Lab 1 -- Analog Lead-Compensation

As mentioned in the Project Definition document, we will be controlling the attitude of a spacecraft, modeled as a double integrator, by building both an Analog and a Digital lead-compensation circuit. In this first lab you will be implementing an analog only solution.

Objective

The aim of Lab 1 is to model a satellite as a **double integrator in the analog domain** using op-amps. Since this "plant" is inherently unstable, we start our design by including an **analog lead compensator** (similar to a proportional/derivative controller) as well as an adjustable gain that will adjust the damping ratio of the system. With the proper selection of gain values, we can adjust the system response to be very slow (overdamped) or very fast (underdamped). As we explore a lower damping ratio, we begin to see overshoot and ringing before the system finally settles on the steady-state value. A fixed value is simulated using the **Simulink** package available in MATLAB and **compared** with the **analog system**.

Sample Lab 1 Reports

- Scott Thompson Spring 2010
- Randy Jokela Spring 2010
- Jason Sepra Spring 2013

Sample Outline

Introduction
Theory
 Plant Design
 Compensator Design
 Summing Junction Design
Analog Circuit Design
 Op-Amp Selection
 Plant Circuit
 Compensator Circuit
 Summing Junction Circuit
 Design Details
  Integration Gain Stage, ADC Bias, and Level Shifter
  Integrator Gain Stage Circuit
  ADC Bias Generator
  Level Shifter and Clamping
  Level Shifter and Clamping Circuit
Simulation
 Simulink Circuit
 Simulink Plots
 Output of Simulation
Hardware Output (via USB Oscilloscope)
Comparison of Theoretical vs. Actual Data
Conclusion
Appendix A: Schematic Diagram (PSPICE Version)