# Checkpoint 2: PID Control, Implementation and Gain Tuning

## Part 1: PID Controller Theory

Section 1.1: Electronic Control

* Benefits of using electronics to control systems
* Gains (include block diagram)
  + What are gains
  + Why do they affect the system response
* Examples of implementations of electronic controls

Section 1.2: Proportional Control

* What does the proportional controller do?
* How does this affect the system?
* What happens with too much proportional gain? Too little?

Section 1.3: Derivative Control

* Problems with proportional control only
* What does derivative control do?
* How does adding derivative help stability?
* PD controller examples and implementation
* What happens when you get too much derivative gain?

Section 1.4: Integrator Control

* Problems with PD control only
* Steady state error and system type (feedback crap)
* How does integration add to system response?
* PI controller examples and implementation.

Section 1.5: PID Controllers

* Benefits of PID control
  + Easy to tune without knowledge of the underlying system
  + Relatively simple calculations
  + Many applications
  + Can be implemented in unstable dynamic systems
* Cost of PID control
  + Not most efficient controller method

## Part 2: Controller Tuning

Section 2.1: Conceptual Tuning

* What is the point of adjusting gains?
* Ziegler Nichols Gain criteria
  + Starting point to get in the ballpark (include equations)

Section 2.2: Practical Tuning

* Start with ZN gain range of values
* Begin tuning for P only, set other gains to 0
* Tether P-gain to right stick values (include code)
  + Create variables
  + Set output range
  + Write multiplier
  + Data output
  + Testing procedure
* Adjust P gain until steady oscillation is achieved
* Analyze results, include multiplier in hard code
* Tether D gain to right stick values
* Adjust D gain until oscillation goes away
* Analyze results, include multiplier in hard code
* Repeat for I gain

## Part 3: Zeigler-Nichols Gains with Step Input

Section 3.1: (figure)

* How is %OS, T\_rise, and T\_settling estimated?
* Comment on figure

## Part 4: Stabilization Controller Performance Optimization

Section 4.1: (figure)

* What are the final gains used?
* General observations about the graph
* Show %OS, Ts, and Tr parameters
* Show disturbance reactions