System Identification – Practical Assignment 3
Transient Analysis of Step Responses

Logistics

Please reread the logistics part of lab 2, the same rules will apply to this lab. The only things that change is the teams assignment, which for this lab is "Lab 3 (step response)", and of course the lab number in the file name.

Assignment description

In this assignment we will perform transient analysis of first-order step response models – see the course material, *Transient Analysis of Step and Impulse Responses*.

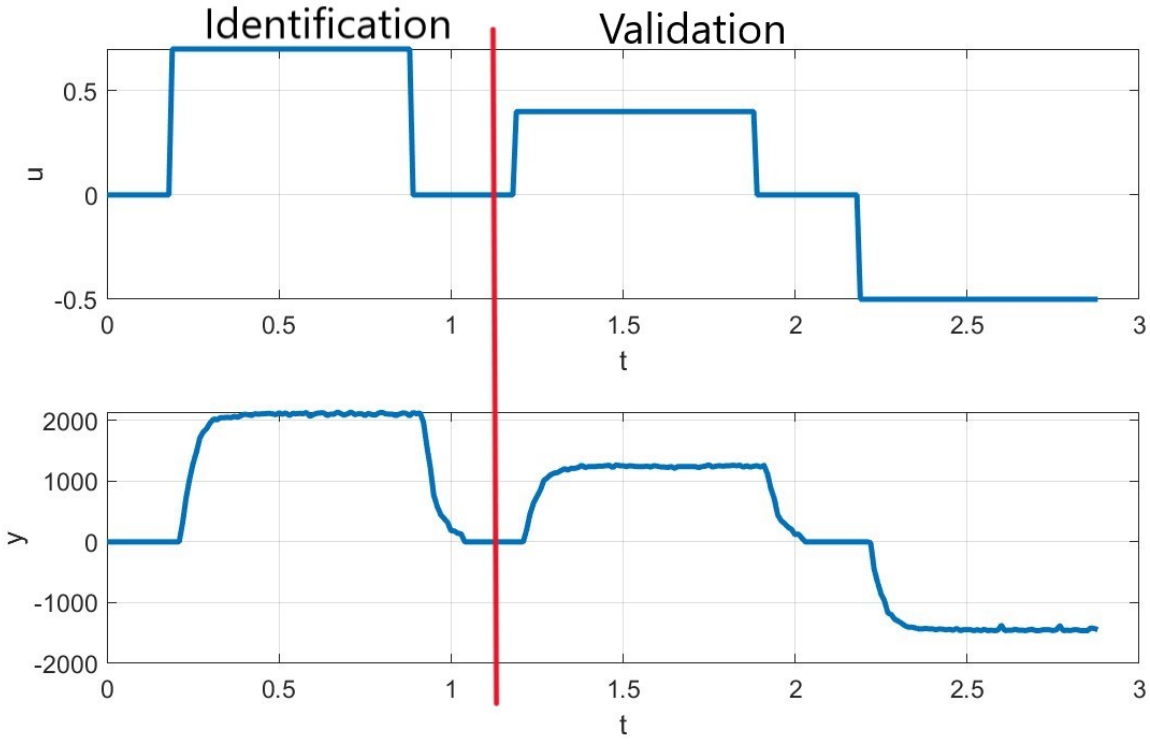
If you did not already do this for Lab 1, as a preliminary step, familiarize yourself with the DC motor system and the ways in which input signals can be applied and output signals can be read, using the guide at the following link:

`https://busoniu.net/teaching/sysid2024/dcmotor_guide_v5.pdf`

Each student will obtain a data set using the DC motor and will identify the system, as detailed in the following instructions.

- To keep things simple, we will create a single, longer sequence of data containing both the identification and validation data. We will use a sampling period of 0.01 s (10 ms). After a 0.3 s range of zero inputs, apply a step input signal with amplitude 0.7 and a length of 0.7 s, followed by another range of zero inputs, and then two step signals of length 0.7 s, with magnitudes 0.4 and -0.5 respectively, separated by a third range of zeros.
- Isolate the data range corresponding first step and copy it to new input and output vectors; this will be our identification data. **Important note**: To minimize system wear, separate the code that generates the data from the code that performs the rest of the steps below (easiest using different script sections, see *Code Sections* in the Matlab documentation), and regenerate the data only when necessary (e.g. not every time you change something in the transfer function).
- Develop a transfer function model of the system with the method described in the lectures, using the first step signal and response from the data. Include instructions that output to the console the transfer function, as well as the gain K and time constant T, when your script is run.
- Validate your model using the validation data (the last two steps). The validation should consist of: (a) a plot where the system output is compared with the model output on the same graph; (b) and the computation of the MSE. Both of these results should be automatically produced by the Matlab code you provide. Use Matlab function `lsim` to simulate the response of the identified transfer function to the validation input.

Some relevant Matlab functions: `tf, lsim, plot`. Operations on ranges of vectors will also be important.


Identification
Validation
u
0.5
0
-0.5
0
0.5
1
1.5
2
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-1000
-2000
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