Documentație Proiect
Identificarea Sistemelor

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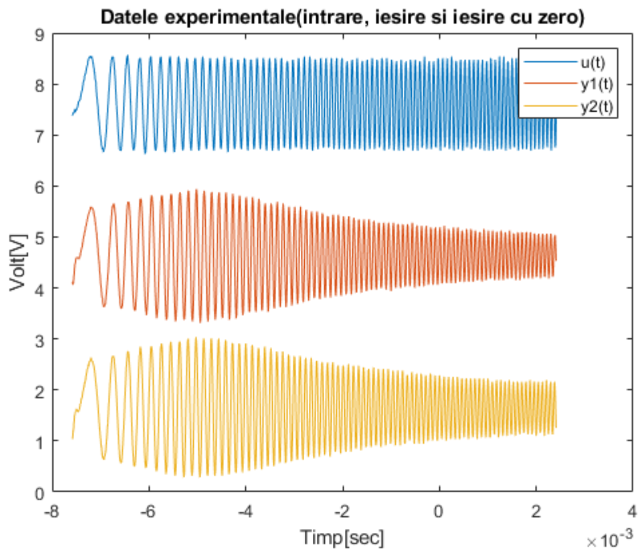
1. Datele experimentale



Unde:

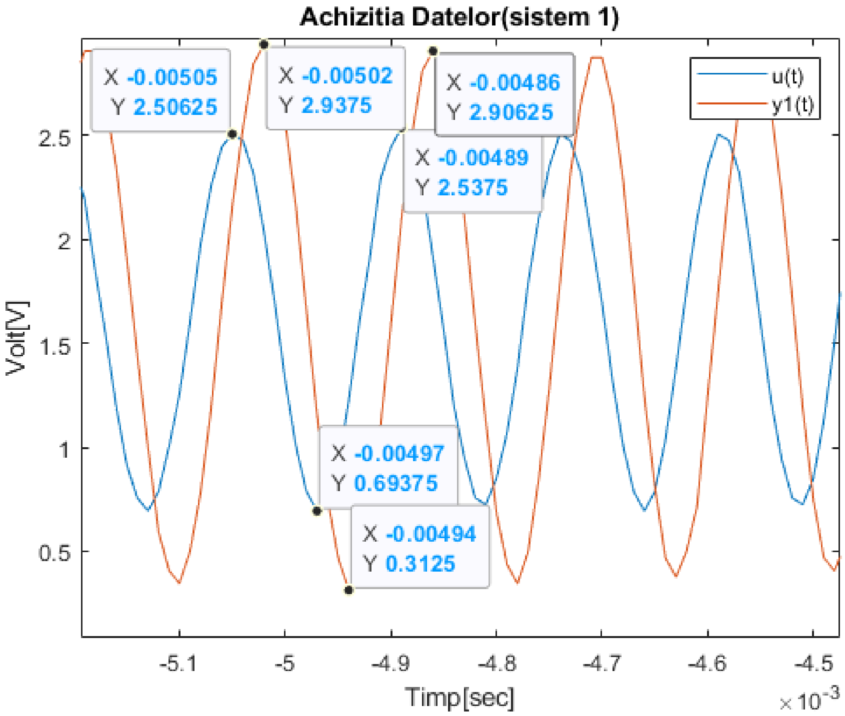
- u(y) - reprezintă intrarea sistemului
- y1(t) - reprezintă ieșirea sistemului de ordinul doi
- y2(t) - reprezintă ieșirea sistemului de ordinul doi cu zero

2. Identificarea Neparametrica

2.1 Identificarea sistemului de ordin 2 prin exploatarea fenomenului de rezonanta

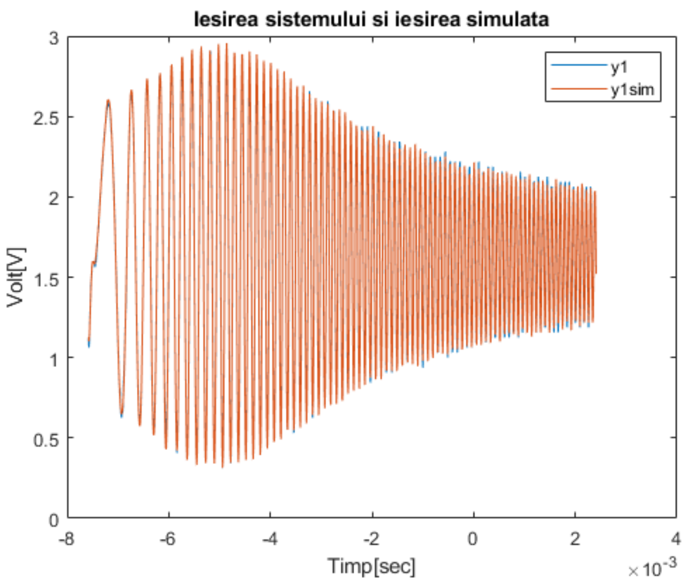
Pași:

1. Achiziția Datelor:



2. Factorul de proporționalitate K, Modulului de rezonanta M_r si ζ:
   K=$\frac{mean(y1)}{mean(u)}$= 1.0132;
   M_r=$\frac{A_y}{A_u}$; unde A_y-amplitudinea ieșirii, iar A_u– amplitudinea intrării
   `Mr1=(y2(257)-y2(265))/(u(254)-u(262))= 1.4483`
   Se identifica ζ din: $Mr = \frac{1}{2\cdot\zeta\sqrt{(1-\zeta^2)}}$;
   de aici: $4 \cdot \zeta^4 - 4 \cdot \zeta^2 + \frac{1}{Mr^2}$=0 =>ζ=0.3719

3. Perioadei de rezonanta T_r, a pulsației de rezonanta ω_r si a pulsației naturale ω_n:
   T_r=t(274)-t(257)=1.6e-04[sec];
   ω_r=$\frac{2\pi}{T_r}$= 3.9270e04[rad/sec]; ω_n=$\frac{\omega_r}{\sqrt{1-2\zeta^2}}$= 4.6172e04[rad/sec]
4. Scrierea funcției de transfer H, simularea ieșirii si calcularea erorii:
   H(s)=$\frac{\omega_n^2}{s^2+2\zeta\omega_n s+\omega_n^2}$=$\frac{2.16e09}{s^2+3.434e04s+2.132e09}$
   A=[0 1; -ω_n^2 -2$\zeta\omega_n$]; B=[0; K*ω_n^2]; C=[1 0]; D=0;



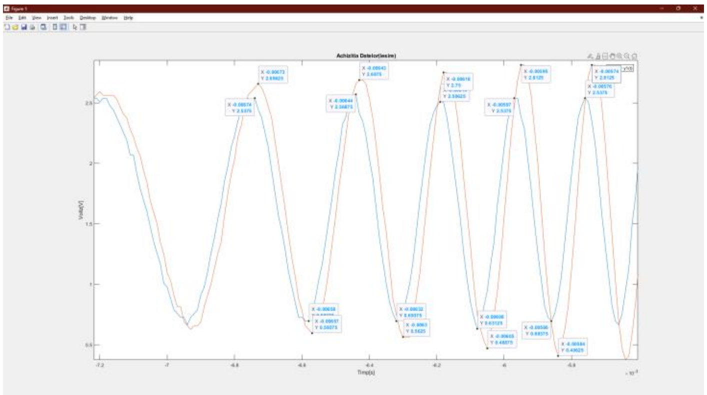
EMPN=0.0431 => eroare de 4.31%

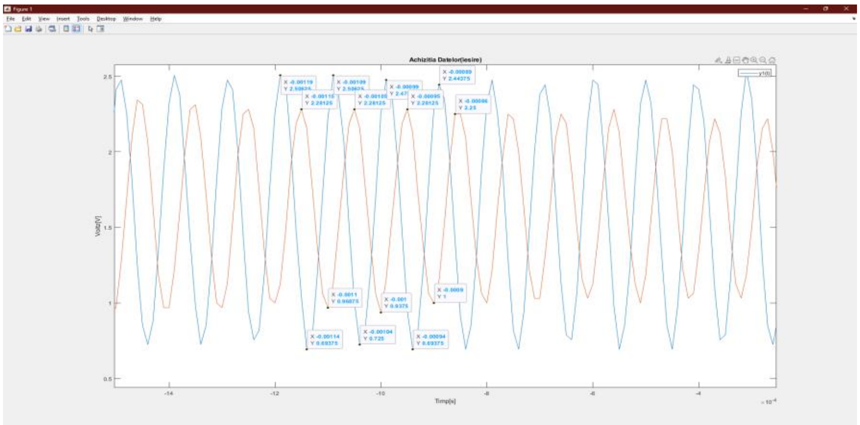
3. Estimarea diagramelor Bode

3.1 Sistemul de ordinul 2

Pași:

1. Alegerea punctelor de la frecvente joase, înalte, de la modul =1 si de la final:





2. Extragerea punctelor in Matlab:

28	1x1 Line	[4.8000e-04,...	807
29	1x1 Line	[4.7000e-04,...	806
30	1x1 Line	[4.4000e-04,...	803
31	1x1 Line	[-0.0028,2.5...	489
32	1x1 Line	[-0.0028,2.5...	486
33	1x1 Line	[-0.0028,0.7...	484
34	1x1 Line	[-0.0029,0.7...	480
35	1x1 Line	[-0.0056,0.3...	195
36	1x1 Line	[-0.0057,0.6...	193
37	1x1 Line	[-0.0057,2.8...	185
38	1x1 Line	[-0.0058,2.5...	183
39	1x1 Line	[-0.0058,0.4...	175
40	1x1 Line	[-0.0059,0.6...	173
41	1x1 Line	[-0.0060,2.8...	164
42	1x1 Line	[-0.0060,2.5...	162
43	1x1 Line	[-0.0061,0.4...	154
44	1x1 Line	[-0.0061,0.6...	151
45	1x1 Line	[-0.0062,2.7...	141
46	1x1 Line	[-0.0062,2.5...	140
47	1x1 Line	[-0.0063,0.5...	129
48	1x1 Line	[-0.0063,0.6...	127
49	1x1 Line	[-0.0064,2.6...	116
50	1x1 Line	[-0.0064,2.5...	115
51	1x1 Line	[-0.0066,0.5...	102
52	1x1 Line	[-0.0066,0.6...	101
53	1x1 Line	[-0.0067,2.6...	86
54	1x1 Line	[-0.0067,2.5...	85

Fields	Target	Position	DataIndex
1	1x1 Line	[0.0024,2.0313]	997
2	1x1 Line	[0.0024,2.4750]	994
3	1x1 Line	[0.0023,1.2188]	993
4	1x1 Line	[0.0023,0.6938]	990
5	1x1 Line	[0.0023,2.0625]	989
6	1x1 Line	[0.0023,2.5063]	986
7	1x1 Line	[9.6000e-04,1.1563]	855
8	1x1 Line	[9.3000e-04,0.6938]	852
9	1x1 Line	[9.2000e-04,2.1563]	851
10	1x1 Line	[8.9000e-04,2.4750]	848
11	1x1 Line	[8.8000e-04,1.1250]	847
12	1x1 Line	[8.4000e-04,0.7250]	843
13	1x1 Line	[8.3000e-04,2.0938]	842
14	1x1 Line	[8.0000e-04,2.4750]	839
15	1x1 Line	[7.8000e-04,1.1563]	837
16	1x1 Line	[7.5000e-04,0.7563]	834
17	1x1 Line	[7.4000e-04,2.1250]	833
18	1x1 Line	[7.1000e-04,2.4750]	830
19	1x1 Line	[7.0000e-04,1.1250]	829
20	1x1 Line	[6.6000e-04,0.7250]	825
21	1x1 Line	[6.5000e-04,2.1563]	824
22	1x1 Line	[6.2000e-04,2.4750]	821
23	1x1 Line	[6.1000e-04,1.1250]	820
24	1x1 Line	[5.7000e-04,0.7563]	816
25	1x1 Line	[5.6000e-04,2.1563]	815
26	1x1 Line	[5.3000e-04,2.4750]	812
27	1x1 Line	[5.1000e-04,1.1250]	810

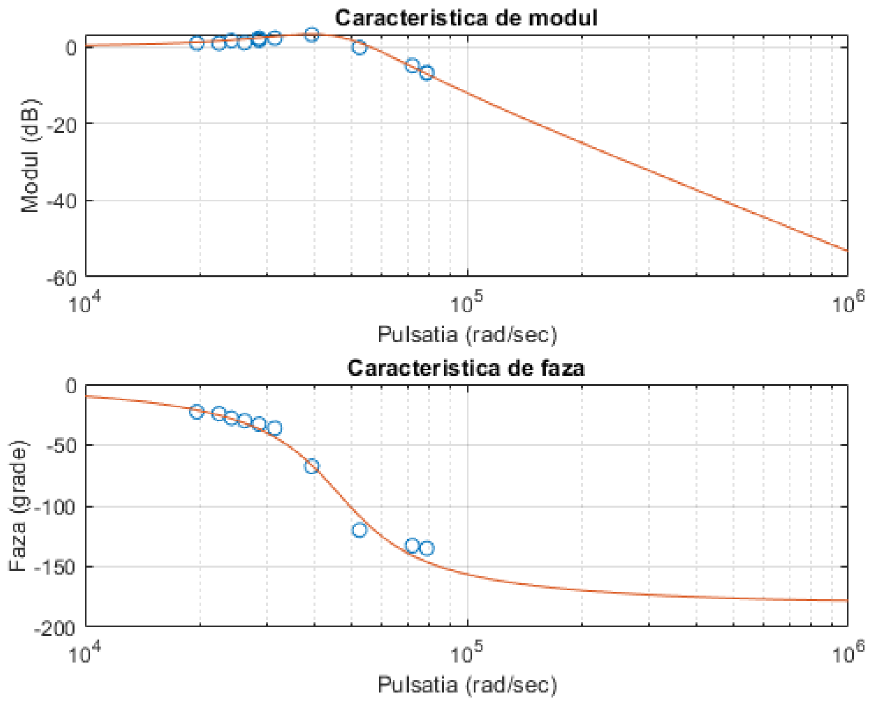
3. Calcul pulsației, modul si faza pentru fiecare punct:

$\omega_i = \frac{\pi}{t(uvarf2)-t(uvarf1)}$[rad/s]; $M_i = \frac{y1(sus)-y1(jos)}{u(sus)-u(jos)}$;

Ph_i=rad2deg($\omega_i \cdot \big(t(uvarf1) - t(yvarf1)\big)$);[grade]

ω	M	Ph
ω_1= 1.9635e+04[rad/s]	M_1=1.1186= 0.9738[dB]	Ph_1= -22.5000[grade]
ω_9= 3.1416e+04 [rad/s]	M_9=1.300=2.2798[dB]	Ph_9=-36.0000[grade]
ω_r= 3.9270e+04[rad/s]	M_r=1.4483= 3.2170[dB]	Ph_r= -67.5000[grade]
ω_{20}= 6.2832e+04[rad/s]	M_{20}=0.5893= -4.593[dB]	Ph_{20}= -126.0000[grade]
ω_{24}= 7.8540e+04[rad/s]	M_{24}=0.4561= -6.818[dB]	Ph_{24}= -135.0000[grade]
ω_{10}= 5.2360e+04[rad/s]	M_{10}=0.9828= -0.151[dB]	Ph_{10}= -120.0000[grade]

4. Plotarea punctelor si suprapunerea lor cu Diagrama Bode a sistemului:



5. Calcului pantei de atenuare pe decada:
   Am calculat folosind punctul unde modulul este aproximativ 1 si pentru punctul de final: ω_{24}=7.8540e+04[rad/sec] ; ω_{10}=5.2360e+04[rad/sec];
   M_{24}=0.4561=-6.8180[dB]; M_{10}=0.9828= -0.1511[dB];
   $$p = \frac{20\cdot\log 10\left(\frac{M_{24}}{M_{10}}\right)}{\left(\frac{\omega_{24}}{\omega_{10}}\right)} \cdot 10 = -44.4464 \text{ dB/dec}$$

4. Identificarea Parametrica

4.1 Sistemul de ordinul 2

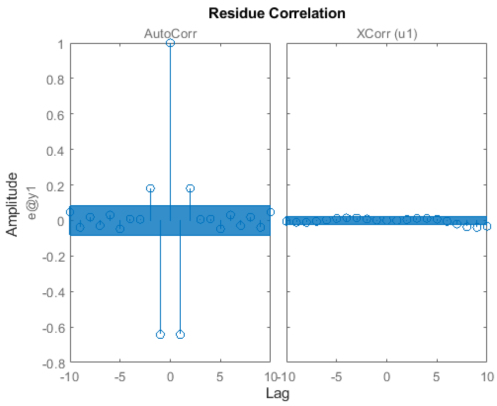
A. ARX

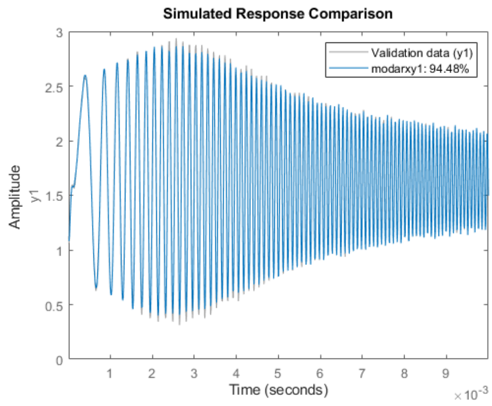
Pași:

1. Determinarea perioadei de achizitie:
   dt=t(2)-t(1)=1e-05[sec]
2. Pregatirea datelor pentru identificare folosind iddata
3. Alegerea gradelor si utilizarea funcției arx:
   $$n_A = 2, n_B = 2, n_d = 0;$$
   Obtinem:
   Discrete-time ARX model: A(z)y(t) = B(z)u(t) + e(t)
   A(z) = 1 - 1.501 z^-1 + 0.6771 z^-2
   B(z) = -0.003182 + 0.182 z^-1

Sample time: 1e-05 seconds
Fit to estimation data: 94.34% (prediction focus)
FPE: 0.001295, MSE: 0.001279

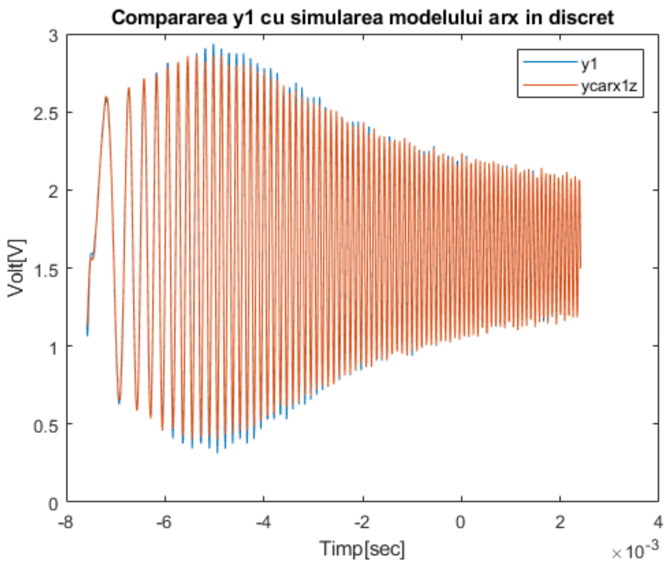
4. Validarea modelului si compararea cu semnalul de iesire y1:





Se observa ce testul de autocorelație nu este validat, in schimb testul de intercorelație se validează . Compararea cu semnalul y1 utilizând funcția compare: eroare de 5.52%

5. Comparare utilizând simularea modelului discret:



EMPN=5.7%

$$H(z)=\frac{-0.003182z^2+0.182z}{z^2-1.501z+0.6771}$$

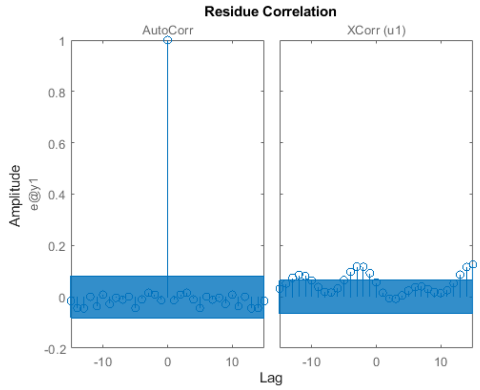
B. ARMAX

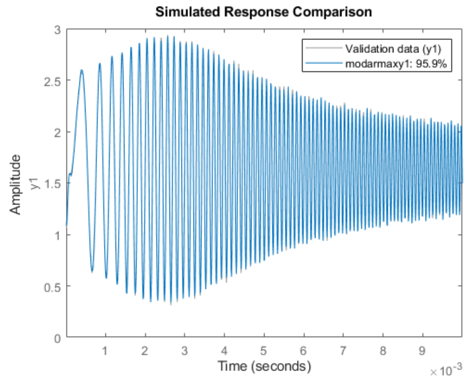
Pași:

1. Cum datele, respectiv perioada de achizitie le avem deja, alegem gradele polinoamelor, numarul tactilor de intarziere si folosim direct functia ARMAX din Matlab:

$n_A = 2$, $n_B = 2$, $n_C = 2$, $n_d = 1$;
Obținem:
Discrete-time ARMAX model: A(z)y(t) = B(z)u(t) + C(z)e(t)
A(z) = 1 - 1.527 z^-1 + 0.6981 z^-2
B(z) = 0.1844 z^-1 - 0.01093 z^-2
C(z) = 1 - 1.161 z^-1 + 0.4424 z^-2
Status:
Estimated using ARMAX on time domain data "datay1".
Fit to estimation data: 96.45% (prediction focus)
FPE: 0.0005118, MSE: 0.0005037

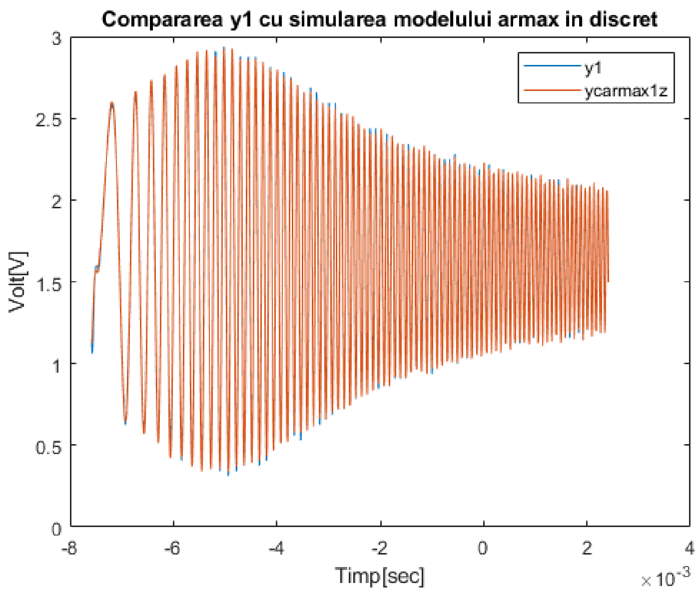
2. Validarea modelului si compararea cu semnalul de iesire y1 folosind functia compare:





Se observa ca autocorelația este validata, însă intercorelația nu este validata.
Compararea cu semnalul y1 utilizând funcția compare: EMPN=4.1%

3. Comparare prin simularea modelului discret:



EMPN=4.33%

$$H(z)=\frac{0.1844z-0.01093}{z^2-1.527z+0.6981}$$

4.2 Sistemul de ordinul 2 cu zero

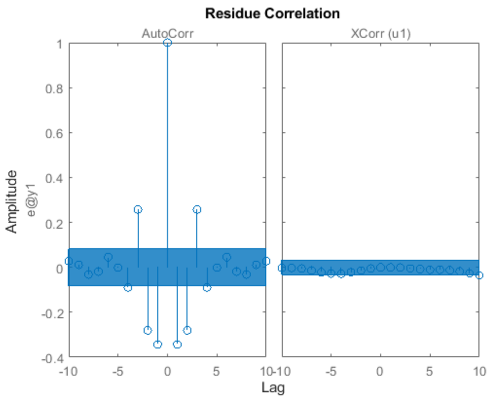
A. ARX

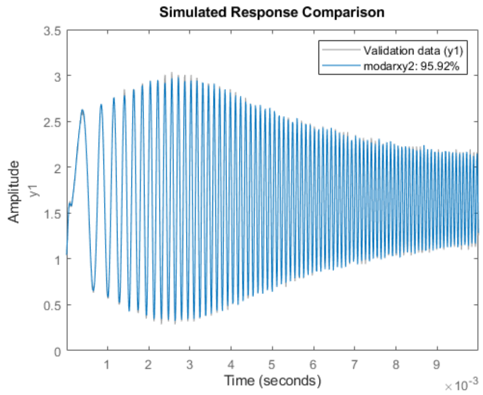
Pasi:

1. Determinarea perioadei de achizitie
   dt=t(2)-t(1)=1e-05[sec]
2. Pregatirea datelor pentru identificare folosind functia iddata
3. Alegerea gradelor si utilizarea funcției arx:

   $$n_A = 3,\ n_B = 2,\ n_d = 0;$$

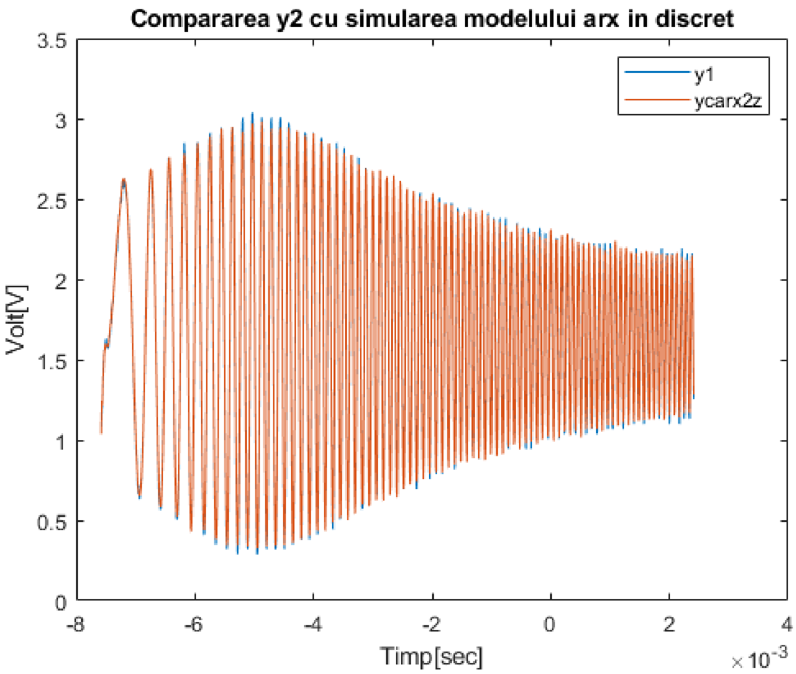
   Obtinem:
   Discrete-time ARX model: A(z)y(t) = B(z)u(t) + e(t)
   A(z) = 1 - 0.8287 z^-1 - 0.3347 z^-2 + 0.474 z^-3
   B(z) = 0.1006 + 0.2169 z^-1
   Sample time: 1e-05 seconds
   Status:
   Estimated using ARX on time domain data "datay2".
   Fit to estimation data: 95.72% (prediction focus)
   FPE: 0.0008553, MSE: 0.0008418
4. Validarea modelului si compararea cu semnalul de iesire y2 folosind functia compare:





   Se observa ca testul de autocorelatie nu este validat, dar cel de intercorelatie se valideaza. Compararea cu semnalul y2 utilizând funcția compare: EMPN=4.08%

5. Comparare prin simularea modelului:



EMPN=4.1%

H(z)=$\frac{0.1006z^3+0.2169z^2}{z^3-0.8287z^2-0.3347z+0.474}$

B. ARMAX

Pasi:

1. Si aici avem deja datele si perioada de esatnionare, deci alegem gradele si aplicam functia ARMAX din Matlab: n_A = 2, n_B= 3, n_C = 2, n_d = 0;

   Obtinem:

   Discrete-time ARMAX model: A(z)y(t) = B(z)u(t) + C(z)e(t)

   A(z) = 1 - 1.524 z^-1 + 0.7 z^-2

   B(z) = 0.104 + 0.1265 z^-1 - 0.0505z^-2 C(z) = 1 - 1.29 z^-1 + 0.5319 z^-2

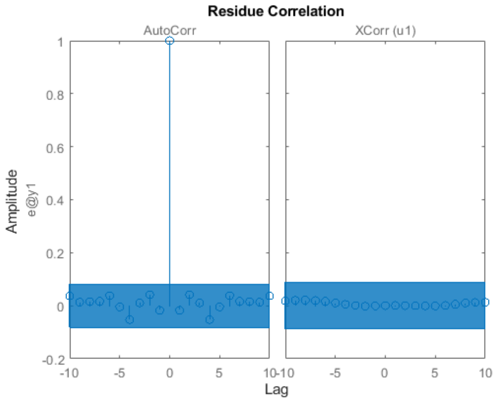
   Status:

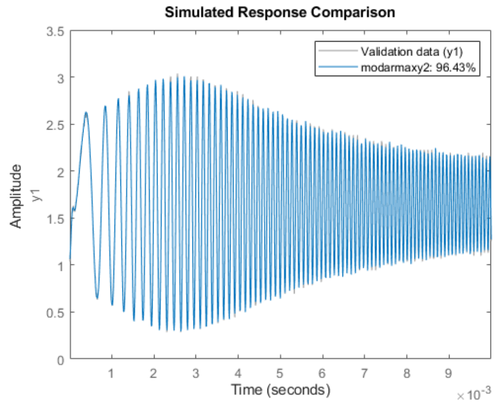
   Estimated using ARMAX on time domain data "datay2".

   Fit to estimation data: 96.62% (prediction focus)

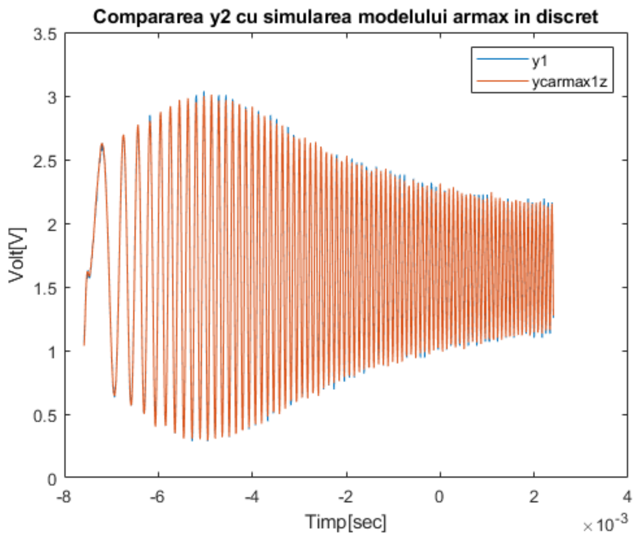
   FPE: 0.0005363, MSE: 0.000526

2. Validarea modelului si compararea cu semnalul de iesire y2 folosind functia compare:





3. Se observa ca se valideaza atat autocorelatia cat si intercorelatia. Compararea cu semnalul y2 utilizând funcția compare: EMPN=3.57%
4. Simularea modelului in discret:



EMPN=3.61%

$$H(z)=\frac{0.104z^2+0.1265z-0.05053}{z^2-1.524z+0.7}$$