2.004 Dynamics and Control II
Spring 2008

Tall Building Active Damping

Final Design Project
2.004 System Dynamics and Control
Fall 2007

Our Problem:

Modify a tall building's dynamic response to reject wind disturbances and earthquakes

Shanghei World
Finance Center
Building

To be completed
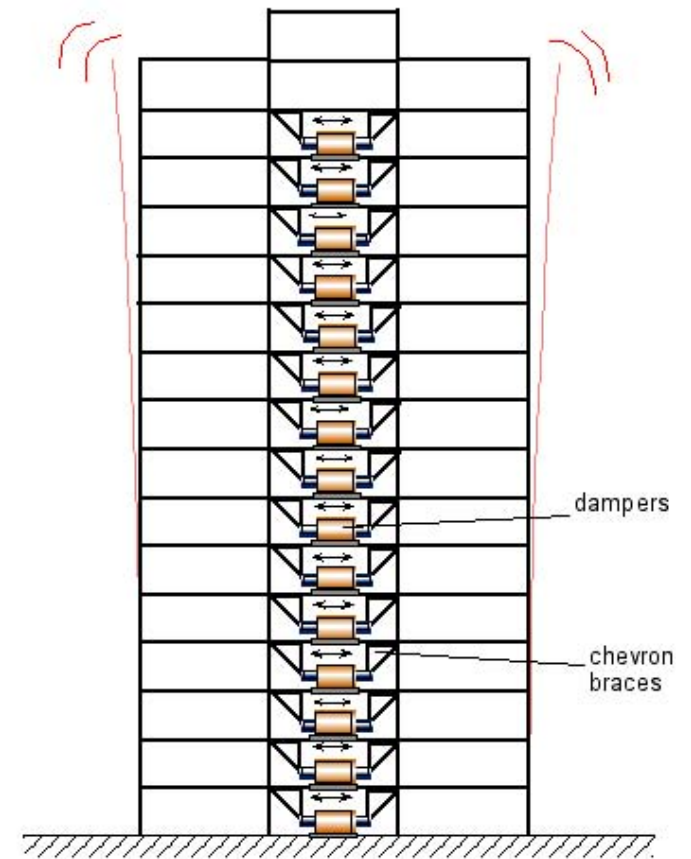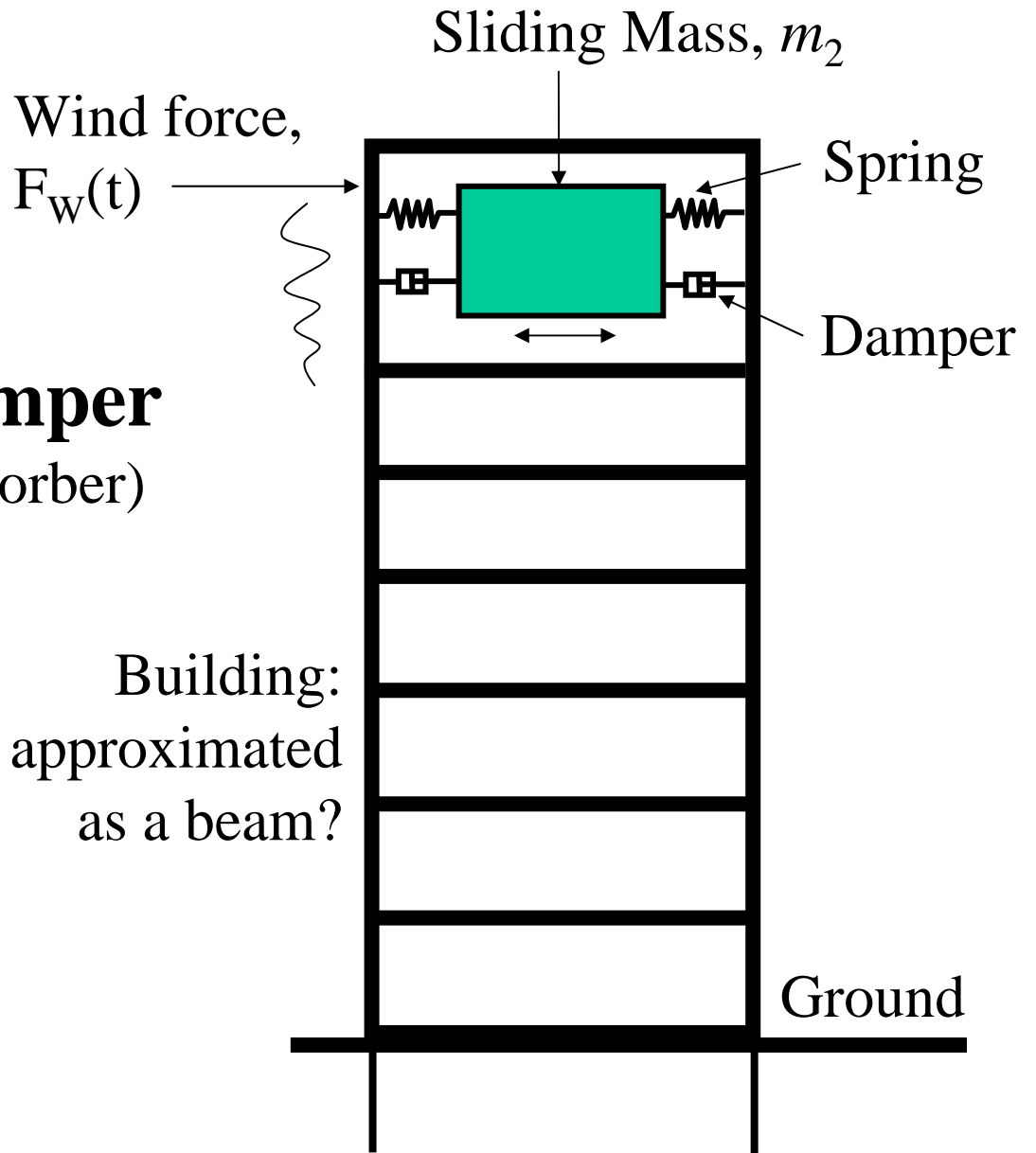in 2008

101 floors
492 m
(1,614 ft)

MIT 2.004 Dynamics and Control II   Harry Asada and Franz Hover

Taipei 101

435 m
101 Floors

Distributed Damper System

dampers

chevron
braces

MIT 2.004 Dynamics and Control II   Harry Asada and Franz Hover
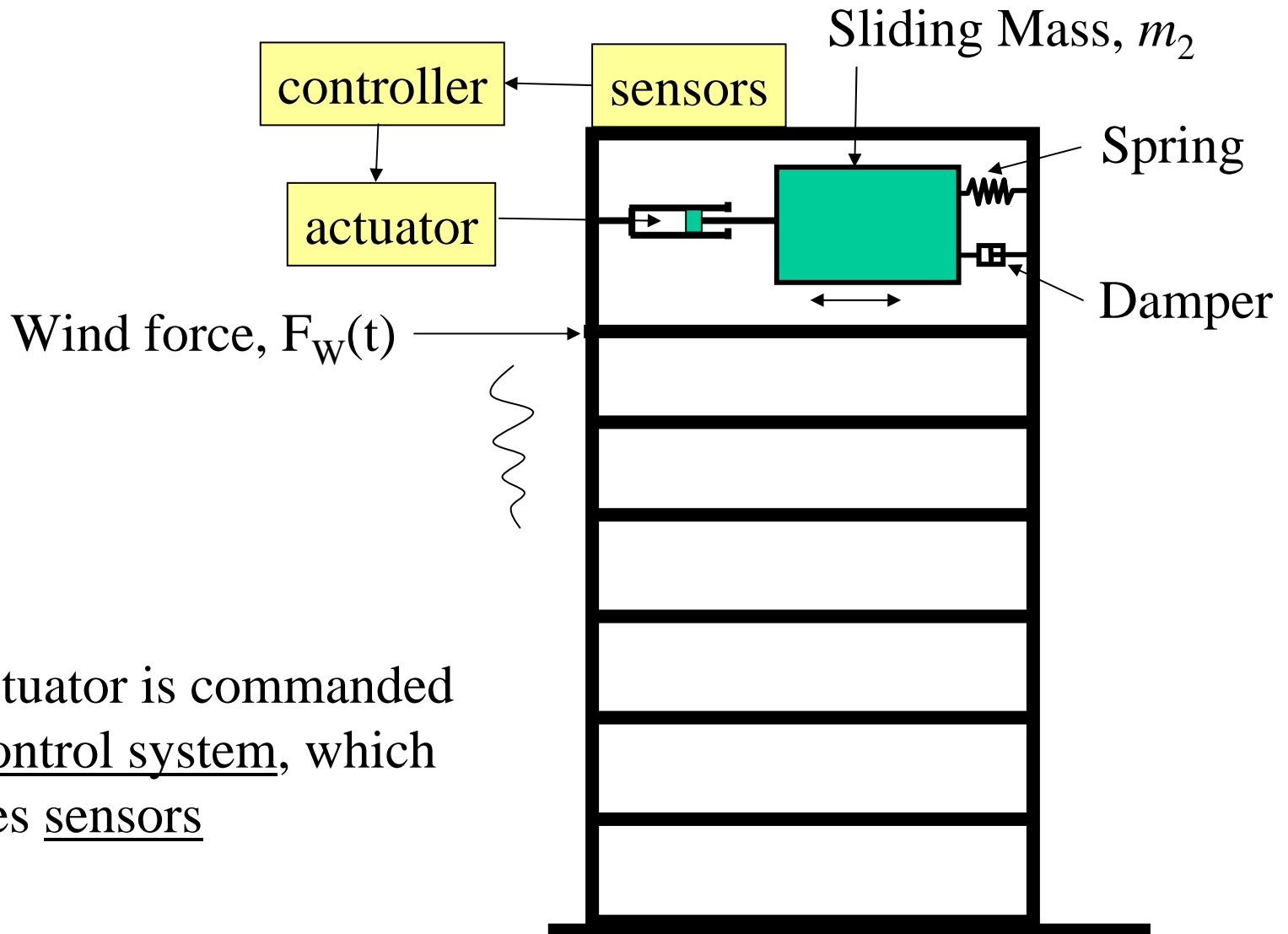
Sliding Mass, m_2

Wind force, $F_W(t)$

Spring

Damper

Here is a **Passive Damper**
(Dynamic Vibration Absorber)

Building: approximated as a beam?

Ground

This Lab: **Active Damper** Design

controller ← sensors

Sliding Mass, m_2

Spring

actuator

Damper

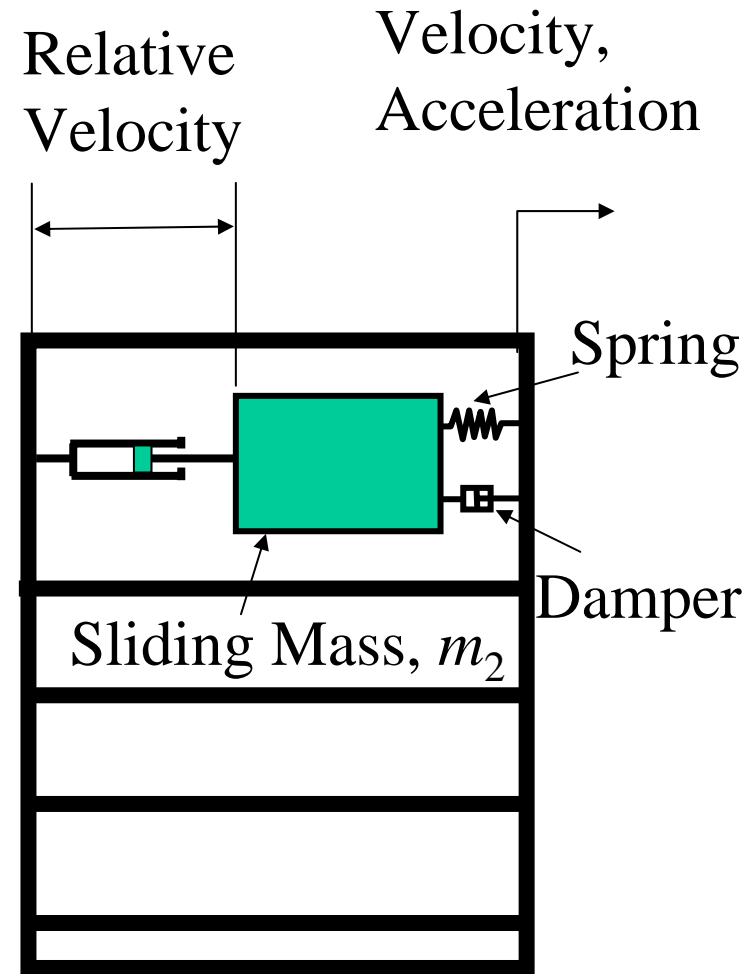Wind force, $F_W(t)$

The actuator is commanded by a <u>control system</u>, which requires <u>sensors</u>

Project Goals

- Design Goals
  - Damp out Induced Vibrations
  - Improve Upon Passive Solution

- Project Deliverables
  - Model of System (LAB 7)
  - Open-Loop Design (LAB 8) ⎫
  - Closed-Loop Design (LAB 8) ⎬ Matlab & Simulink
  - Final Design and Experimental Verification (LAB 9)
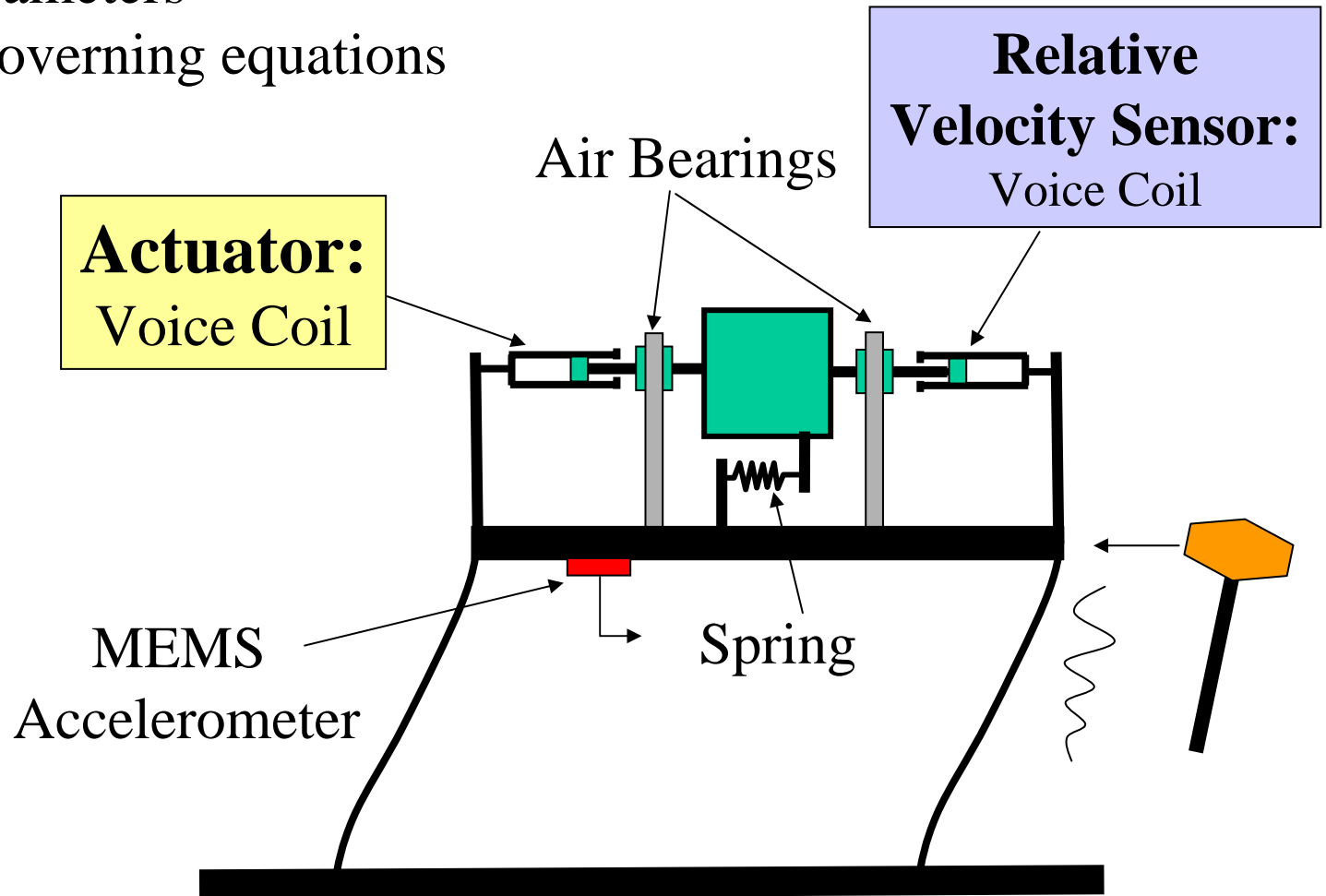 - Design History and Performance Record Document

Lab 7

- ## Create Linear Model of System
    - Inputs?
    - Output?
    - State Space?
    - Transfer Function(s)?
    - System Parameters?
        - Mass, damping, stiffness…

- ## Deliverable
    - State Space or Transfer Function Model verified by Instructor
    - Estimates of System Parameters

Relative Velocity

Velocity, Acceleration
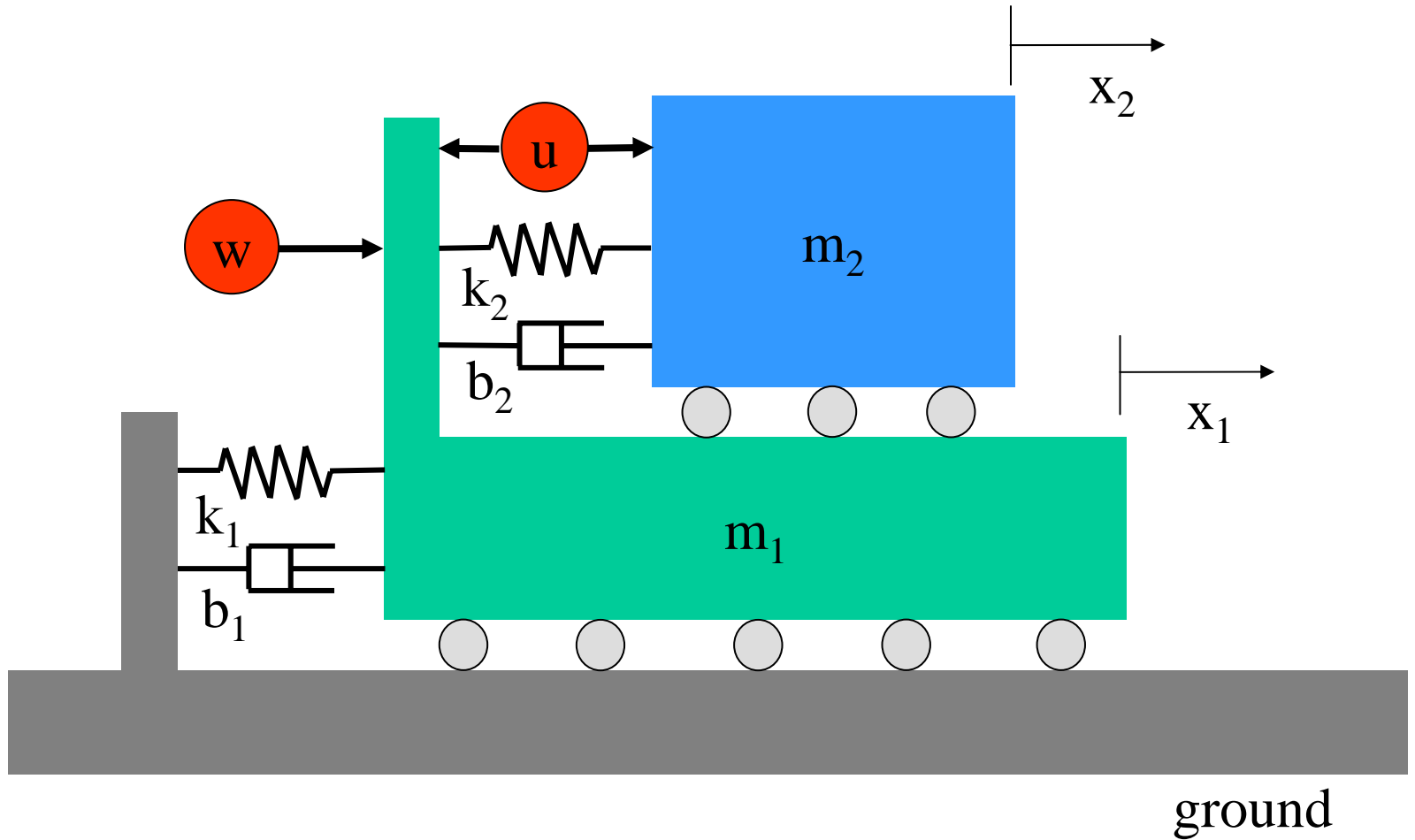
Spring

Sliding Mass, m_2

Damper

Modeling:

- Make your own sketch of the system
- Draw an icon model: mass, spring, damper, actuator, etc.
- Define parameters
- Develop governing equations

Relative Velocity Sensor:
Voice Coil

Air Bearings

Actuator:
Voice Coil

MEMS
Accelerometer

Spring

A schematic with all the parameters and variables you need!

Today's Lab

- Understanding the system
- Modeling
- Parameter Identification