

Reguleringsteknik 1

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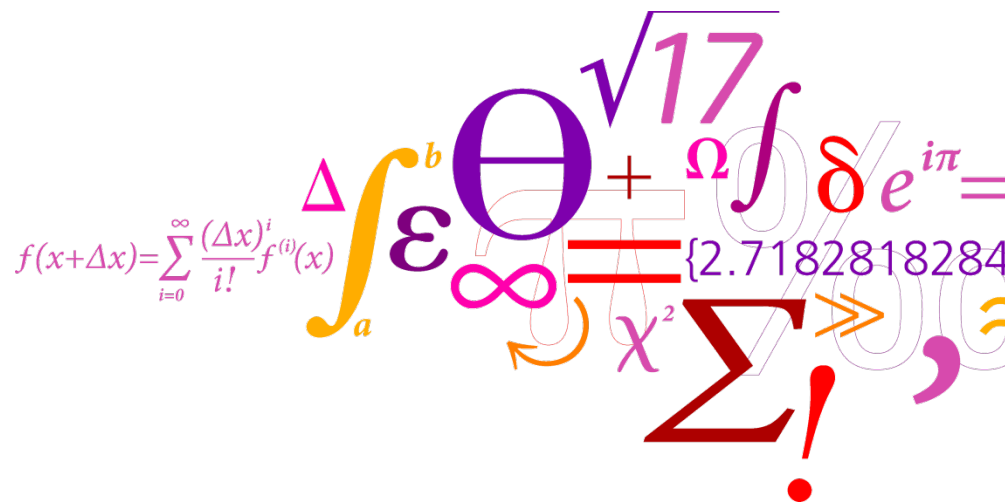
Kursusuge 3

Eksempel

- Modelleringsmetoder
- Ulinært system med støj

Øvelse

- Modellering af robot



Modellering

- Modellering kan ske på 3 måder:

- Åbent system (white box)

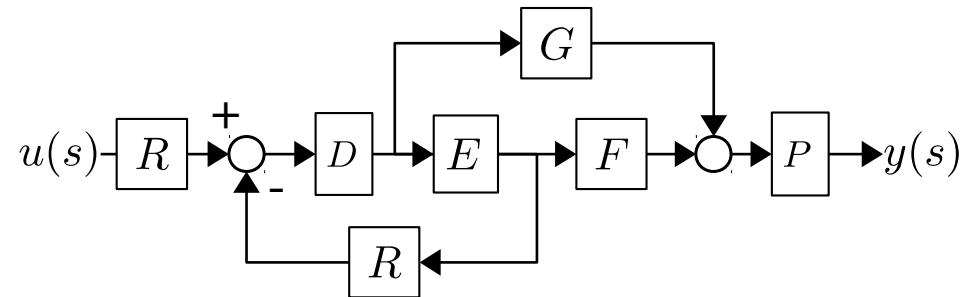
Model ud fra fysik,
målinger er – ideelt – ikke
nødvendigt.

- Ukendt system (black box)

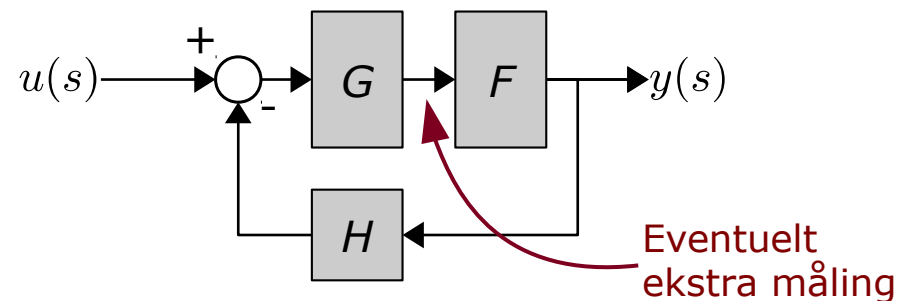
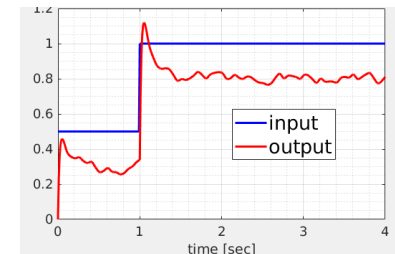
Kun målinger er kendt.

- Delvist kendt system (gray boks)

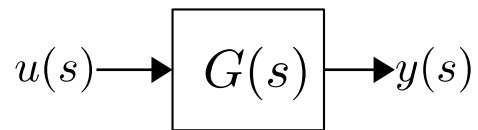
Noget fysik er kendt,
resten ud fra målinger.



Måling



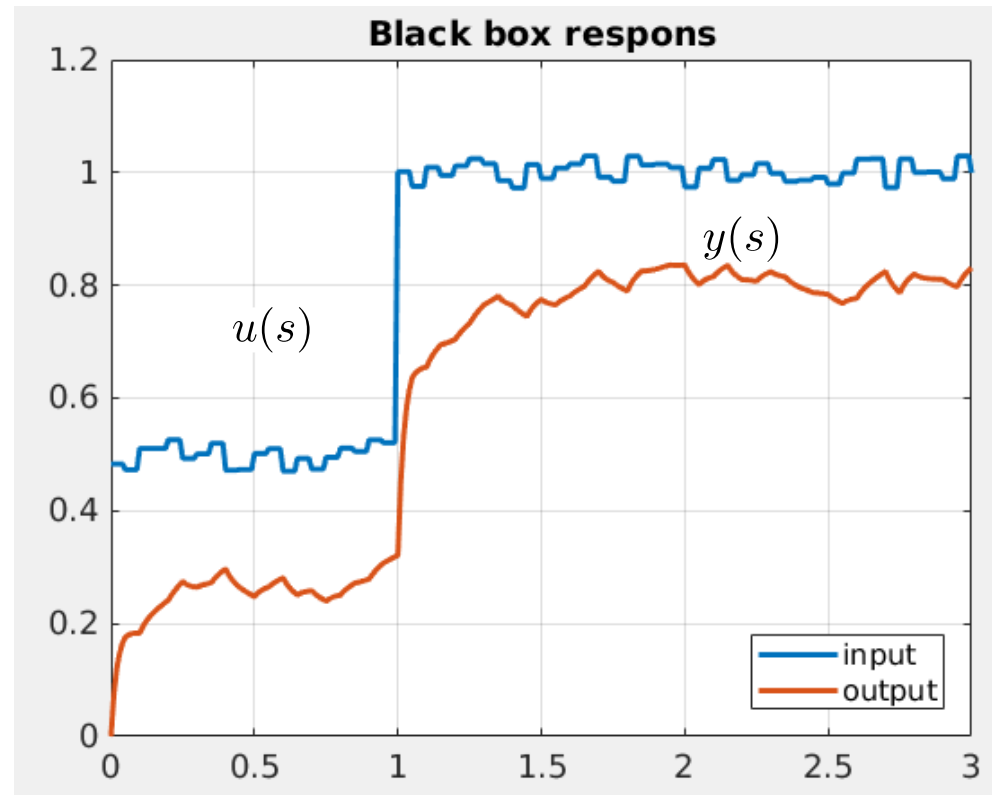
Modelling (black box)



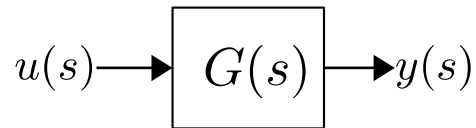
Hvad er
overføringsfunktionen?

$$\frac{y(s)}{u(s)} = G(s) = ?$$

Er systemet kausalt?
Årsag → virkning



Modelling (black box)

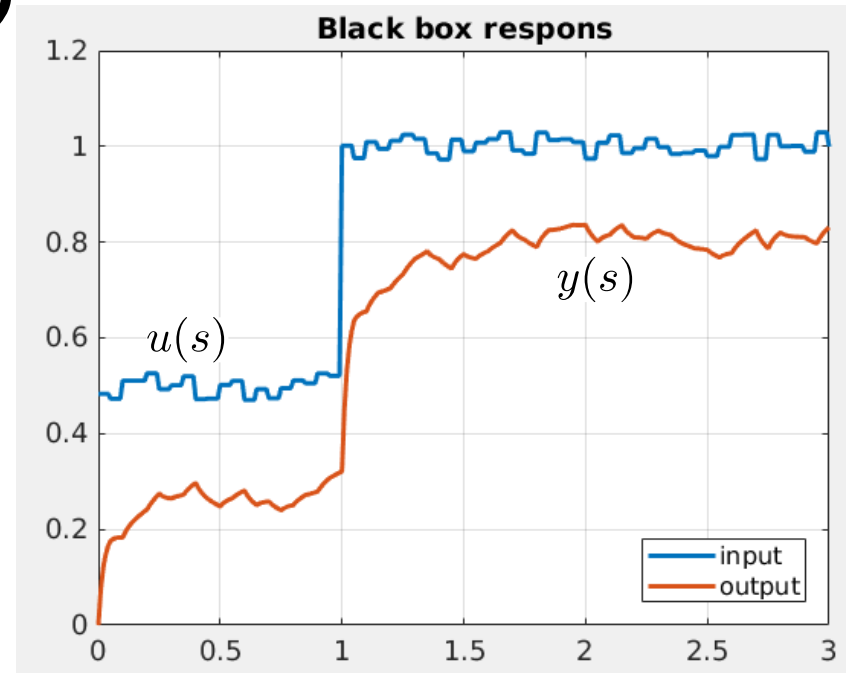


Hvad er
overføringsfunktionen?
- steady state?:

$$y = 0.8u ?$$

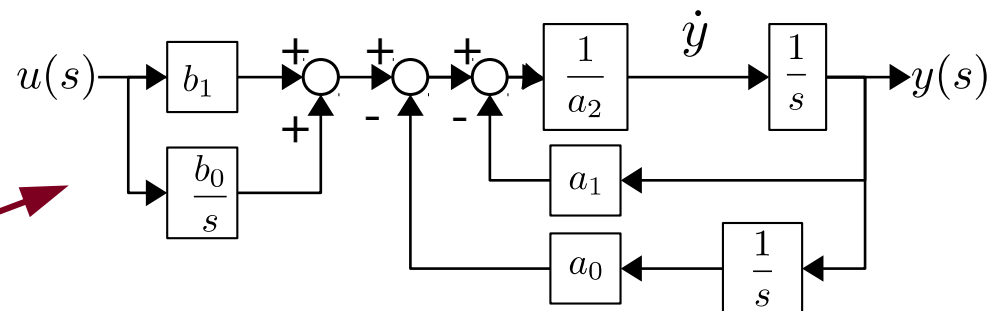
$$y = u ?$$

- dynamisk?:
er der poler? nulpunkter?



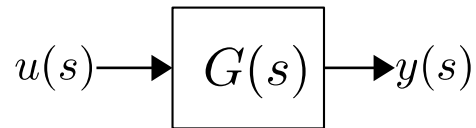
$$y = \frac{b_0}{a_1 s + 1} u ?$$

$$y = \frac{b_1 s + b_0}{a_2 s^2 + a_1 s + 1} u ?$$



Modelling (black box)

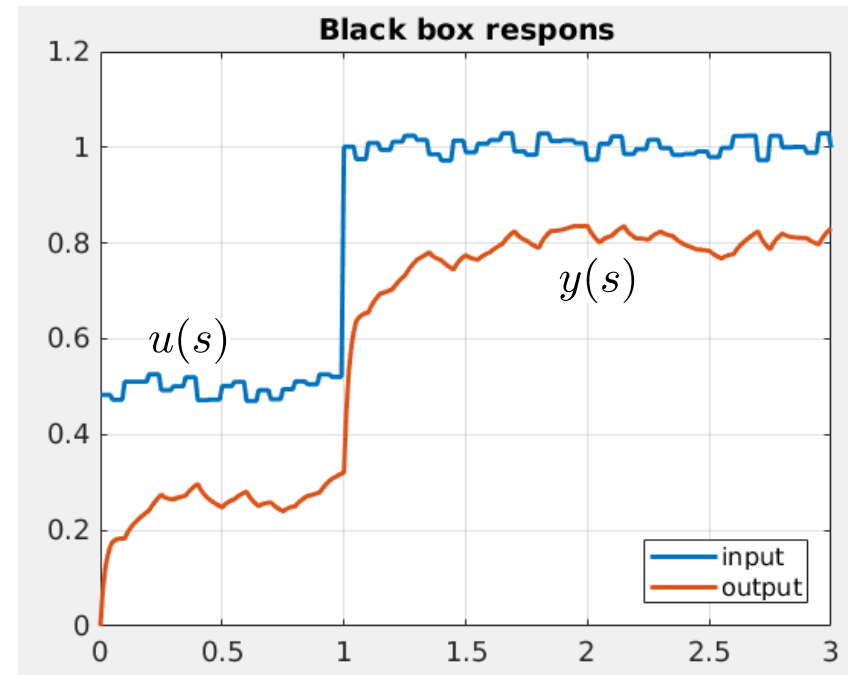
- man kan vel prøve sig frem?



$$y = \frac{b_0}{a_1 s + 1} u ?$$

$$y = \frac{b_1 s + b_0}{a_2 s^2 + a_1 s + 1} u ?$$

$$y = \frac{b_0}{a_3 s^3 + a_2 s^2 + a_1 s + 1} u ?$$



Alt for mange parametre, kan MATLAB hjælpe?

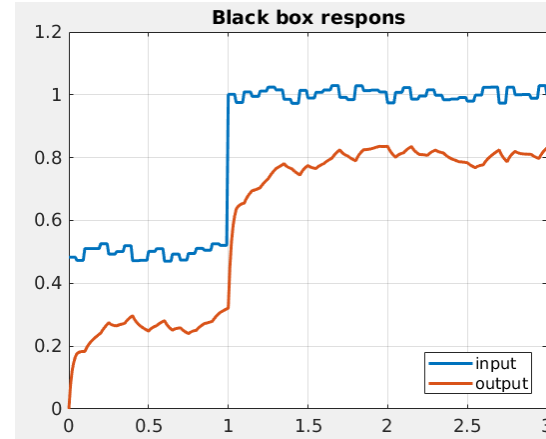
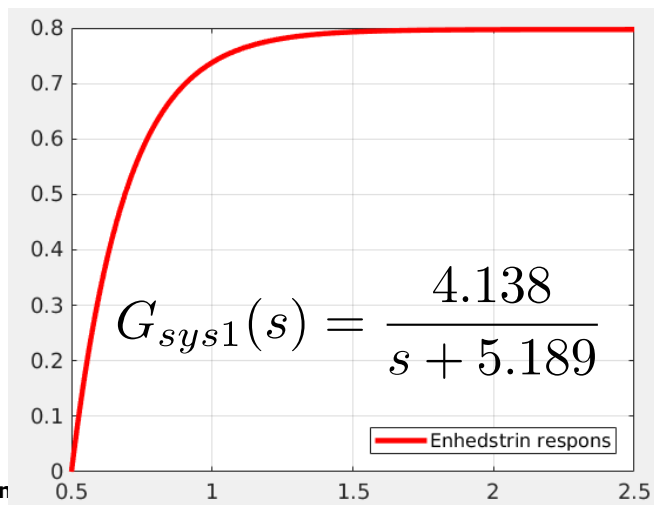
Modelling (black box) MATLAB Transfer Function ESTimate

```
data = load('fil.txt');
dd = iddata(data(:,3), data(:,2), 0.01);
sys1 = tfest(dd, 1, 0);
figure(100);
step(sys1);
```

Sampel tid

1 pol
0 nulpunkter

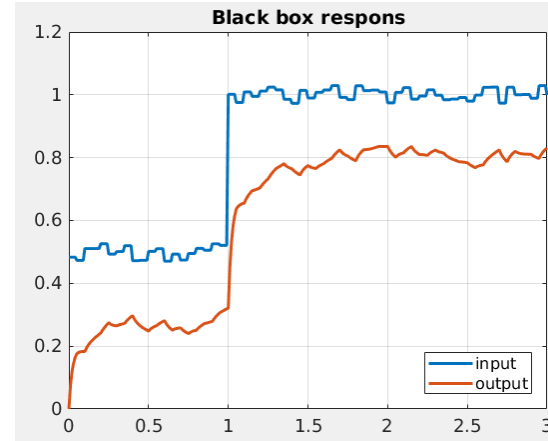
Godt nok?



Fil.txt:

```
% Testdate for system T=10ms
% 1 time [sec]
% 2 data ind
% 3 data ud
0.010000 0.483138 0.0744597
0.020000 0.483138 0.119962
0.030000 0.483138 0.147891
0.040000 0.483138 0.16515
0.050000 0.472823 0.175927
0.060000 0.472823 0.179743
0.070000 0.472823 0.18178
0.080000 0.472823 0.182747
0.090000 0.472823 0.183074
0.100000 0.510732 0.183021
0.110000 0.510732 0.193844
...
```

Modelling (black box) MATLAB Transfer Function ESTimate



```
data = load('fil.txt');
```

```
dd = iddata(data(:,3), data(:,2), 0.01);
```

```
sys2 = tfest(dd, 2, 0)
```

```
sys3 = tfest(dd, 2, 1)
```

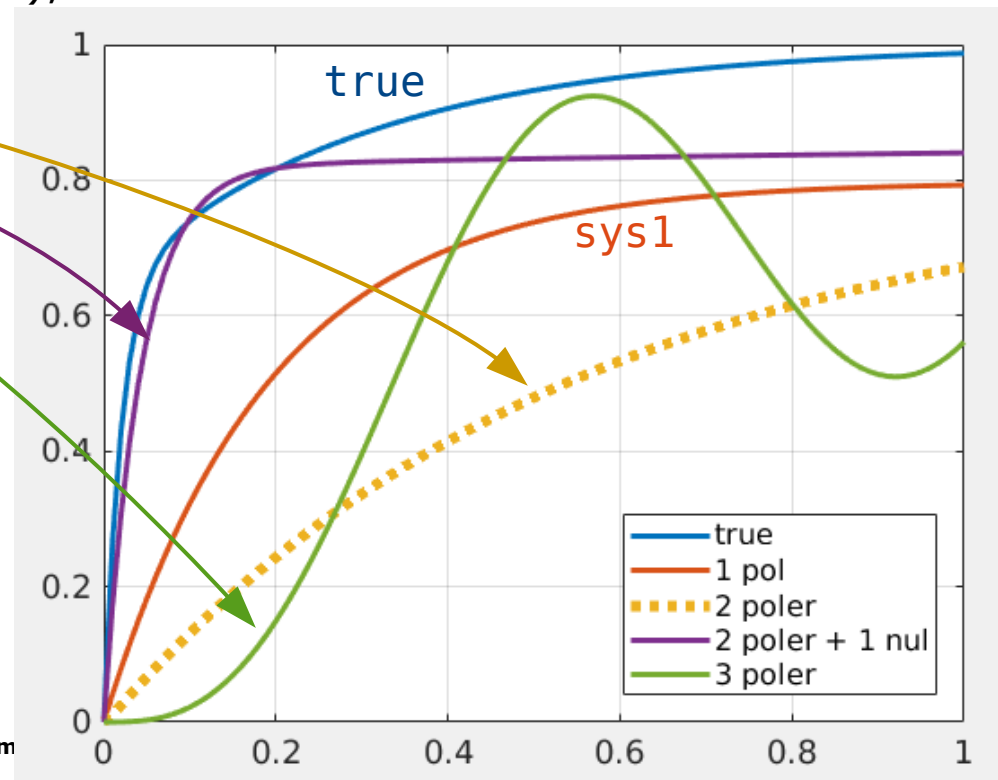
```
sys4 = tfest(dd, 3, 0)
```

$$G_{sys1}(s) = \frac{4.138}{s + 5.189}$$

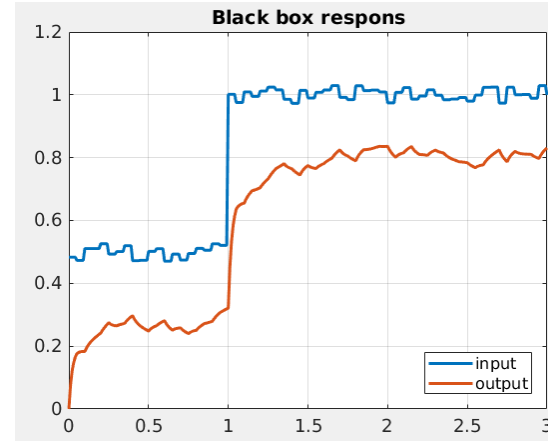
$$G_{sys2}(s) = \frac{538.6}{s^2 + 368.3s + 673.5}$$

$$G_{sys3}(s) = \frac{19.16s + 12}{s^2 + 23.93s + 13.87}$$

$$G_{sys4}(s) = \frac{145.8}{s^3 + 2.665s^2 + 65.55s + 174.7}$$



Modelling (black box) MATLAB Transfer Function ESTimate



```
data = load('fil.txt');
```

```
dd = iddata(data(:,3), data(:,2), 0.01);
```

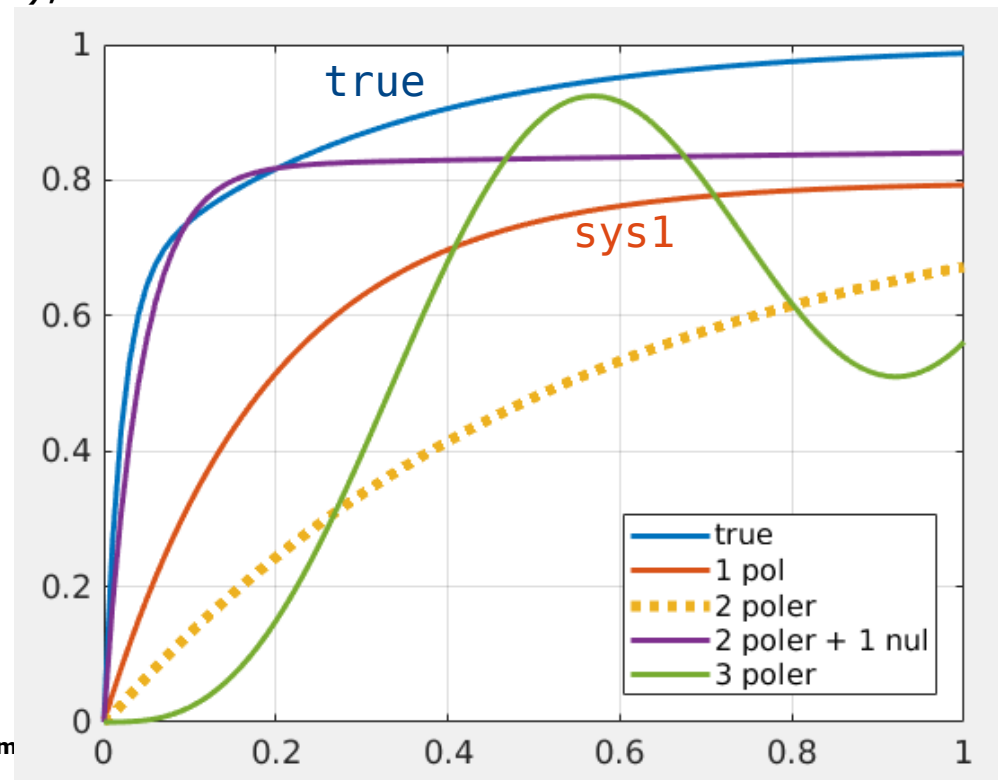
```
sys2 = tfest(dd, 2, 0)
```

```
sys3 = tfest(dd, 2, 1)
```

```
sys4 = tfest(dd, 3, 0)
```

Er det godt nok?

Hvorfor går det så galt?



Modellering (black box)

MATLAB

Transfer Function ESTimate

Systemet er ulineært

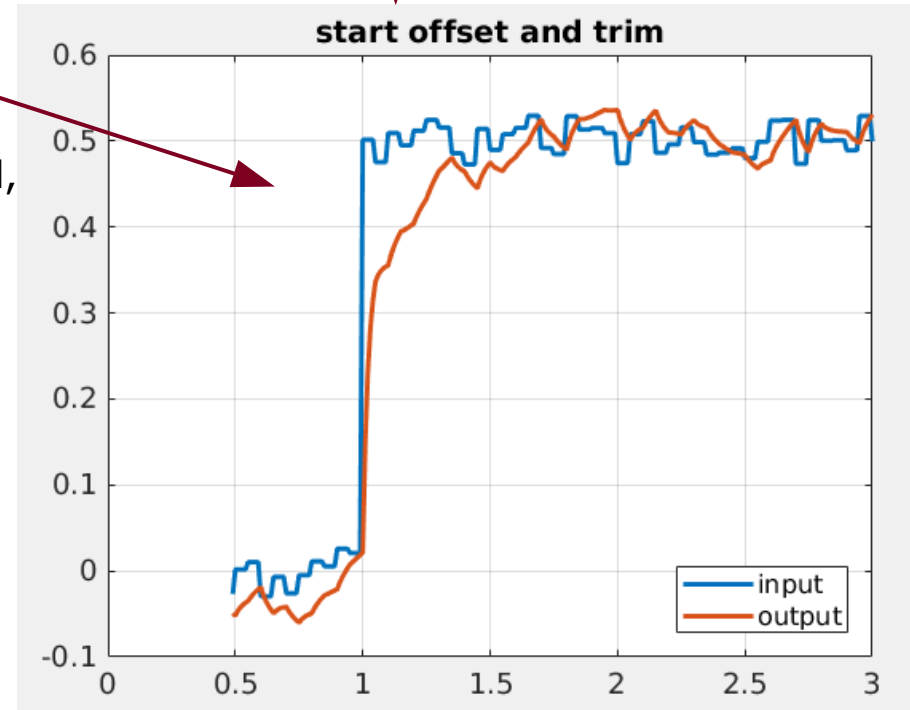
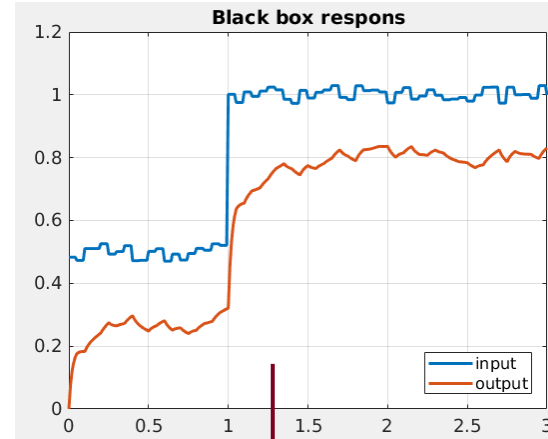
- kun ændring ved 1s er OK
- starten skal undlades
- offset data så de starter i 0

Det ser også straks bedre ud

Et lineært (stabilt) system med 0 ind giver 0 ud, og her leder vi efter en lineær model.

```
data = load('fil.txt');
dd = iddata( ...
    data(50:end, 3) - offsetUd, ...
    data(50:end:, 2) - offsetInd, ...
    0.01);
```

```
sys1 = tfest(dd, 1, 0)
sys2 = tfest(dd, 2, 0)
sys3 = tfest(dd, 2, 1)
sys4 = tfest(dd, 3, 0)
```



Modelling (black box)

MATLAB

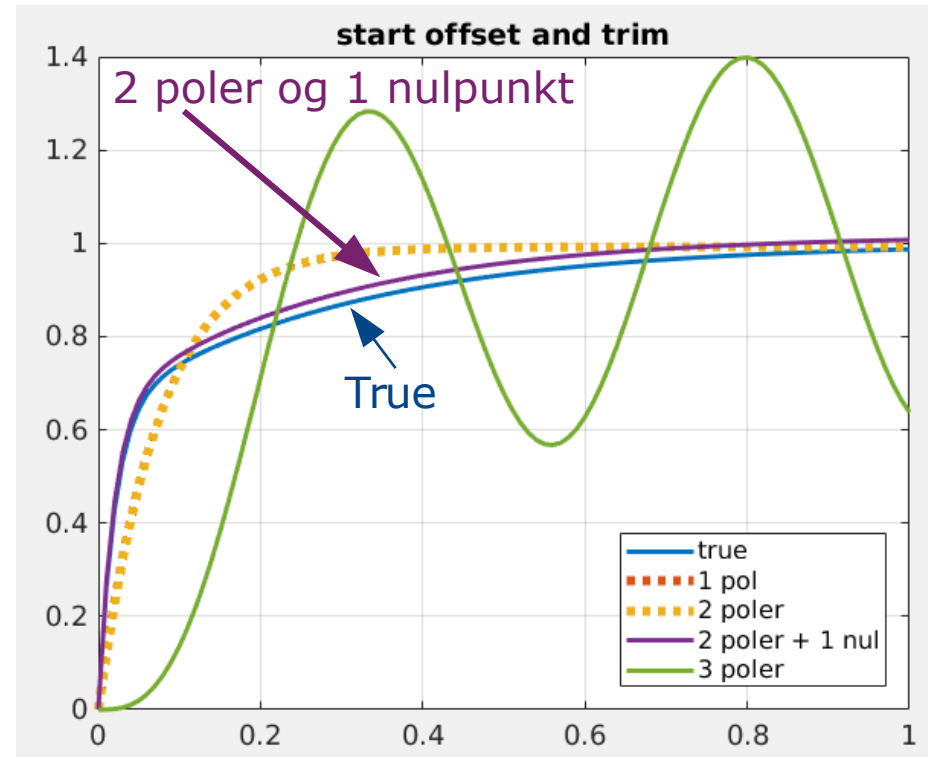
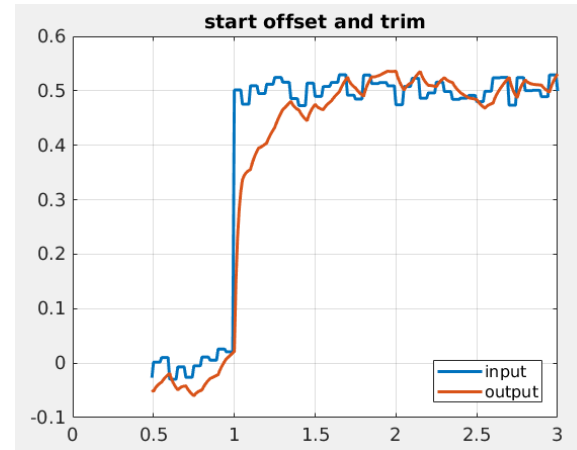
Transfer Function ESTimate

Systemet er ulineært

- kun *ændring* i arbejds punkt er OK
- start (indsvingning) undlades
- offset data så de starter i 0

```
data = load('fil.txt');
dd = iddata( ...
    data(50:end,3) - offsetUd, ...
    data(50:end,2) - offsetInd, ...
    0.01);
```

```
sys1 = tfest(dd, 1, 0)
sys2 = tfest(dd, 2, 0)
sys3 = tfest(dd, 2, 1) ←
sys4 = tfest(dd, 3, 0)
```



Øvelse og peer review

- Modellering øvelse (gælder 2 øvelsesgange)
 - Motor model i Simulink (motor, gear og hjul)
 - Parameterestimering ud fra måling på robot
 - Robot med hjul på gulv (tilføjelse af robottens masse)
 - Model med regulering
- Peer review af rapport 1
 - Hver person skal gennemføre:
 - Peer review af egen gruppes aflevering
 - Peer review af 2 andre gruppers rapport
 - Åbent peer review: reviewer kan se forfatter, forfatter kan se reviewer.
 - Review resultat indgår ikke i karakter, men aflevering og review skal kunne godkendes for at have ret til at gå til eksamen.