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Advisor: Dr. Gary Dempsey

Design of Simulink® -based Electromechanical Control Workstation for Load Disturbance Testing (EMCW)

Presentation Outline

- Summary
- Previous Work
- High Level Block Diagram
- Important System Components
    - Hardware
    - Software
- Major Project Objectives
    - Modeling
    - Controller Design
    - Graphical User Interface (GUI) Development
    - Performance Specifications
- Schedule
- Questions

Summary

- To design in Simulink® an electromechanical control workstation to examine the effects of load disturbance on the GM9236C534-R2 Pittman DC-geared motor.

- The controller's response to various load disturbances will be tested by coupling a second motor to the first to act as a DC generator.

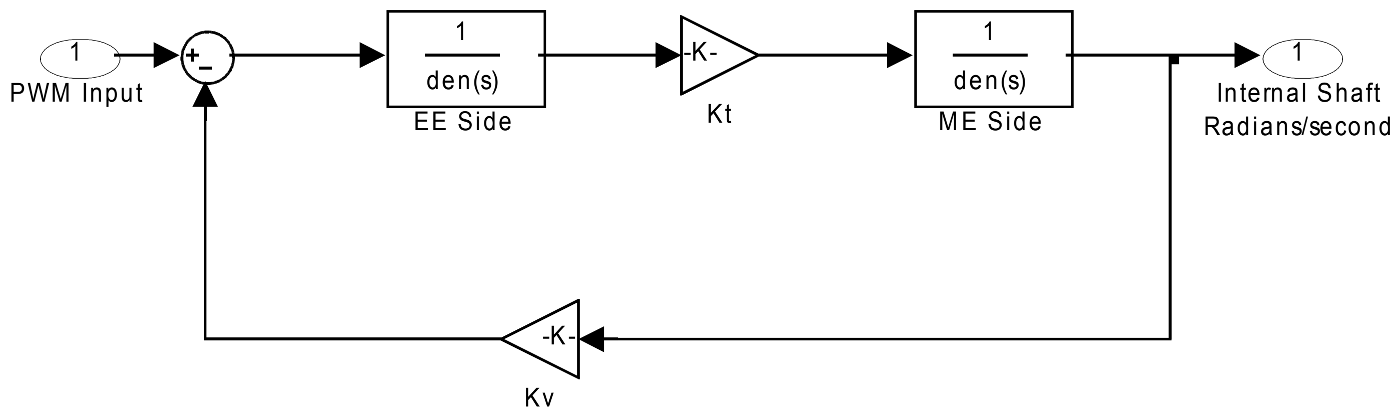
Summary

- Modeled in SimMechanics® as well as Simulink®. Various experiments and motor/clutch datasheets will be used for system ID.

- Graphical User Interface (GUI) will be developed to allow for easy variation of system parameters, command signals, and loads.

Previous Work

- Linear Motor Model
  - Developed during Mini-Project Fall 2006.



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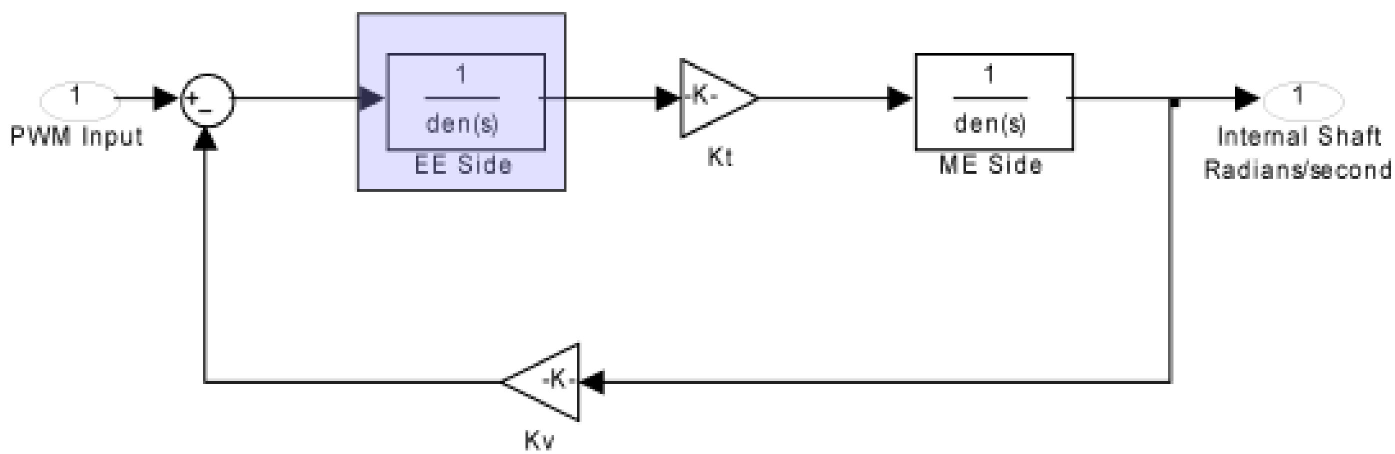

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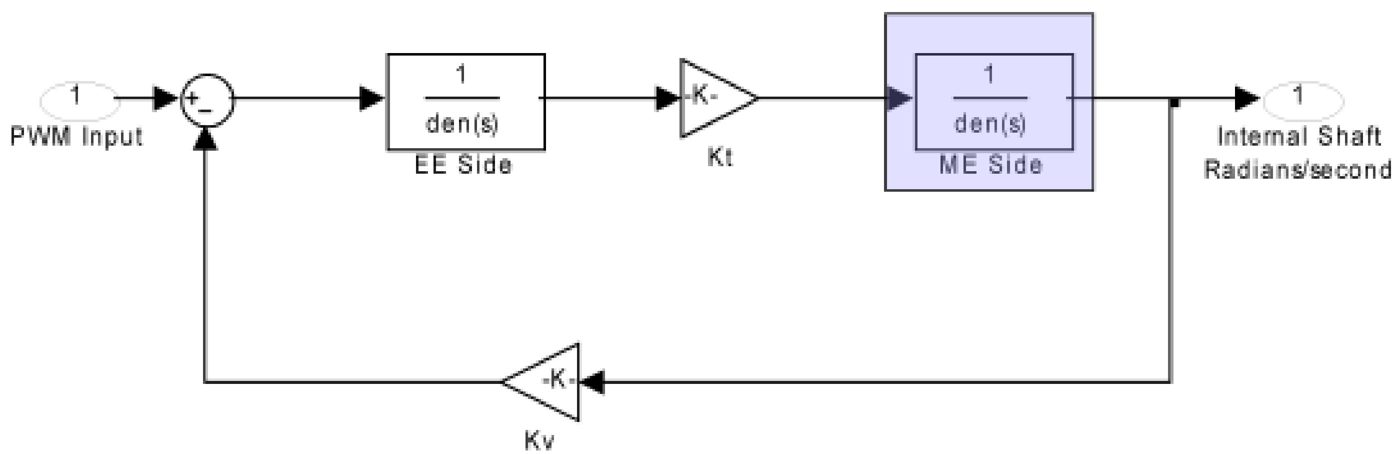
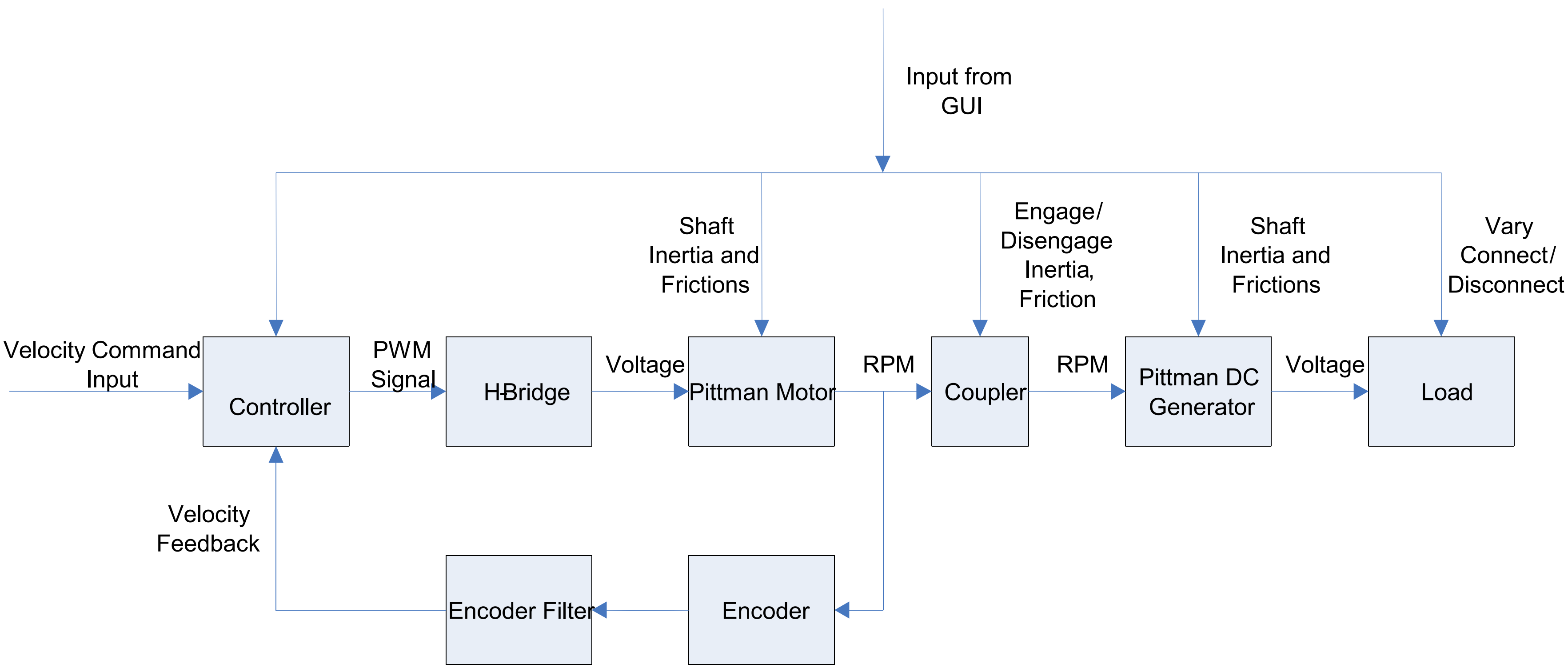


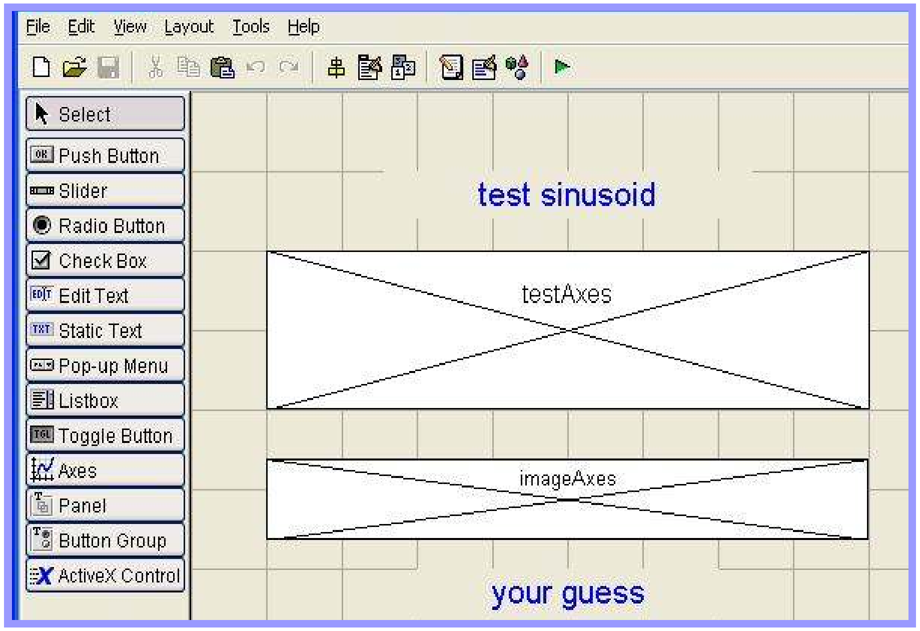
High Level Block Diagram

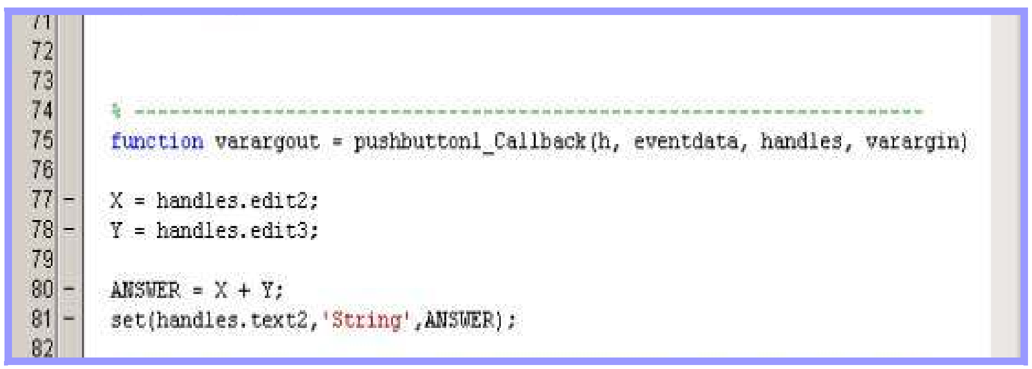


Important Components

- The Hardware
  - GM9236C534-R2 Pittman Motor
  - Reell EC15 Coupler
- The Software
  - Simulink for Electrical & Mechanical Systems
  - Matlab's "Guide" for GUI development
  - SimMechanics for Mechanical Systems

The Software cont'd





- Matlab's "Guide"
  - A Matlab GUI development tool.
  - Allows the user to create complex interfaces by simply specifying layout.
  - Automatically generates layout code.

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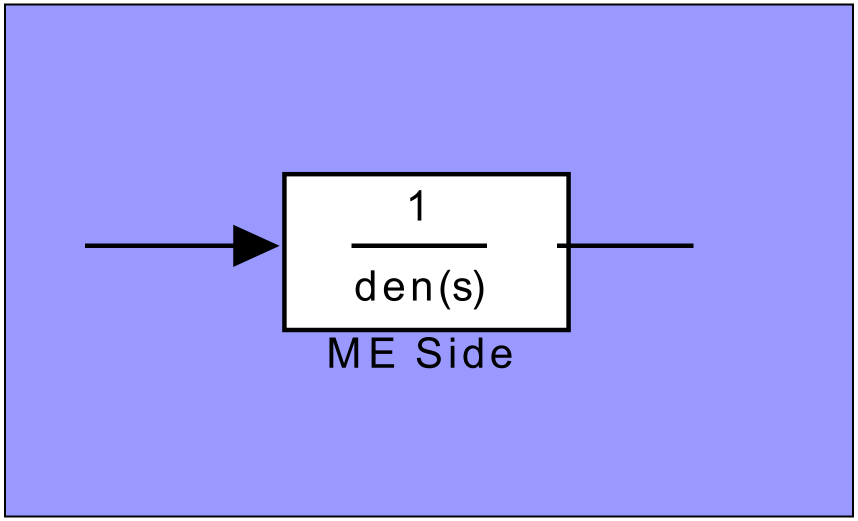
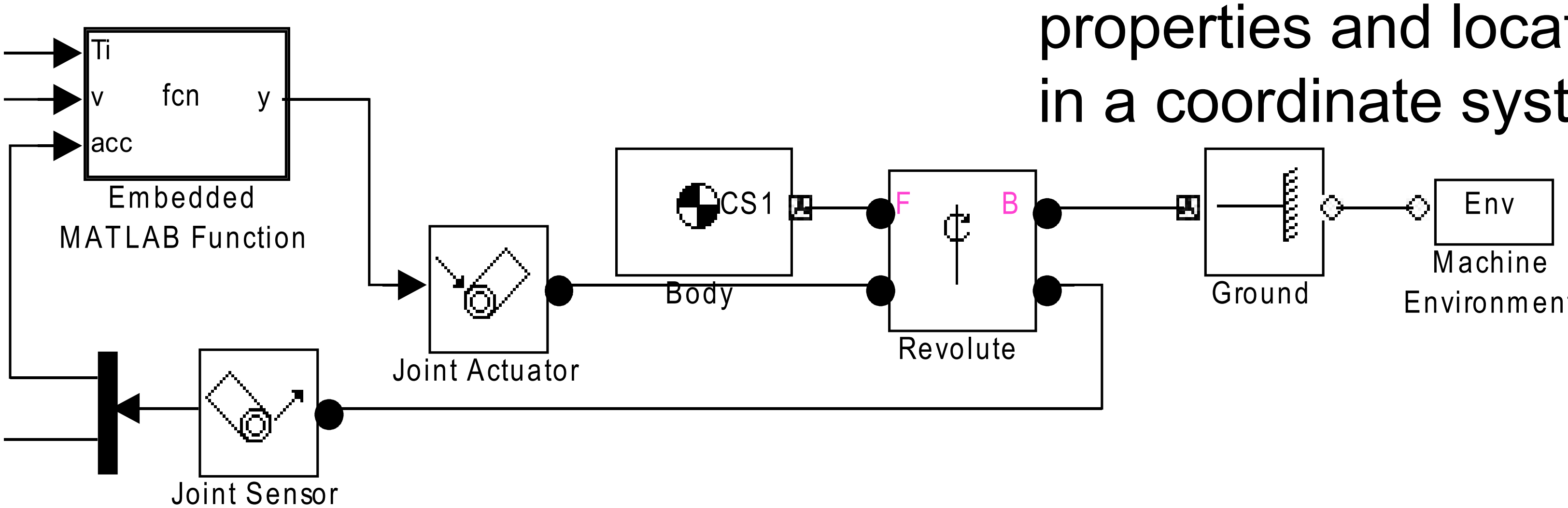
The Software



- About SimMechanics
  - A feature of Simulink.
  - Enables the user to model mechanical systems based on components' physical properties and location in a coordinate system



The Software

Pendulum Tutorial

Major Project Objectives

- Modeling: The following will be modeled in both SimMechanics and Simulink.
  - Motor
  - DC Generator
  - Coupler

- Controller Design

- Graphical User Interface (GUI) Development

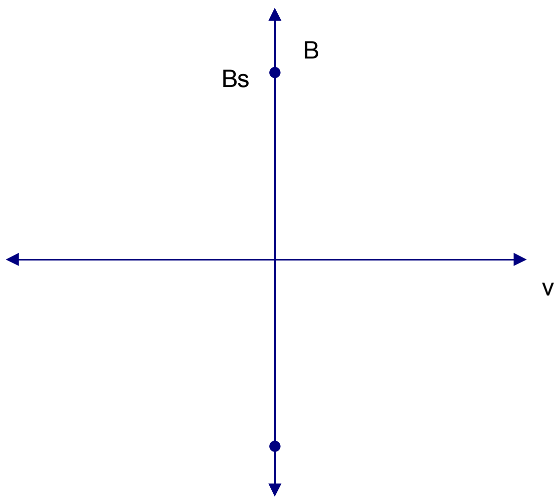
Models

- The Motor
  - Unlike previous models of the Pittman DC motor the model used will be nonlinear.
  - Our Model will take into account various nonlinear frictions.

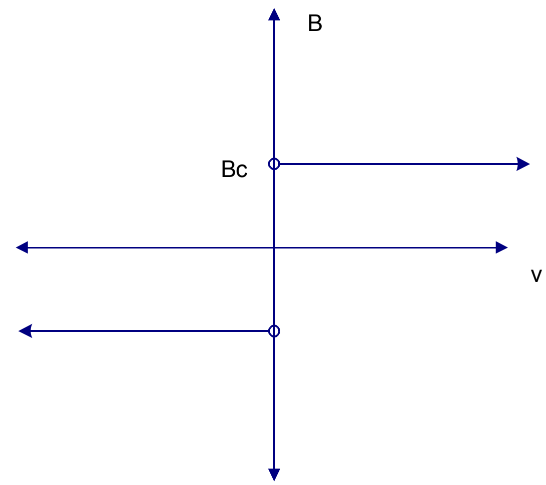
See following slide for nonlinear frictions.

Models

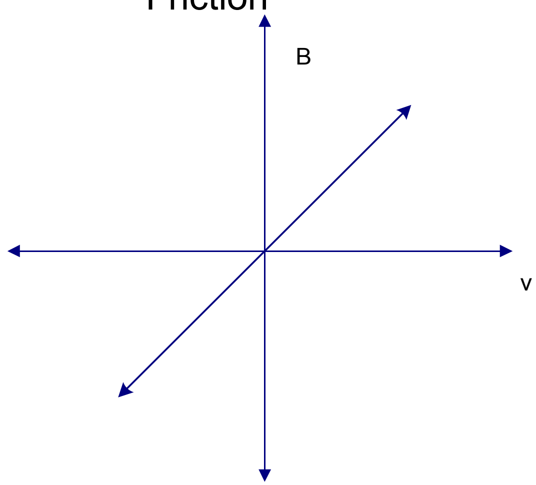
Nonlinear Frictions of the Motor



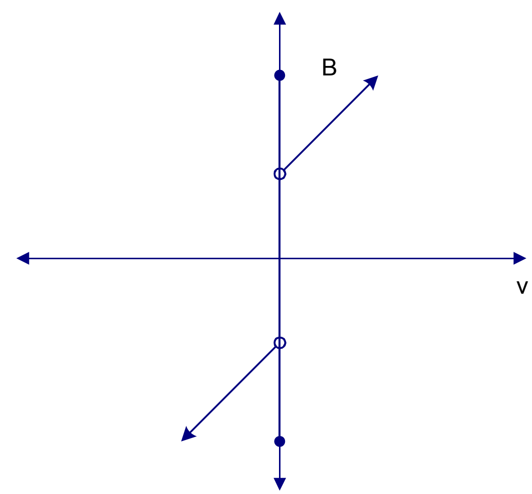
Static Friction



Coulomb Friction



Viscous Friction



Combined Friction

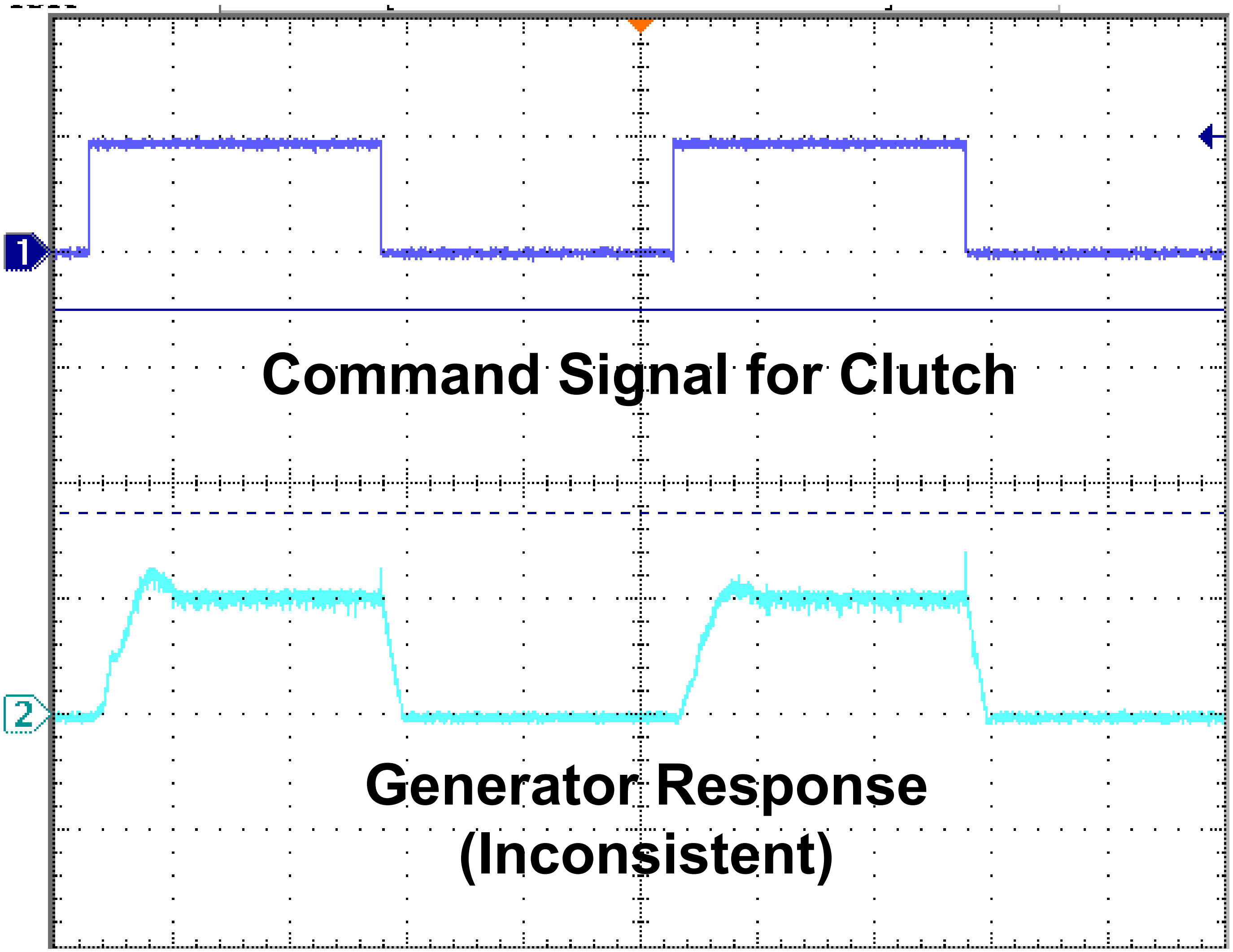
Models

- The DC Generator
  - Another Pittman motor driven by the first.
  - Rheostat across generator terminals varies load seen by motor.
    - Open circuit corresponds to smallest load.
    - Short circuit corresponds to largest load.

Models

- The Coupler
  - A coupler between the motor and generator.
  - Model must take into account,
    - Added inertia and friction.
    - Time delay caused by spring mechanism.
  - Designed method to observe transient response of coupler.

Transient Response

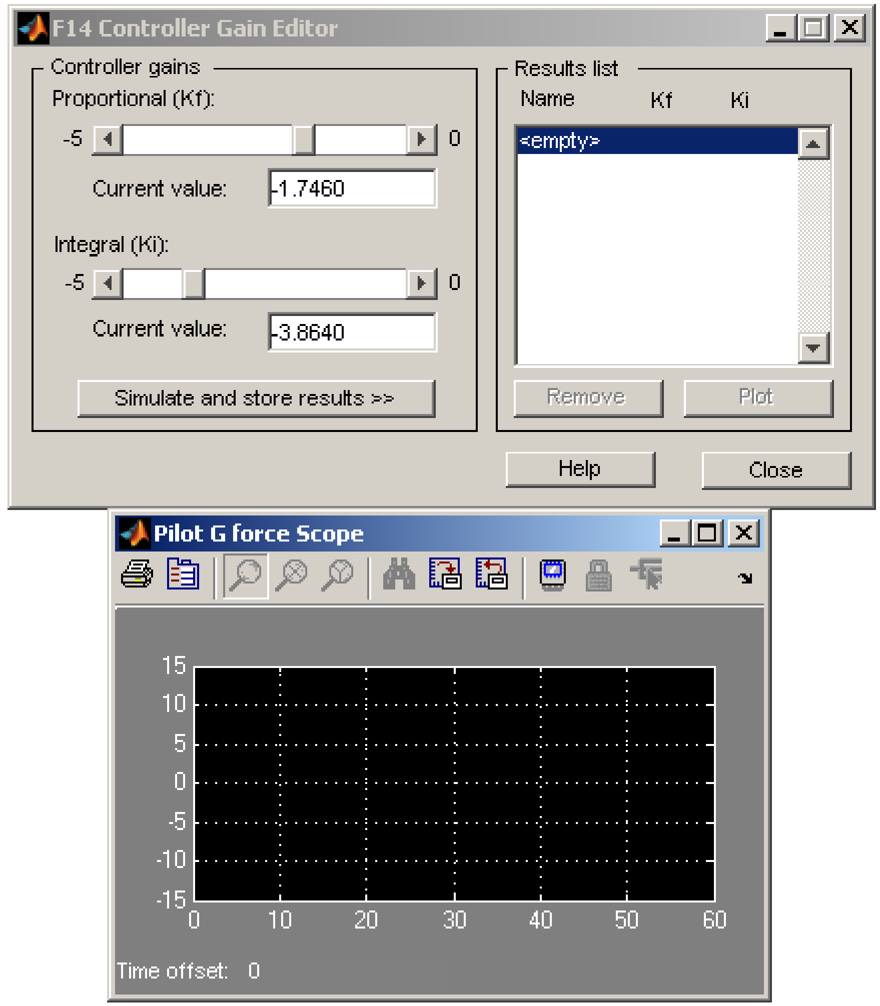


Controller Design

- Upon verifying the models, controller design will begin.
- Initially, a single loop velocity controller will be used, with more advanced designs to follow.

The GUI

- Will allow the user to adjust:
  - Controller Gain/Type
  - Frictions & Inertias
  - Coupler Status
  - The Load
- Graphing capabilities will also be included for various outputs and inputs.



System Specifications

Functional Requirements and Performance Specifications of Subsystem Components	
Subsystem	**Primary Objectives**
Controller	• Nonlinear characteristics of motor must be accounted for. • X% overshoot with Y load. • ___ settling time with Y load. • ___ rise time with Y load. • Regulation range: 0rpm – 500rpm.
DC Motor Model	• Initial model parameters accurate. • Motor model based on measured parameters accurate to within X% (velocity, current). • All model parameters should be variable using GUI.
Clutch	• Experimental time delay accurately depicted in clutch model. • Clutch model engaged/disengaged through GUI. • Model only works in one direction. • All model parameters should be variable using GUI, including inertia, friction, and spring constant.
DC Generator Model	• Initial model parameters accurate. • Generator model based on measured parameters accurate to within X% (voltage, current). • All model parameters should be variable using GUI. • Load varied/connected/disconnected through GUI.
GUI	• Aesthetically pleasing and intuitive layout. • Outputs of interest displayed and graphed vs. command inputs.

The Schedule

Spring Semester Schedule		
Week	Laith Slaton	Adesegun Sun-Basorun
1-3	Coupler System ID	Motor System ID
4-5	Validation of models	
6	Single loop velocity control	
7-8	GUI design	
9	Two-loop velocity/acceleration	Single-loop feed-forward
10	Serial interface between Simulink and physical system	
11-12	Advanced Controllers (Optimum Phase Margin, Disturbance Rejection, State-variable, Three-loop with torque control, Nonlinear controller, Adaptive Feed-Forward Control)	

Questions?