVIEW

Vertical Take-Off and Landing (VTOL) Trainer

DC Motor Trainer

HVAC Trainer

Rotary Inverted Pendulum Controls Trainer

## Experiments

### DC motor

- System modeling and model validation
- Position and speed control
- System simulation
- PID controller design
- Tracking error
- Sensitivity analysis
- Phase and gain margins
- Disturbance rejection

### Rotary Inverted Pendulum

- System modeling
- Parameter estimation
- Balance control
- LQR design
- Non-minimum phase
- Friction compensation
- Nonlinear swing-up design
- Energy-based design
- Hybrid balance/swing-up control

### HVAC

- Temperature control
- Relay/on-off control design
- System modeling and model validation
- Parameter identification
- PI control design

### VTOL

- Flight dynamics
- Identifying parameters experimentally
- Model validation
- PID control
- Cascade control
- Dealing with actuator dynamics