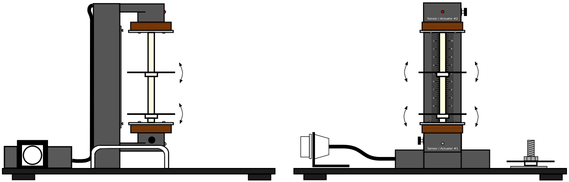
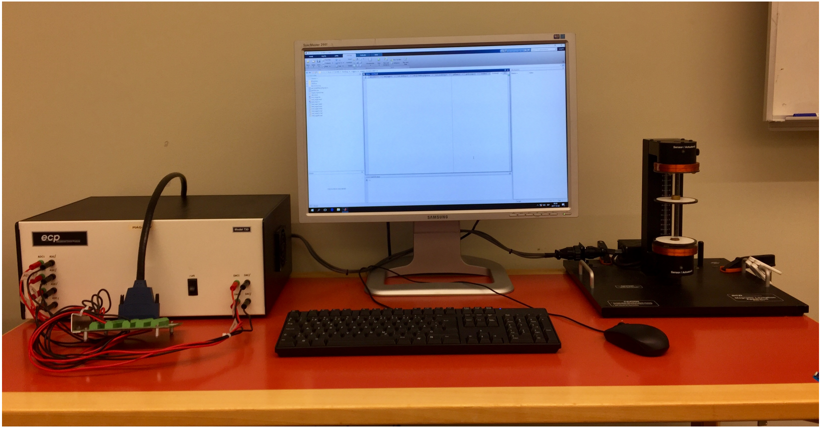
Laboratory Exercise 3:
Modeling of a Magnetic Levitator

Mina Ferizbegovic (e-mail: `minafe@kth.se`)

September 20th, 2020



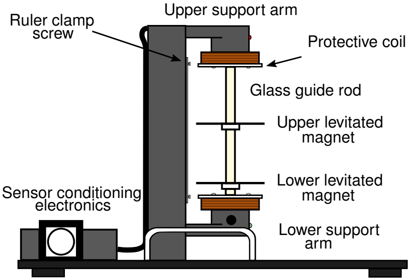
System Overview



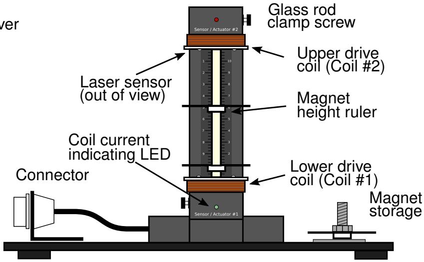
System Overview

Dataset	L	A	
binary_signal_1	1.5-3	0.25	20000
binary_signal_2	1.5-4	0.25	20000
binary_signal_3	1.5-4	0.5	20000
binary_signal_4	1.5-3	0.5	20000
binary_signal_5	1.5-4	0.75	20000
binary_signal_6	1.5-3	0.75	20000
binary_signal_7	1.5-3	1	20000
binary_signal_8	1.5-4	1	20000
binary_signal_9	1.5-3	0	20000
binary_signal_10	1.5-4	0	20000
white_noise_1	1.5-3	-	20000
white_noise_2	1.75-2.5	-	20000
white_noise_3	1.5-4	-	10000
white_noise_4	1.5-4	-	20000

The Plant

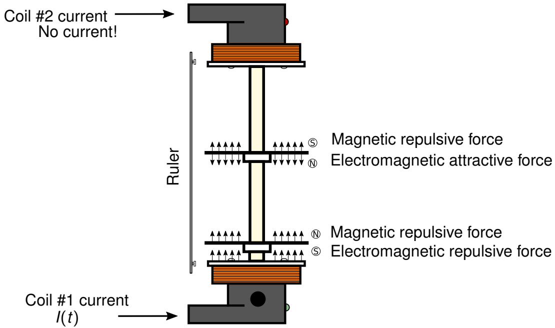


Side View



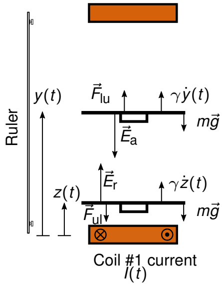
Front View

The Plant



Coil #2 current
No current!
Ruler
Magnetic repulsive force
Electromagnetic attractive force
Magnetic repulsive force
Electromagnetic repulsive force
Coil #1 current
$I(t)$

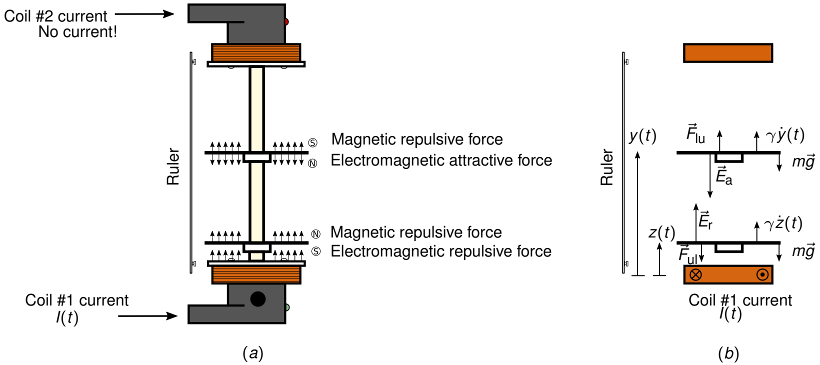
(a)



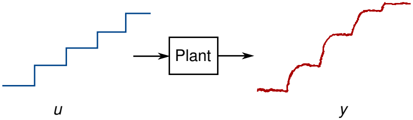
Ruler
$y(t)$
$\vec{F}_{lu}$
$\gamma\dot{y}(t)$
$m\vec{g}$
$\vec{E}_a$
$\vec{E}_r$
$\gamma\dot{z}(t)$
$z(t)$
$\vec{F}_{ul}$
$m\vec{g}$
Coil #1 current
$I(t)$

(b)

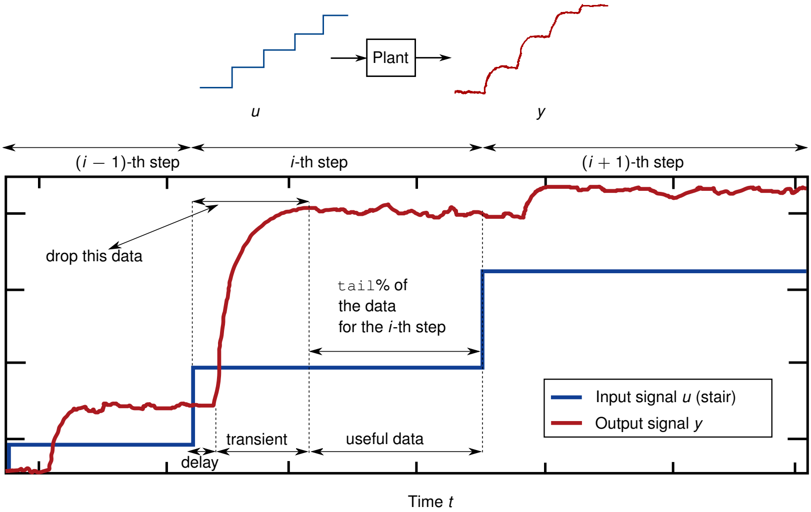
Preparation Task 1: Derive a state space model.



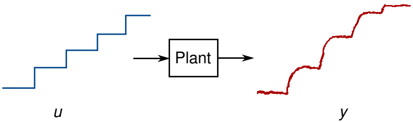
Working Region

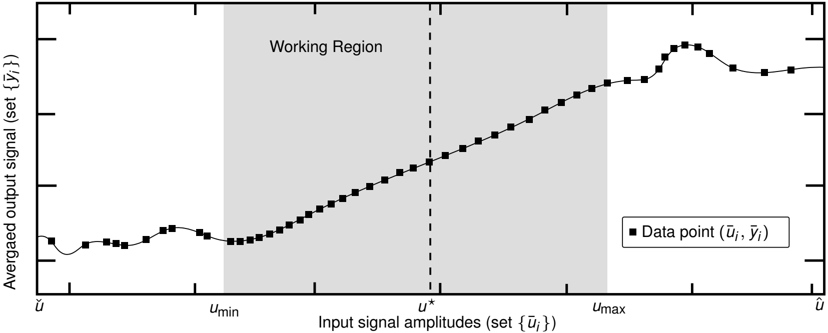


Working Region



Working Region

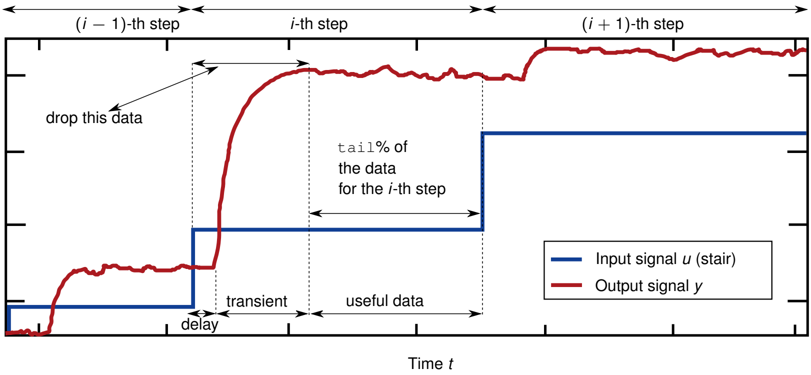




Working Region

Preparation Task 2: Design a function

```
bar_v = getAverage(v, tail)
```



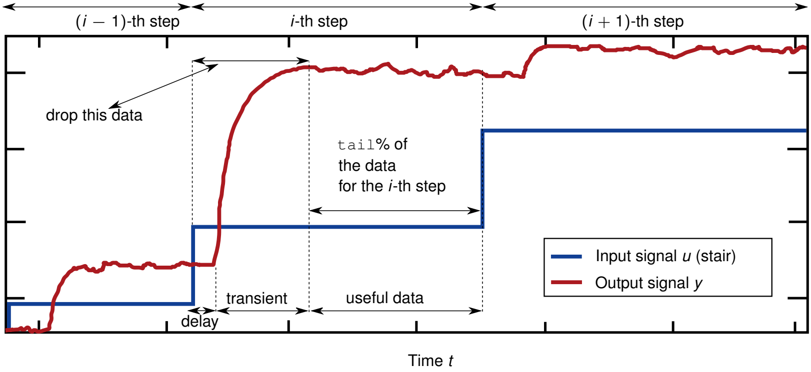
Working Region

Preparation Task 2: Design a function

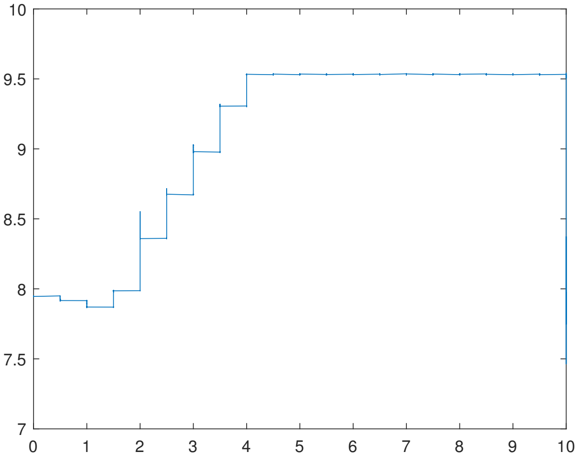
```
bar_v = getAverage(v, tail)
```

Preparation Task 3: Design a function

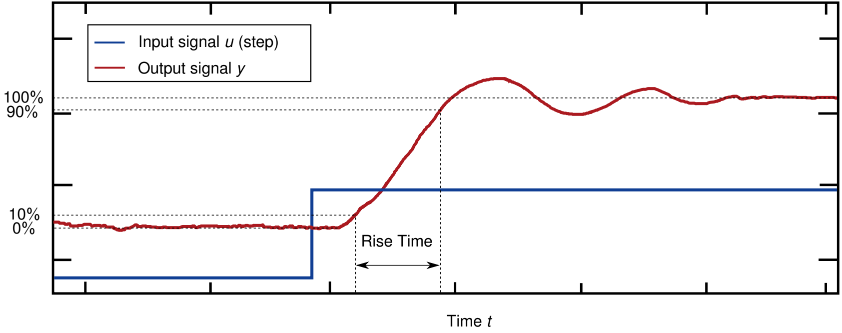
```
bar_y = getStationaryAverages(y_step, Nwr, tail)
```



Working region

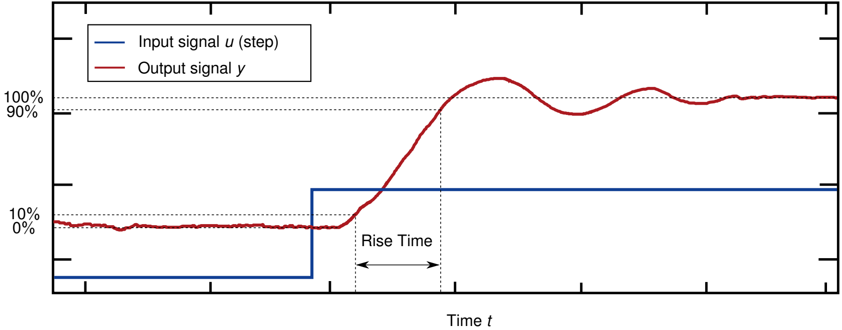


Sampling Period



Sampling Period

$4 \sim 10$ samples per rise time.



Sampling Period

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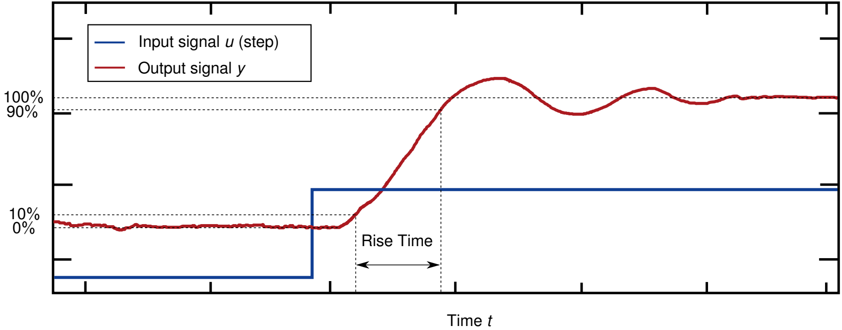
$T_s = 1$ [ms]



Identification Experiments

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1. Choose two datasets with **uniformly distributed white noise** as an input signal. Using these datasets, find where the plant's frequency response is larger.
2. Choose a dataset with **random binary signal**. Choose $\alpha^\star \in \{0, 0.25, 0.5, 0.75, 1\}$ such that the spectrum of **binary random signal** focus more spectral power where the plant's frequency response is larger.

Identification Methods

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3. Ranking of top 4 models $\rightarrow$ (one-step ahead) fit coefficient.

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2. Compare one model performance for **uniformly distributed white noise** and **binary signal**.
3. Ranking of top 4 models $\rightarrow$ (one-step ahead) fit coefficient.
4. Compare your best and your worst models using Bode diagrams, pole-zero diagrams and residual analysis.

Report

- Use templates (Word and Latex).

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- Submit a **.pdf file**.

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- Spellcheck!

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- To the point!
- No need to write introduction/theory.
- Present what you did and why you did it.

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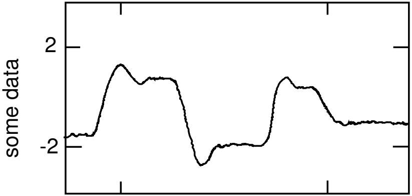
- To the point!
- No need to write introduction/theory.
- Present what you did and why you did it.
- Motivate all your choices.

How NOT to do it

Figures



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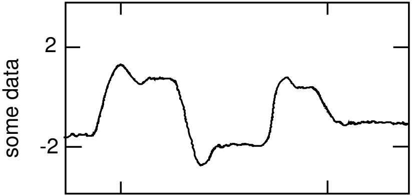

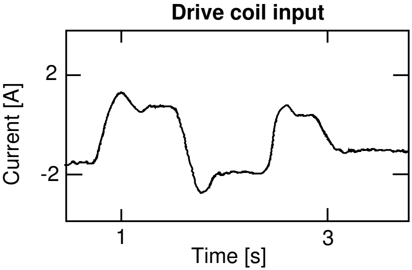

Figure: Trace of the first four seconds of the designed input signal.

Figures

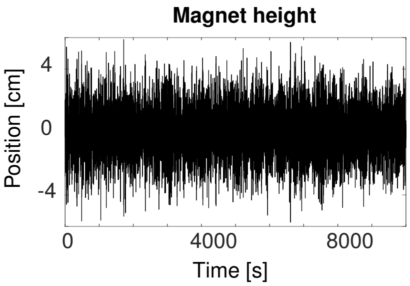

Figure: Output measurement when the input is white noise of variance $\sigma^2 = 1$.

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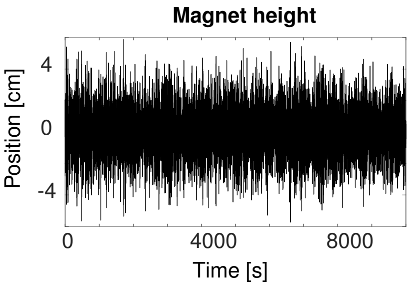

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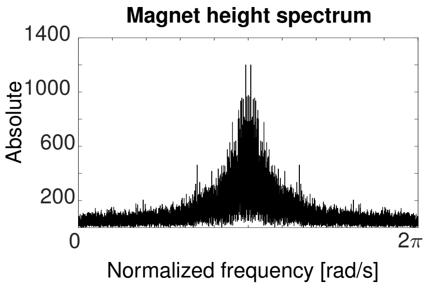

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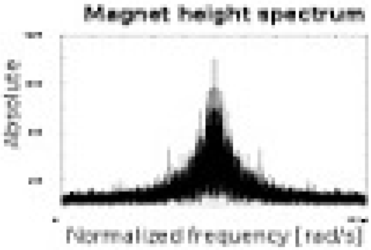

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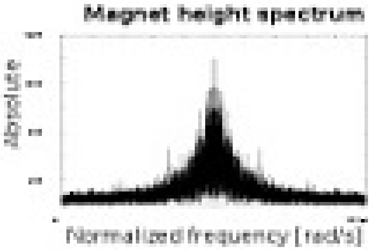

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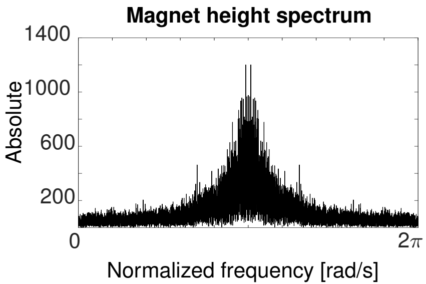

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Language

Note that, it can be proven that the chosen procedure leads to estimates that can be shown to be consistent and asymptotically efficient

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Brevity: write as if you were speaking.

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