Introductory Motion and Control
Introduction to System Identification

- ***System identification*** (ID) is the process of ***developing*** a ***quantitative numerical model*** from a set of input and output data that represents the response of a dynamic system. For this reason, it is necessary for the recording of the ***input*** and ***output*** data to be ***synchronous***.
- The system ID process is ***not strictly*** a ***numerical process*** of finding the model that best matches the response data. For the resulting model to be useful in the compensator design process, it must ***capture*** the ***essential physics*** of the system.
- The system ID process can be broken into the following ***basic steps***:
  - Determine the most ***appropriate input*** (excitation) for the system.
  - ***Collect*** multiple sets of input-output data. ***Averaging*** and/or ***filtering*** (e.g. anti-aliasing filters) can be used to minimize the effects of system variability, noise, and errors associated with sampling data.
  - Modify the data as necessary before searching for the best model to represent the data. Be careful ***not to alter*** the ***basic character*** of the data.
  - Define the ***form*** of the ***model*** to match the physics of the system, if possible.
  - Compute the ***best-fit parameters*** for a model of this form.
  - Use the model to predict system response to verify that it provides physically realistic results.
  - If the model-predicted system results are not considered to be representative of the system, try again with another form of model.
- Two typical types of data are used for the system ID process, ***time-response***, or ***frequency-response*** data.
- ***Time-response data*** is simply a pair of input-output synchronized time histories. The time histories are usually sampled at a fixed sampling rate that is fast enough to capture the highest frequencies present in the data.
- ***Frequency-response data*** may be simply Fast Fourier Transforms (FFTs) of time histories, or it may be in the form of a ***Bode diagram***, giving the magnitude and phase of the harmonic response of the system.