ELEC-E8103

Final exercise

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Problem 1

a)

Output: position z

Input: current i

Constants: p, ϵ_0, m, g, k, b, z_0

Time varying: $\left(\frac{i}{z+\epsilon_0}\right)^2$

b)

$\sum F = ma$

magnetic force downwards

$F_{mag}(z,i) = p\left(\frac{i}{z+\epsilon_0}\right)^2$

$, where\ p = 1.5\ x\ 10^{-5}\ and\ \epsilon_0 = 0.5mm$

$F_{damper} = b\dot{z}$

$F_{spring} = k(z_0 - z)$

$$F_{mag} = F_{damper} + F_{spring} + m\ddot{z}$$

$$m\ddot{z} = -b\dot{z} - k(z_0 - z) + p\left(\frac{i}{z+\epsilon_0}\right)^2$$

$$\ddot{z} = -\frac{b}{m}\dot{z} - \frac{k}{m}(z_0 - z) + \frac{p}{m}\left(\frac{i}{z+\epsilon_0}\right)^2$$

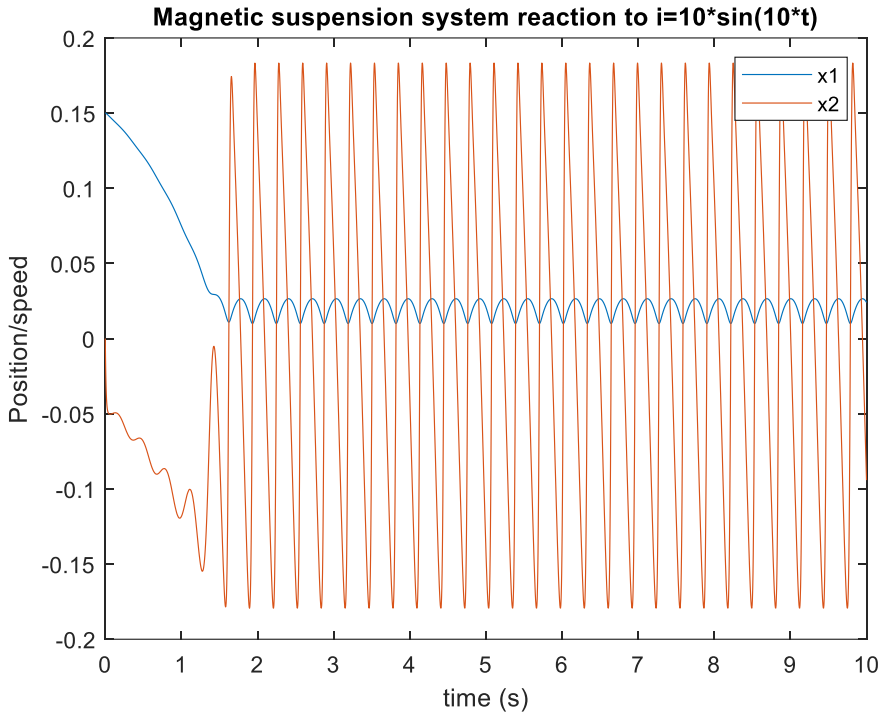
States of the system:

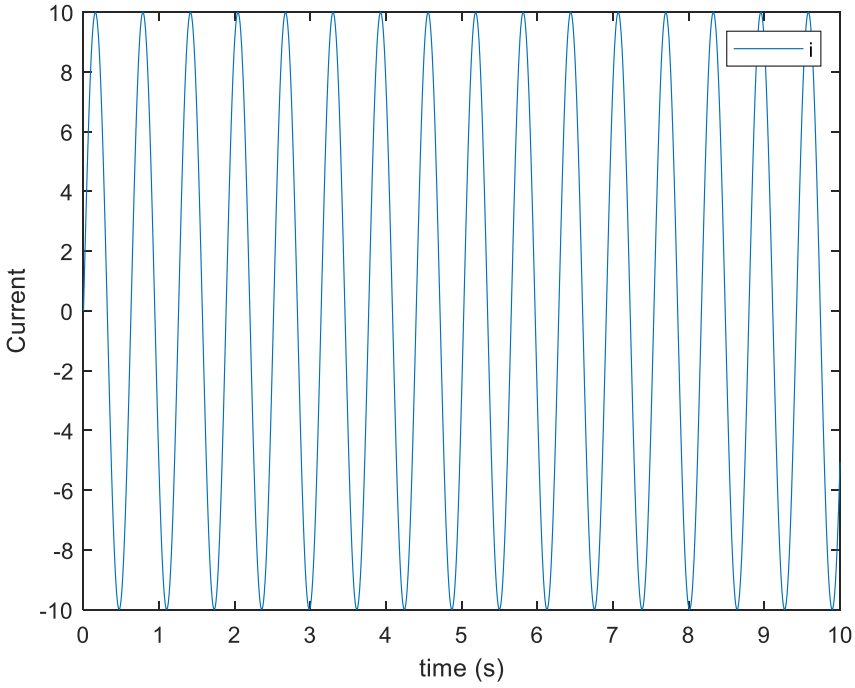
$x_1 = z \qquad \dot{x}_1 = x_2 = \dot{z} \qquad \dot{x}_2 = \ddot{z}$

$$\dot{x}_2 = -\frac{b}{m}x_2 - \frac{k}{m}(z_0 - x_1) + \frac{p}{m}\left(\frac{i}{x_1+\epsilon_0}\right)^2$$

$$\begin{cases} \dot{x}_1 = x_2 \\ \dot{x}_2 = -\frac{b}{m}x_2 - \frac{k}{m}(z_0 - x_1) + \frac{p}{m}\left(\frac{i}{x_1 + \epsilon_0}\right)^2 \end{cases}$$

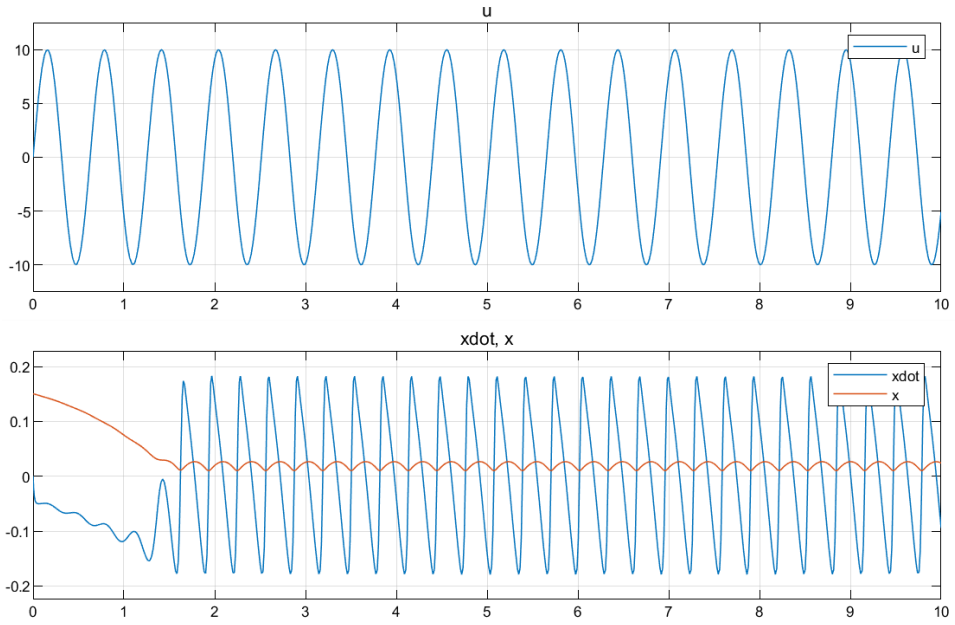
c)





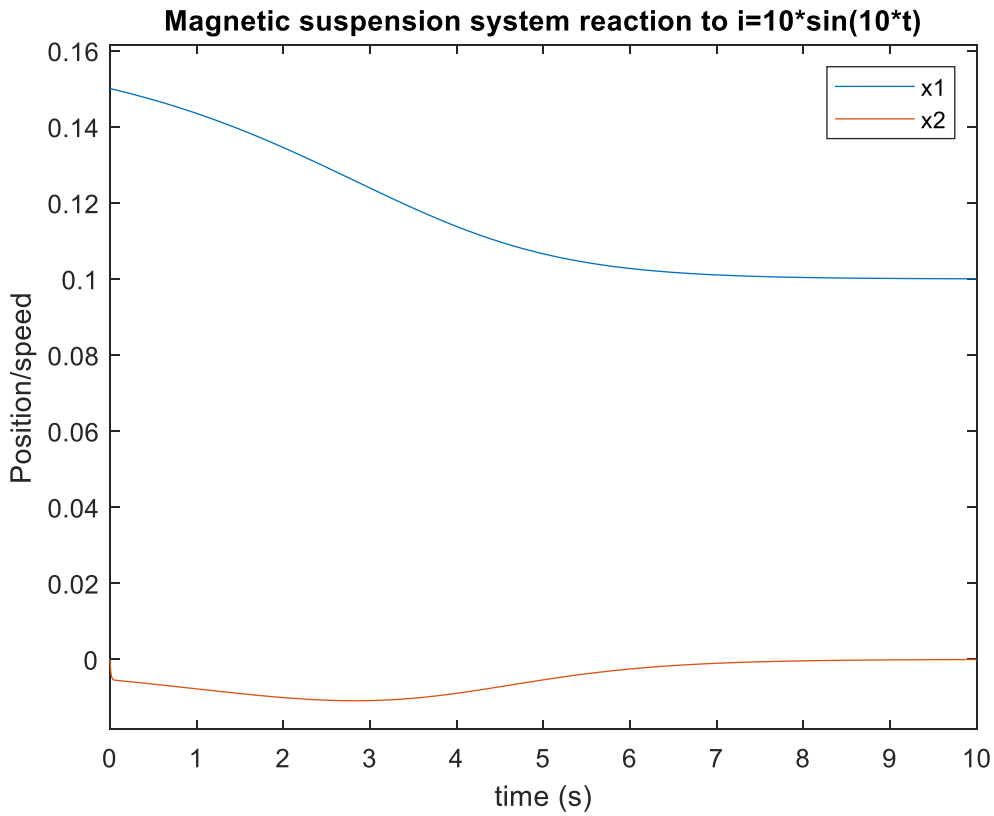
Final position of the bar at t=10s is 0.0240m=2.40cm

d)



e)

Value i where the system balances at 0.1m is `25.948`.



Problem 2

Estimated prices:

Price1=232335.2

Price2=254638.4

Price3=311721.6

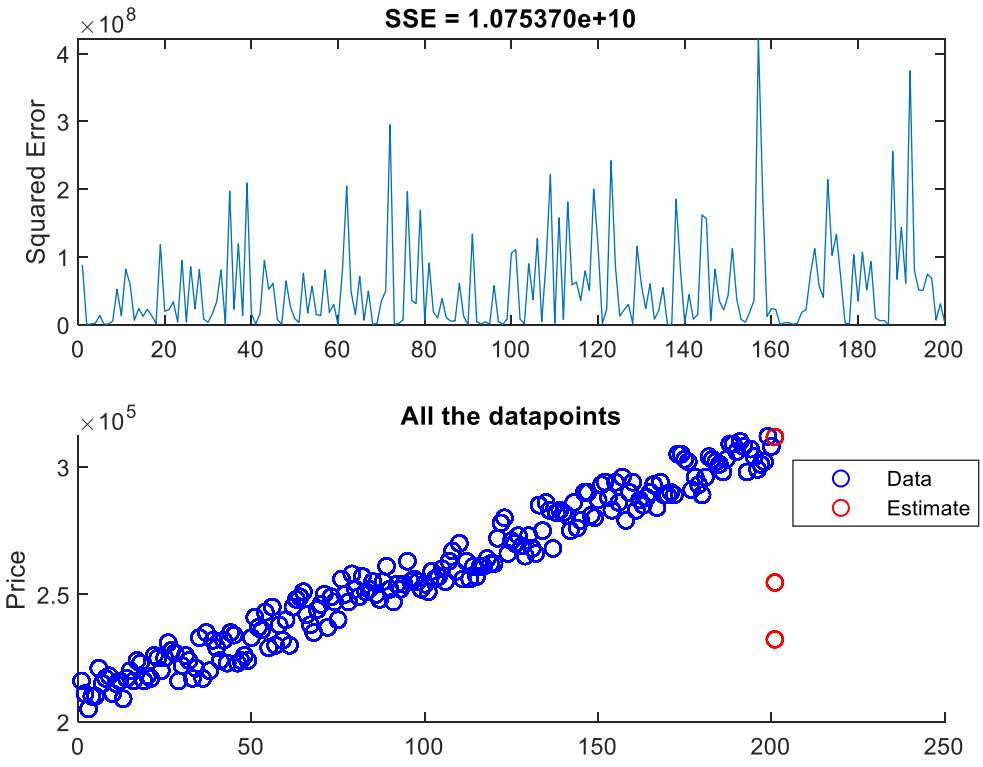
Validation data:

R^2=0.936308

SSE=10753704297.4

SST=168839120000.0

Variance=55431465.5



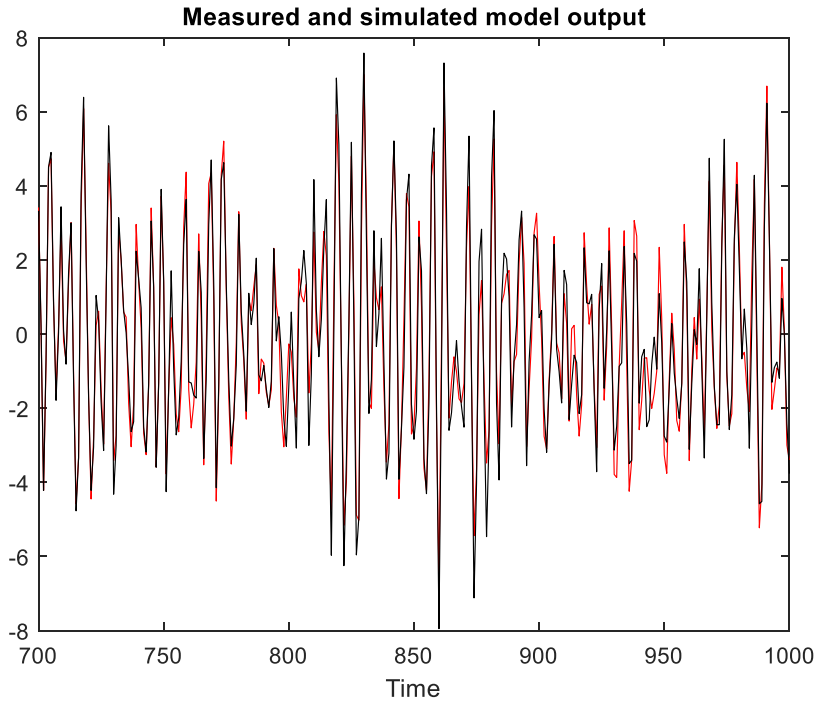
It is impossible to draw the estimation for all the data points as it would need 5d mapping, but as we can see from plotting all the data points, the estimated values fall inside the largest and smallest prices. As our R^2 value is close to 1 (0.936), it means our estimation is very good, because our sum of square error is much smaller than total sum of squares. SST calculates the difference between the real value and mean.

Problem 3

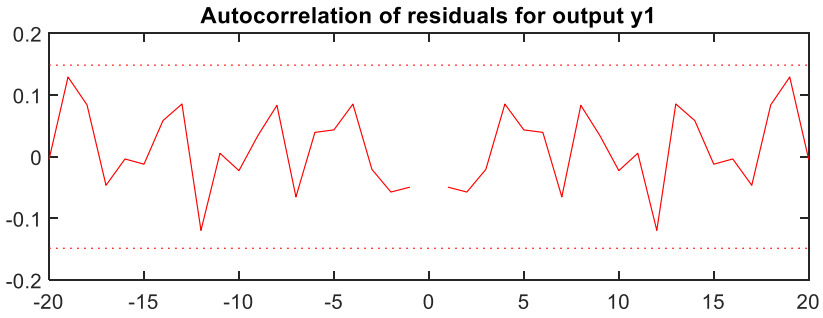
u1/u2

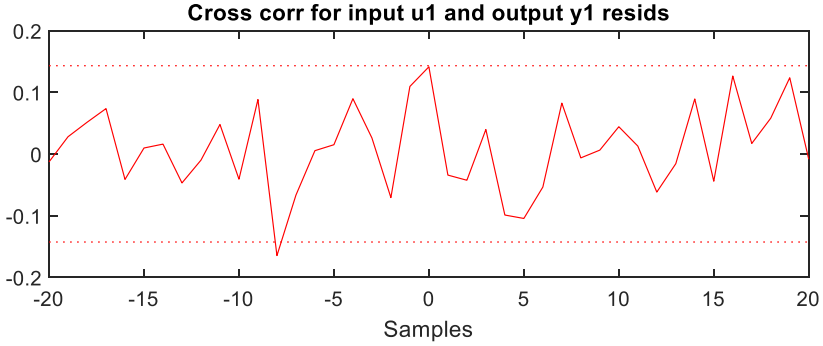
Model AMX2221 (optional model BJ22221)

Good fit (74.95)

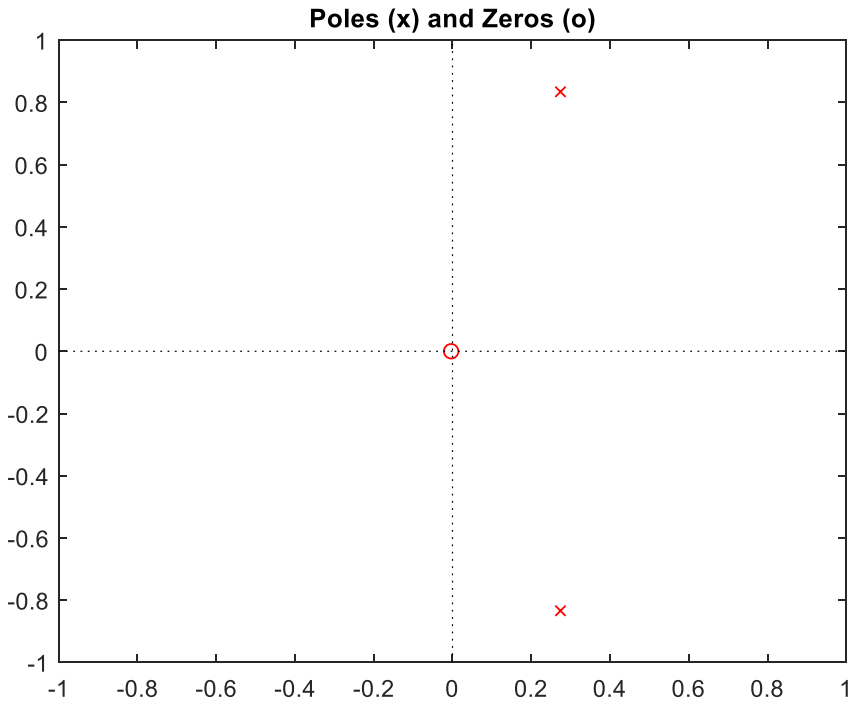


Inside confidence levels (mostly)





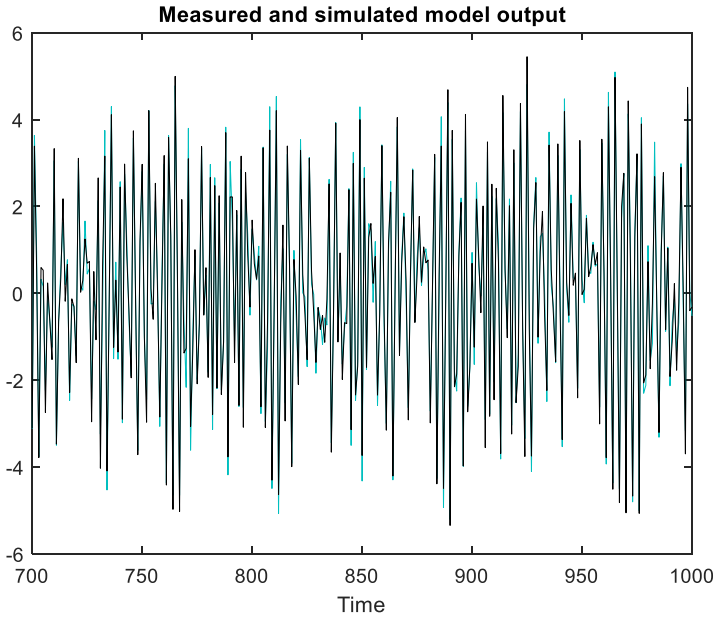
Poles and zeros inside unit circle and zeros not close to poles.



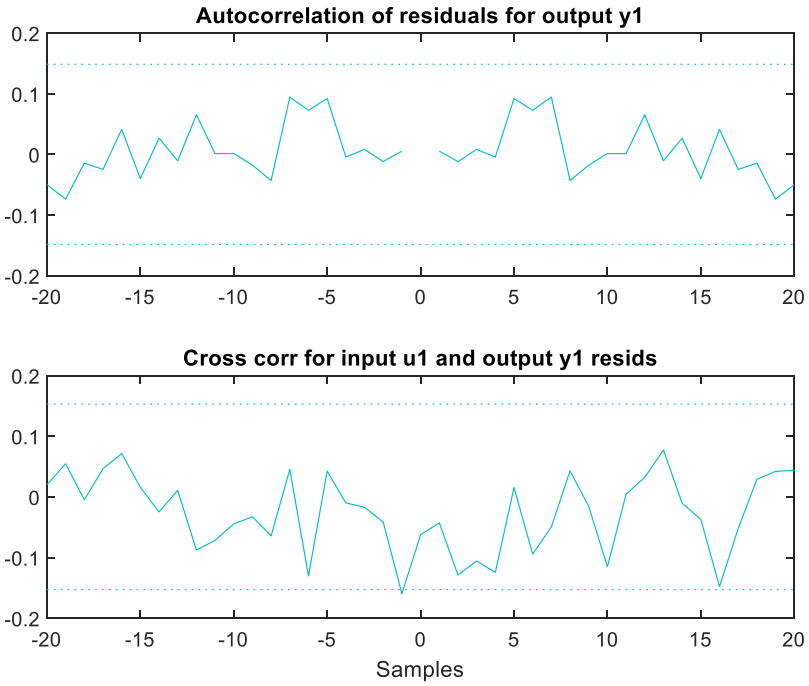
u2/y2

Good fit (87.03)

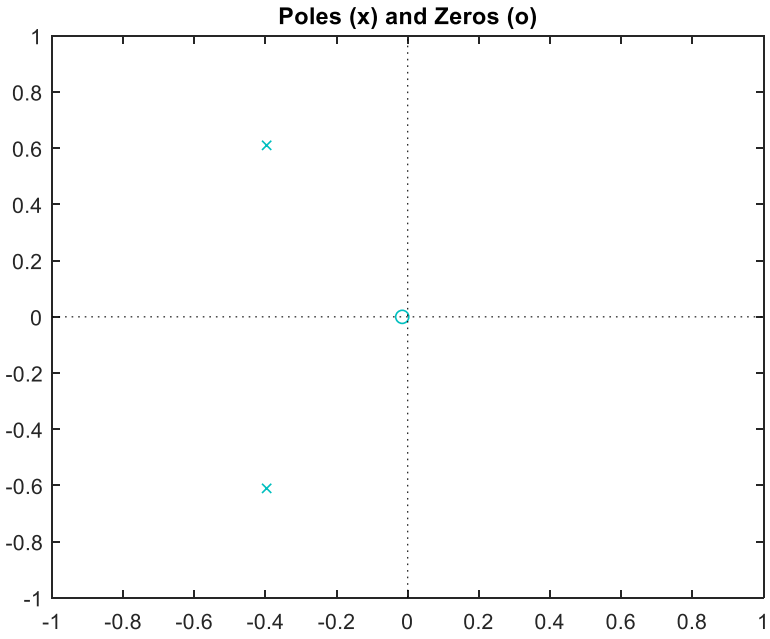
Model: bj22221



Correlation inside lines



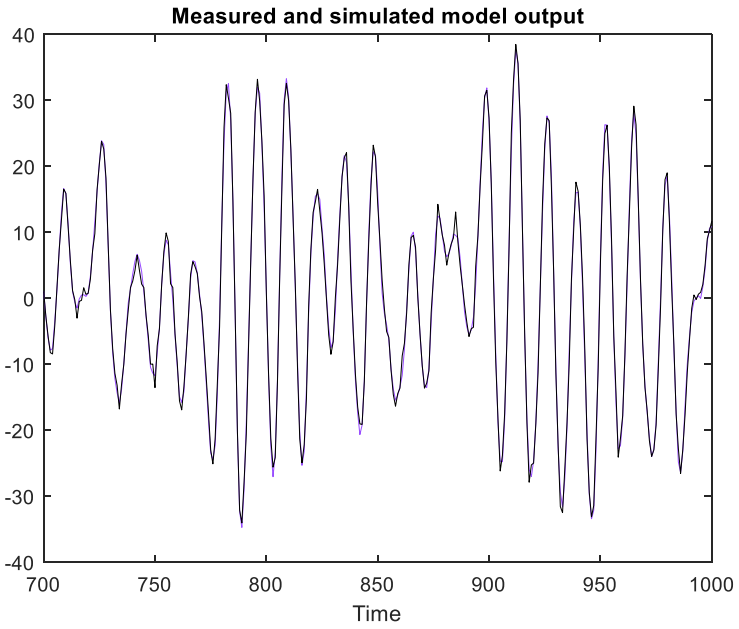
Poles and zeros inside unit circle and zeros not close to poles.



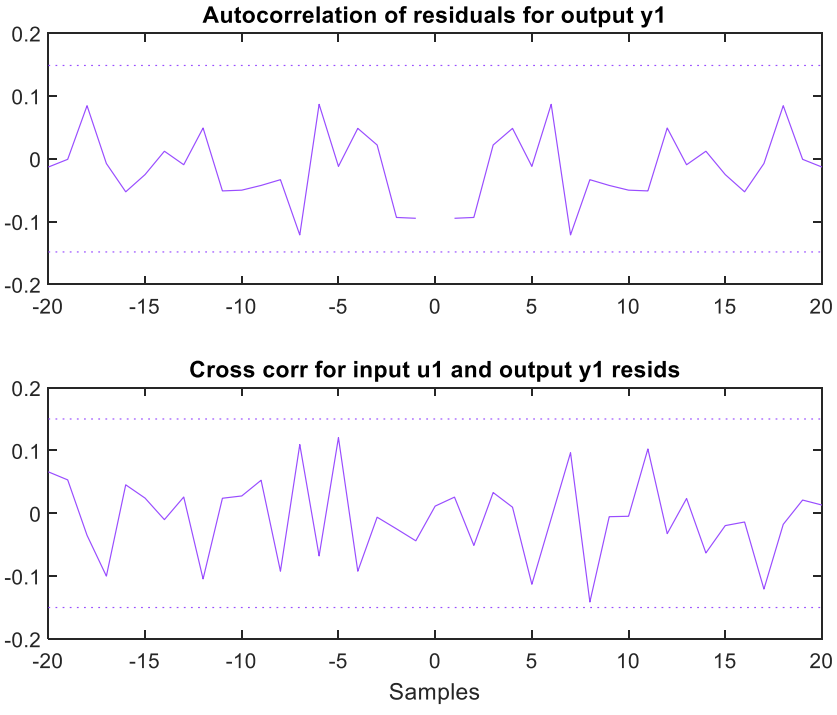
u3/y3

Model: bj32222

Extremely Good fit (93.84)



Residual correlation low on both (inside lines)



Poles and zeros inside unit circle and zeros not close to poles.