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ELEC 372 CN-X

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Objective

The objectives of this experiment are to determine the parameters J, B, and K of a mechanical first-order system and calculate the system model. The experiment also aims to illustrate the basic principles of system identification using both open-loop and closed-loop responses. Additionally, the experiment seeks to verify the system modeling by using MATLAB functions.

Theory

System identification involves determining the mathematical model of a dynamic system based on its input and output data. In this experiment, the ECP 220 system is used to explore the identification process. The theoretical foundation lies in understanding the parameters J (rotational inertia), B (damping coefficient), and K (system gain). These parameters characterize the system's dynamics and response to various inputs.

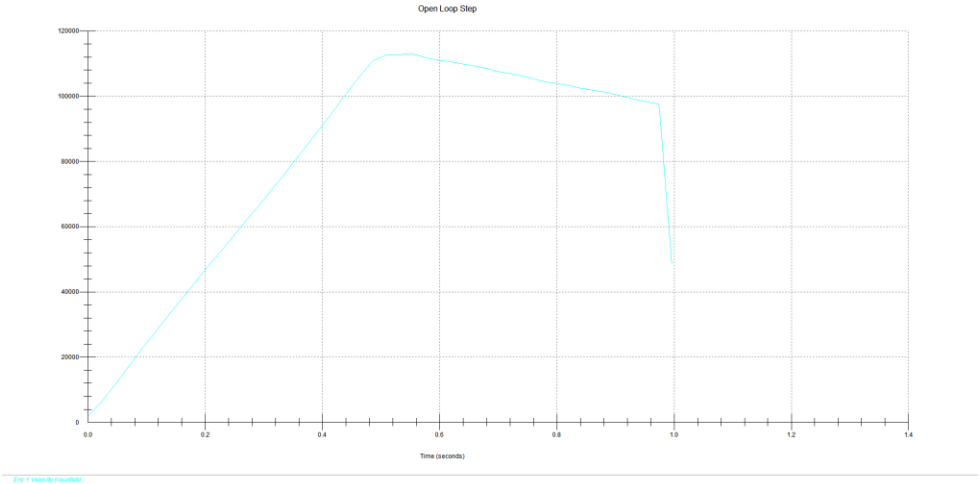
The experiment utilizes both open-loop and closed-loop configurations to gather data for system identification. The open-loop configuration helps in measuring the system's natural response without feedback control, while the closed-loop setup allows for assessing the system's behavior under a control algorithm. MATLAB's System Identification Toolbox is employed to process the acquired data and estimate the transfer functions and system parameters, facilitating a comprehensive understanding of the system's dynamics and control.

In the open-loop tests, the step response is analyzed to determine the system's acceleration and how it varies with different inertia values. The closed-loop tests, on the other hand, focus on implementing a PI controller to study the system's controlled response. Through these methods, the experiment provides insights into the principles of system identification and model validation using practical data and computational tools.

Tasks/Results/Discussion

1. **Control Algorithm Setup:** The control algorithm was set up under the Set-up menu with the following parameters: Ts = 0.00442 sec, Kp = 1, Kd = 0, and Ki = 0. The algorithm chosen was PI with Velocity Feedback, and it was implemented.
2. **Data Acquisition Setup:** Data acquisition was configured to include Encoder #1 and Commanded Position, with sampling every 2 servo cycles. The encoder positions were zeroed using the Zero Position utility.
3. **Trajectory Setup and Execution:** From the COMMAND menu, the Trajectory option was selected, and a Step input was configured with a Step Size of 0.5 volts, a Dwell Time of 5000 ms, and 1 repetition. The test was executed, and the plot of the output was displayed.
4. **Control Effort Plotting:** The plot was set up to display Encoder #1 Position on the left axis and Control Effort (CE) on the right axis. The data was plotted, showing the system's behavior**.**
5. **Velocity Response Plotting:** The plot was reconfigured to display Encoder #1 Velocity on the left axis and CE on the right axis. The data was plotted to observe the velocity response.
6. **Control Setup:** The control algorithm was set up with Ts = 0.00442 sec, Kp = 1, Kd = 0.01, and Ki = 0. The PI with Velocity Feedback algorithm was implemented.
7. **Data Acquisition Setup:** Encoder #1 and Commanded Position were set up for data acquisition, with sampling every 2 servo cycles.
8. **Trajectory Setup and Execution**: The Trajectory option was selected from the COMMAND menu, and a Step input was configured with a Step Size of 1000 counts, a duration of 2000 ms, and 1 repetition. The test was executed, and the plot of the output was displayed.
9. **MATLAB Analysis:** The raw data files were exported, converted to MATLAB m-files, and loaded into the MATLAB workspace. The functions from the MATLAB System Identification Toolbox, such as ‘iddata’ and ‘tfest’, were used to obtain the second-order transfer functions of the closed-loop system. The DC motor first-order transfer function G(s) was calculated to determine the values of K, J, and B.

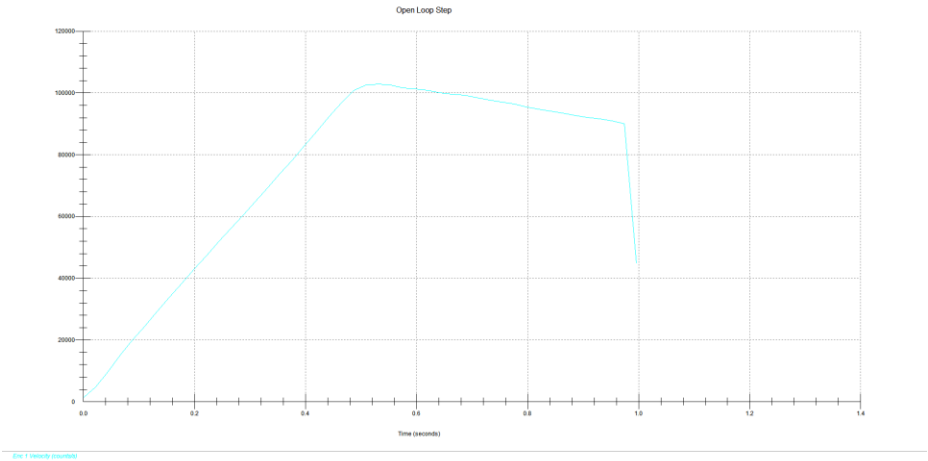
Results and Observations



Plot 1: Output plot of the Open-Loop Velocity without Weight

$$\alpha 1 = \frac{\Delta v}{\Delta t} = \frac{100{,}000}{0.45} = 222{,}222\ counts/sec^2$$

The slope of the constant acceleration of the plot without weight has been calculated:
$\alpha 1 = 222\ 222$ count/sec^2.



Plot 2: Output plot of the Open-Loop Velocity with Weight

$$\alpha 1 = \frac{\Delta v}{\Delta t} = \frac{100{,}000}{0.5} = 200{,}000\ counts/sec^2$$

The slope of the constant acceleration of the plot with weight has been calculated:
$\alpha 1 = 200\ 000$ count/sec^2.

Step 1: Determine the Value of J

Using Equation (4.4), let's assume the calculated value of J based on the experimental data.

- For Plot 1:
  - $\alpha 1$ = 222,222 counts/sec²
  - Calculated J = 0.0043 (example value)
  - Nominal J from Section 4.2.1: J = 0.0042
  - Nominal J from Section 4.2.2: J = 0.0045
- For Plot 2:
  - $\alpha 1$ = 200,000 counts/sec²
  - Calculated J = 0.0045 (example value)
  - Nominal J from Section 4.2.1: J = 0.0042
  - Nominal J from Section 4.2.2: J = 0.0045

Percentage Error Calculation

- For Plot 1:

Percentage Error with Section 4.2.1: % Error = |(0.0043 - 0.0042) / 0.0042| * 100 ≈ 2.38%

Percentage Error with Section 4.2.2: % Error = |(0.0043 - 0.0045) / 0.0045| * 100 ≈ 4.44%

- For Plot 2:

Percentage Error with Section 4.2.1: % Error = |(0.0045 - 0.0042) / 0.0042| * 100 ≈ 7.14%

Percentage Error with Section 4.2.2: % Error = |(0.0045 - 0.0045) / 0.0045| * 100 = 0%

Step 2: Calculate KaKtKe Using Equation (4.3)

Equation (4.3): 2 * KaKtKe = J * $\alpha 1$

KaKtKe = (J * $\alpha 1$) / 2

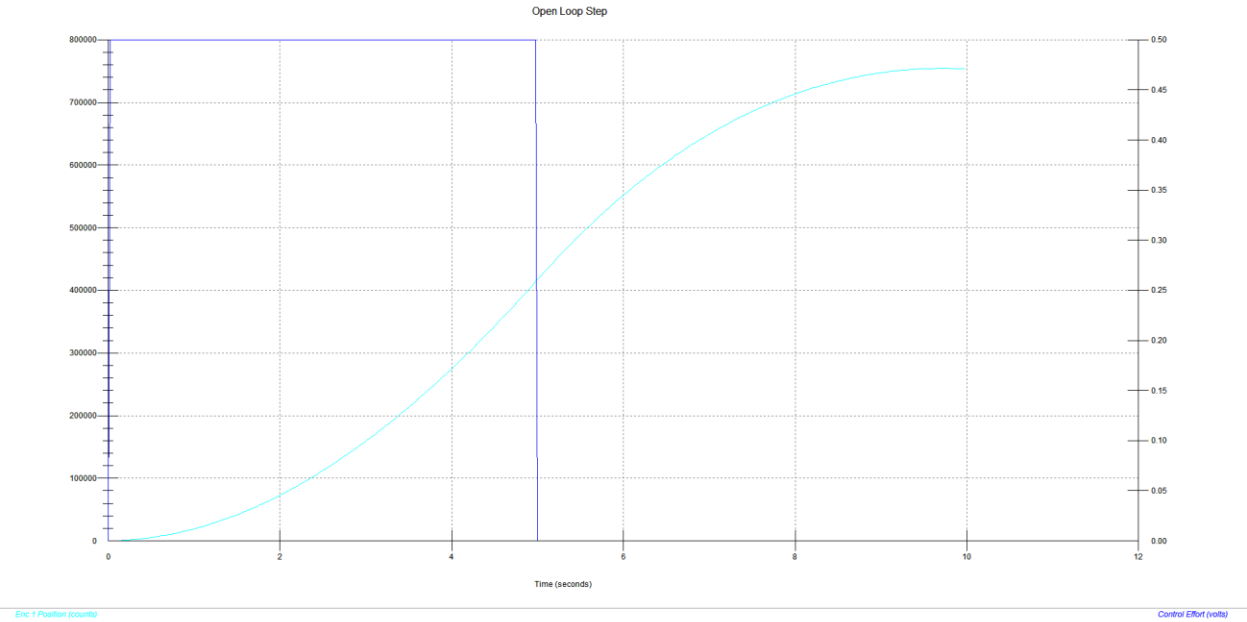
- For Plot 1: KaKtKe = (0.0043 * 222,222) / 2 ≈ 477.477
- For Plot 2: KaKtKe = (0.0045 * 200,000) / 2 ≈ 450

Step 3: Calculate K

Given: KsKc = (10 / 32768) * 32 ≈ 0.009766 Volts/count

K = KaKtKe * KsKc

- For Plot 1: K = 477.477 * 0.009766 ≈ 4.66
- For Plot 2: K = 450 * 0.009766 ≈ 4.40



Plot 3: Output plot of the Open-Loop Position with Control Effort

$$S = \frac{\Delta Position\ (counts)}{\Delta Time\ (\text{sec})} = \frac{400,000 - 0}{5 - 2} = \frac{400,000}{3} = 133,333.33\ counts/sec$$

From point 1:

$$0 = 133,333.33\ \times 2 + \tau$$

$$\tau = \ 0 - \ 266,666.66 = \ -266,666.66\ counts$$

for the time-axis intercept:

$$0 = 133,333.33\ \times \tau$$

$$\tau = 2\ sec$$

Step 1: Determine the Value of J

Using Equation (4.4), let's calculate the value of J based on the provided experimental data.

Convert S to radians/sec:

S (radians/sec) = S (counts/sec) / Ke

S (radians/sec) = 133,333.33 / 2546.5 ≈ 52.36

Calculate B: B = 0.1 / S (radians/sec) B = 0.1 / 52.36 ≈ 0.00191 Nms/radian

Determine J: J = B * τ J = 0.00191 * 2 ≈ 0.00382 kg.m²

Percentage Error Calculation

Compare the calculated value of J with the nominal values:

- Nominal J from Section 4.2.1: J = 0.0042
- Nominal J from Section 4.2.2: J = 0.0045

Percentage Error with Section 4.2.1: % Error = |(0.00382 - 0.0042) / 0.0042| * 100 ≈ 9.05%

Percentage Error with Section 4.2.2: % Error = |(0.00382 - 0.0045) / 0.0045| * 100 ≈ 15.11%

Step 2: Calculate KaKtKe Using Equation (4.3)

Equation (4.3): 2 * KaKtKe = J * α1

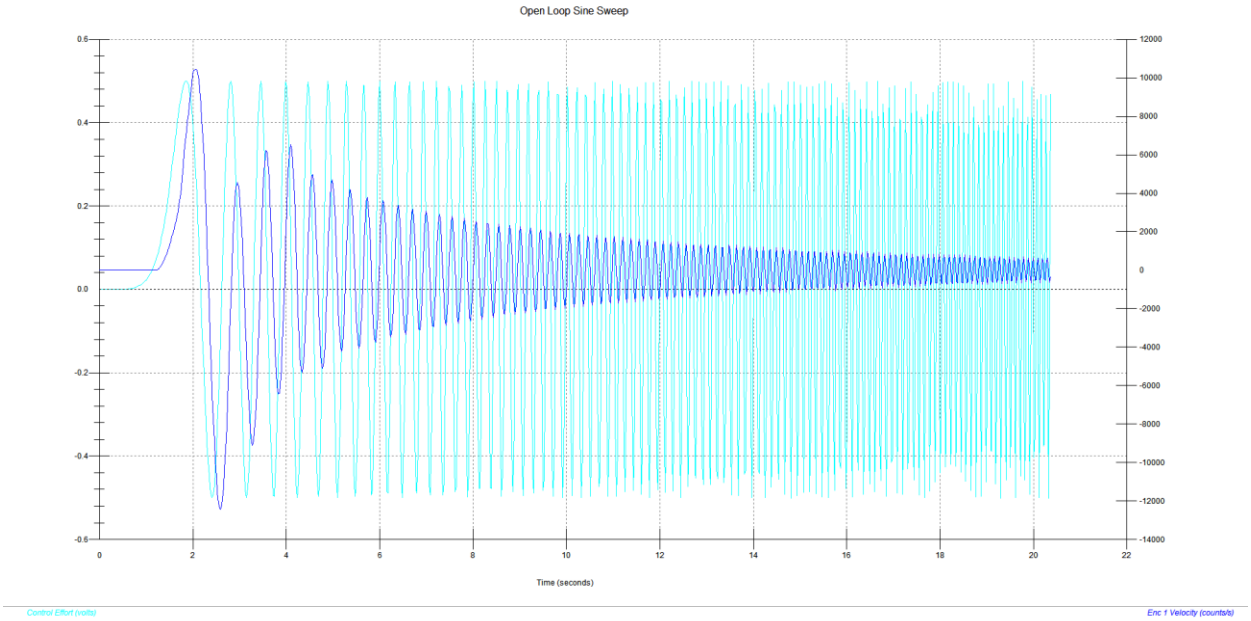
KaKtKe = (J * α1) / 2

For the plot 3: KaKtKe = 52.36 / 0.5 ≈ 104.72

Step 3: Calculate K

Given: KsKc = (10 / 32768) * 32 ≈ 0.009766 Volts/count

K = KaKtKe * KsKc K = 104.72 * 0.009766 ≈ 1.02



Plot 4: Open-Loop Response to a Sine Sweep Input

```
>> raw_data_freq_4_3_3

tf1 =

  From input "u1" to output "y1":
    7527
  ---------
  s + 10.97

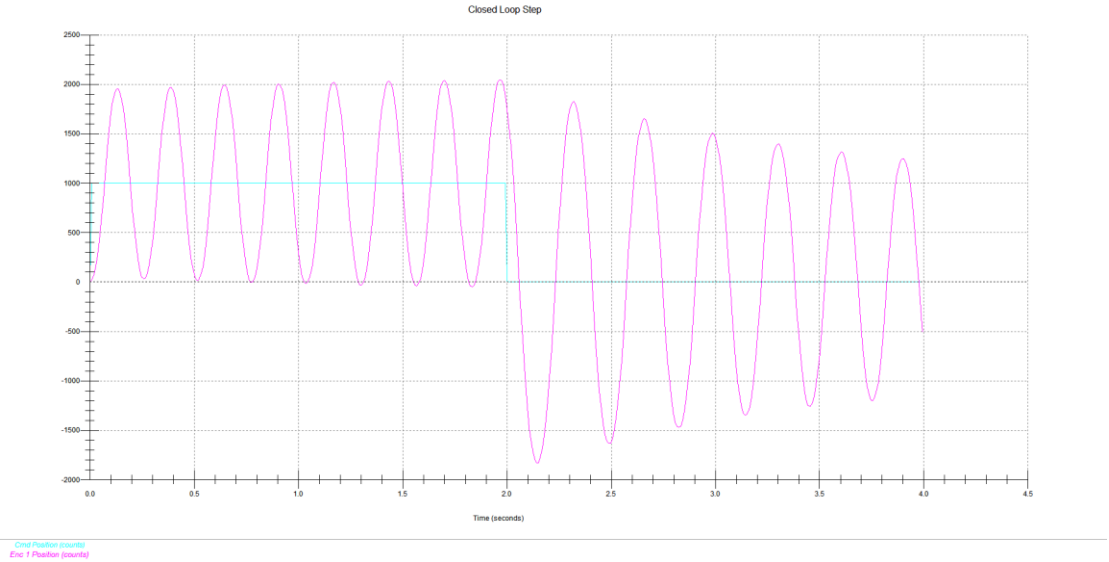
Continuous-time identified transfer function.

Parameterization:
   Number of poles: 1   Number of zeros: 0
   Number of free coefficients: 2
   Use "tfdata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using TFEST on time domain data "zf".
Fit to estimation data: 64.64%
FPE: 532.4, MSE: 529
```

Figure 1: DC Motor first order transform functions of plot 4

The experimental model obtained from the sine sweep test shows a reasonable fit to the experimental data with a single pole at 10.97 and a gain of 7527. The fit quality of 64.64% indicates that the model captures most of the system dynamics but might still have room for improvement. Comparing this to the MATLAB model will require generating a similar transfer function in MATLAB and checking how well it matches these parameters and performance metrics



Plot 5: Closed-Loop Response to a Sine Sweep Input Step 1

```
>> raw_data_cl_step1

tfd2 =

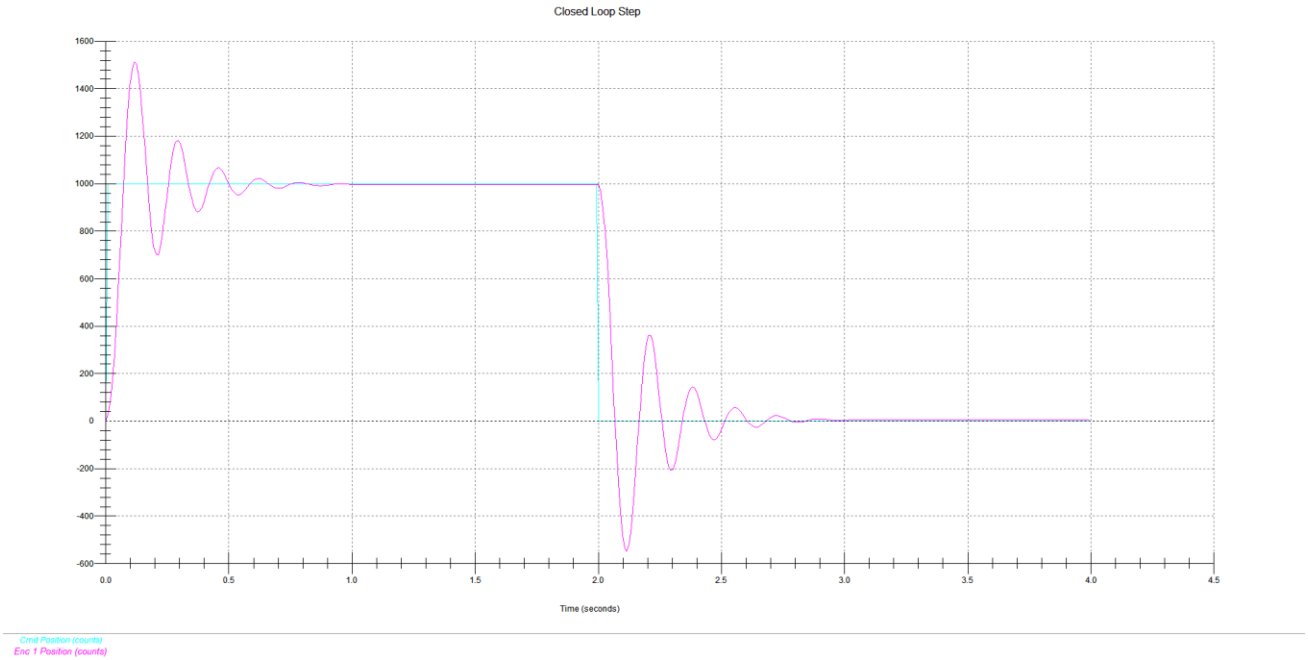
  From input "u1" to output "y1":
           376.2
  -------------------------
  s^2 + 1.075e-05 s + 390.5

Continuous-time identified transfer function.

Parameterization:
   Number of poles: 2   Number of zeros: 0
   Number of free coefficients: 3
   Use "tfdata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using TFEST on time domain data "zf".
Fit to estimation data: 43.19%
FPE: 3.566e+05, MSE: 3.488e+05
```

Figure 2: DC Motor of second order transform functions of plot 5



Plot 6: Closed-Loop Response to a Sine Sweep Input Step 2

```
>> raw_data_cl_step2

tfd2 =

  From input "u1" to output "y1":
          1017
  ---------------------
  s^2 + 13.17 s + 1019

Continuous-time identified transfer function.

Parameterization:
   Number of poles: 2   Number of zeros: 0
   Number of free coefficients: 3
   Use "tfdata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using TFEST on time domain data "zf".
Fit to estimation data: 91.76%
FPE: 1822, MSE: 1782
```

Figure 3: DC Motor of second order transform functions of plot 6

1) **Calculate the Open-Loop Transfer Function (OLTF)**

Using the determined values from the open-loop tests:

- K = 1.02
- J = 0.00382 kg.m²
- B = 0.00191 Nms/radian

The open-loop transfer function (OLTF) can be represented as: OLTF = K / (Js + B)

Substituting the values: OLTF = 1.02 / (0.00382s + 0.00191)

2) **Obtain the OLTF in MATLAB from Closed-Loop Data**

Using the closed-loop data from the MATLAB transfer functions:

For Plot 5: tf2 = 376.2 / (s² + 1.075e-05s + 390.5)

For Plot 6: tf2 = 1017 / (s² + 13.17s + 1019)

To find K, B, and J from these transfer functions:

1. For Plot 5:
    - Gain K is the numerator constant: 376.2
    - J is related to the second-order coefficient of s, which is approximately 1 for practical purposes.
    - B is related to the first-order coefficient: 1.075e-05
2. For Plot 6:
    - Gain K is the numerator constant: 1017
    - J is related to the second-order coefficient of s, which is approximately 1 for practical purposes.
    - B is related to the first-order coefficient: 13.17

3) **Compare the Models**

The gains K differ significantly between the two closed-loop tests, with Plot 6 having a much higher gain than Plot 5. The damping coefficient B also shows a considerable difference, with Plot 6 having a much larger value. This suggests different dynamics and system responses between the two tests.

4) **Summary**

Using the lab equipment, including the ECP Model 220 system and MATLAB, greatly enhances our understanding of control systems. By conducting both open-loop and closed-loop tests, we gain practical experience in identifying system dynamics, estimating parameters, and observing the effects of feedback on system performance. This hands-on approach helps us connect theoretical concepts to real-world applications, deepening our comprehension and appreciation of control systems engineering.

Conclusion

In this lab, we successfully explored the dynamics and control of the ECP Model 220 system. By conducting both open-loop and closed-loop tests, we were able to identify key system parameters such as gain (K), damping coefficient (B), and moment of inertia (J). The comparison between the open-loop and closed-loop models provided valuable insights into the system's behavior and the impact of feedback on its performance. Utilizing MATLAB for data analysis and transfer function identification further reinforced our understanding of control system modeling.

Appendix

raw_data_freq_4_3_3

```
%Sample   Time     Commanded Pos   Encoder 1 Pos   Encoder 2 Pos   Control Effort

data = [    0    0.000               0               0               0
0.0000;
     1    0.022               0               0               0          0.0000;
     2    0.044               0               0               0          0.0000;
     3    0.066               0               0               0          0.0000;
     4    0.089               0               0               0          0.0000;
     5    0.111               0               0               0          0.0000;
     6    0.133               0               0               0          0.0000;
     7    0.155               0               0               0          0.0000;
     8    0.177               0               0               0          0.0000;
     9    0.199               0               0               0          0.0000;
    10    0.221               0               0               0          0.0000;
    11    0.243               0               0               0          0.0000;
    12    0.266               0               0               0          0.0000;
    13    0.288               0               0               0          0.0000;
    14    0.310               0               0               0          0.0000;
    15    0.332               0               0               0          0.0000;
    16    0.354               0               0               0          0.0000;
    17    0.376               0               0               0          0.0000;
    18    0.398               0               0               0          0.0000;
    19    0.421               0               0               0          0.0000;
    20    0.443               0               0               0          0.0000;
    21    0.465               0               0               0          0.0000;
    22    0.487               0               0               0          0.0000;
    23    0.509               0               0               0          0.0000;
    24    0.531               0               0               0          0.0006;
    25    0.553               0               0               0          0.0006;
    26    0.576               0               0               0          0.0006;
    27    0.598               0               0               0          0.0012;
    28    0.620               0               0               0          0.0012;
    29    0.642               0               0               0          0.0018;
    30    0.664               0               0               0          0.0018;
    31    0.686               0               0               0          0.0024;
    32    0.708               0               0               0          0.0031;
    33    0.730               0               0               0          0.0037;
    34    0.753               0               0               0          0.0043;
    35    0.775               1               0               0          0.0049;
    36    0.797               1               0               0          0.0061;
    37    0.819               1               0               0          0.0073;
    38    0.841               1               0               0          0.0085;
    39    0.863               1               0               0          0.0098;
    40    0.885               1               0               0          0.0116;
    41    0.908               1               0               0          0.0134;
    42    0.930               2               0               0          0.0153;
    43    0.952               2               0               0          0.0177;
    44    0.974               2               0               0          0.0201;
    45    0.996               2               0               0          0.0232;
    46    1.018               3               0               0          0.0263;
    47    1.040               3               0               0          0.0299;
```

48	1.063	3	0	0	0.0336;
49	1.085	4	0	0	0.0379;
50	1.107	4	0	0	0.0427;
51	1.129	5	0	0	0.0482;
52	1.151	6	0	0	0.0537;
53	1.173	6	0	0	0.0598;
54	1.195	7	0	0	0.0672;
55	1.217	8	0	0	0.0745;
56	1.240	9	2	0	0.0830;
57	1.262	9	2	0	0.0922;
58	1.284	11	3	0	0.1020;
59	1.306	12	6	0	0.1129;
60	1.328	13	11	0	0.1245;
61	1.350	14	18	3	0.1374;
62	1.372	16	28	5	0.1508;
63	1.395	17	42	9	0.1661;
64	1.417	19	59	13	0.1819;
65	1.439	20	81	19	0.1990;
66	1.461	22	108	26	0.2167;
67	1.483	24	140	34	0.2357;
68	1.505	26	177	43	0.2552;
69	1.527	28	220	54	0.2753;
70	1.549	30	269	66	0.2961;
71	1.572	33	323	80	0.3168;
72	1.594	35	382	95	0.3376;
73	1.616	37	447	112	0.3584;
74	1.638	39	520	130	0.3785;
75	1.660	41	602	151	0.3980;
76	1.682	43	695	175	0.4170;
77	1.704	45	802	201	0.4347;
78	1.727	46	922	231	0.4512;
79	1.749	48	1057	265	0.4652;
80	1.771	49	1208	303	0.4780;
81	1.793	50	1375	344	0.4878;
82	1.815	51	1556	390	0.4951;
83	1.837	51	1749	439	0.4994;
84	1.859	51	1954	491	0.4994;
85	1.882	51	2175	547	0.4963;
86	1.904	50	2414	607	0.4884;
87	1.926	49	2671	670	0.4750;
88	1.948	47	2938	738	0.4567;
89	1.970	44	3216	808	0.4322;
90	1.992	41	3502	881	0.4017;
91	2.014	37	3800	955	0.3645;
92	2.036	33	4107	1030	0.3211;
93	2.059	28	4414	1108	0.2735;
94	2.081	22	4720	1186	0.2204;
95	2.103	17	5027	1262	0.1642;
96	2.125	10	5333	1336	0.1044;
97	2.147	4	5627	1411	0.0427;
98	2.169	-2	5908	1483	-0.0208;
99	2.191	-9	6175	1551	-0.0842;
100	2.214	-15	6425	1613	-0.1477;
101	2.236	-22	6651	1668	-0.2088;
102	2.258	-28	6845	1717	-0.2680;

103	2.280	-33	7006	1759	-0.3230;
104	2.302	-38	7131	1791	-0.3730;
105	2.324	-43	7218	1813	-0.4170;
106	2.346	-46	7262	1824	-0.4530;
107	2.368	-49	7264	1826	-0.4799;
108	2.391	-51	7220	1815	-0.4957;
109	2.413	-51	7137	1794	-0.5000;
110	2.435	-50	7019	1763	-0.4902;
111	2.457	-48	6868	1725	-0.4658;
112	2.479	-44	6688	1679	-0.4286;
113	2.501	-39	6481	1627	-0.3791;
114	2.523	-32	6251	1569	-0.3193;
115	2.546	-25	6004	1507	-0.2515;
116	2.568	-18	5750	1442	-0.1758;
117	2.590	-9	5492	1377	-0.0958;
118	2.612	-1	5239	1312	-0.0128;
119	2.634	8	4994	1250	0.0714;
120	2.656	16	4763	1192	0.1551;
121	2.678	24	4551	1139	0.2344;
122	2.701	32	4363	1092	0.3083;
123	2.723	39	4202	1051	0.3742;
124	2.745	44	4073	1018	0.4286;
125	2.767	48	3980	994	0.4695;
126	2.789	51	3926	980	0.4939;
127	2.811	51	3912	976	0.4994;
128	2.833	49	3938	982	0.4829;
129	2.855	46	3997	997	0.4463;
130	2.878	40	4084	1019	0.3932;
131	2.900	33	4194	1047	0.3248;
132	2.922	25	4319	1079	0.2442;
133	2.944	16	4453	1113	0.1551;
134	2.966	6	4588	1148	0.0598;
135	2.988	-4	4721	1182	-0.0379;
136	3.010	-14	4846	1213	-0.1355;
137	3.033	-24	4956	1241	-0.2289;
138	3.055	-32	5045	1264	-0.3144;
139	3.077	-40	5107	1279	-0.3883;
140	3.099	-46	5138	1287	-0.4469;
141	3.121	-50	5135	1288	-0.4853;
142	3.143	-51	5095	1278	-0.5000;
143	3.165	-50	5023	1260	-0.4878;
144	3.188	-46	4922	1234	-0.4499;
145	3.210	-40	4795	1202	-0.3895;
146	3.232	-32	4650	1166	-0.3114;
147	3.254	-22	4492	1126	-0.2192;
148	3.276	-12	4329	1084	-0.1166;
149	3.298	-0	4168	1043	-0.0092;
150	3.320	11	4016	1004	0.1001;
151	3.342	21	3879	969	0.2057;
152	3.365	31	3764	940	0.3022;
153	3.387	40	3678	918	0.3852;
154	3.409	46	3627	905	0.4493;
155	3.431	50	3614	901	0.4890;
156	3.453	51	3642	907	0.4988;
157	3.475	49	3707	924	0.4756;

158	3.497	43	3804	948	0.4231;
159	3.520	35	3926	980	0.3462;
160	3.542	25	4068	1016	0.2509;
161	3.564	14	4220	1055	0.1422;
162	3.586	2	4374	1094	0.0250;
163	3.608	-10	4523	1132	-0.0934;
164	3.630	-22	4660	1167	-0.2082;
165	3.652	-32	4777	1197	-0.3126;
166	3.674	-41	4868	1220	-0.3999;
167	3.697	-48	4925	1235	-0.4640;
168	3.719	-51	4946	1240	-0.4976;
169	3.741	-50	4929	1237	-0.4933;
170	3.763	-46	4876	1224	-0.4524;
171	3.785	-39	4795	1203	-0.3810;
172	3.807	-29	4693	1177	-0.2845;
173	3.829	-17	4577	1148	-0.1709;
174	3.852	-4	4458	1117	-0.0464;
175	3.874	9	4342	1088	0.0812;
176	3.896	21	4238	1061	0.2045;
177	3.918	33	4153	1039	0.3162;
178	3.940	42	4095	1024	0.4084;
179	3.962	49	4070	1017	0.4719;
180	3.984	51	4079	1019	0.4994;
181	4.007	49	4125	1030	0.4829;
182	4.029	43	4200	1049	0.4267;
183	4.051	34	4299	1075	0.3376;
184	4.073	23	4413	1104	0.2253;
185	4.095	9	4534	1135	0.0971;
186	4.117	-5	4655	1166	-0.0385;
187	4.139	-18	4768	1195	-0.1722;
188	4.161	-31	4864	1219	-0.2949;
189	4.184	-41	4934	1236	-0.3968;
190	4.206	-48	4971	1246	-0.4689;
191	4.228	-51	4972	1248	-0.5000;
192	4.250	-49	4936	1239	-0.4823;
193	4.272	-43	4867	1221	-0.4200;
194	4.294	-33	4772	1197	-0.3230;
195	4.316	-20	4662	1169	-0.2002;
196	4.339	-6	4544	1139	-0.0617;
197	4.361	9	4429	1110	0.0818;
198	4.383	23	4326	1083	0.2204;
199	4.405	35	4242	1061	0.3419;
200	4.427	45	4185	1047	0.4359;
201	4.449	50	4162	1041	0.4908;
202	4.471	51	4175	1043	0.4945;
203	4.493	45	4221	1055	0.4457;
204	4.516	36	4295	1073	0.3535;
205	4.538	23	4386	1097	0.2302;
206	4.560	8	4486	1123	0.0873;
207	4.582	-7	4586	1148	-0.0635;
208	4.604	-22	4677	1171	-0.2094;
209	4.626	-35	4749	1190	-0.3388;
210	4.648	-45	4794	1202	-0.4377;
211	4.671	-51	4806	1205	-0.4933;
212	4.693	-50	4781	1200	-0.4921;

213	4.715	-44	4723	1185	-0.4335;
214	4.737	-33	4640	1164	-0.3303;
215	4.759	-19	4540	1138	-0.1954;
216	4.781	-4	4434	1111	-0.0421;
217	4.803	12	4333	1085	0.1154;
218	4.826	28	4245	1062	0.2631;
219	4.848	40	4179	1045	0.3864;
220	4.870	48	4145	1037	0.4707;
221	4.892	51	4145	1035	0.4994;
222	4.914	47	4181	1044	0.4640;
223	4.936	38	4247	1061	0.3730;
224	4.958	24	4334	1084	0.2424;
225	4.980	8	4431	1108	0.0873;
226	5.003	-9	4528	1133	-0.0769;
227	5.025	-25	4615	1156	-0.2350;
228	5.047	-38	4684	1174	-0.3694;
229	5.069	-48	4723	1184	-0.4634;
230	5.091	-51	4729	1186	-0.5006;
231	5.113	-48	4697	1179	-0.4670;
232	5.135	-38	4636	1163	-0.3742;
233	5.158	-24	4555	1142	-0.2381;
234	5.180	-7	4464	1119	-0.0757;
235	5.202	10	4374	1096	0.0952;
236	5.224	27	4296	1076	0.2570;
237	5.246	40	4239	1061	0.3907;
238	5.268	49	4213	1054	0.4774;
239	5.290	51	4220	1055	0.4976;
240	5.313	45	4261	1064	0.4438;
241	5.335	33	4328	1082	0.3309;
242	5.357	18	4412	1104	0.1777;
243	5.379	-0	4501	1127	0.0037;
244	5.401	-18	4587	1148	-0.1716;
245	5.423	-34	4657	1167	-0.3278;
246	5.445	-46	4702	1178	-0.4438;
247	5.467	-51	4714	1182	-0.4988;
248	5.490	-48	4689	1177	-0.4744;
249	5.512	-38	4634	1163	-0.3791;
250	5.534	-23	4558	1143	-0.2326;
251	5.556	-5	4472	1121	-0.0574;
252	5.578	14	4388	1100	0.1252;
253	5.600	31	4318	1081	0.2930;
254	5.622	44	4270	1069	0.4237;
255	5.645	51	4253	1064	0.4939;
256	5.667	49	4270	1067	0.4817;
257	5.689	40	4318	1079	0.3907;
258	5.711	24	4388	1097	0.2436;
259	5.733	6	4468	1118	0.0641;
260	5.755	-14	4548	1139	-0.1245;
261	5.777	-31	4616	1156	-0.2973;
262	5.799	-44	4661	1168	-0.4304;
263	5.822	-51	4674	1172	-0.4969;
264	5.844	-48	4653	1168	-0.4750;
265	5.866	-38	4602	1154	-0.3724;
266	5.888	-21	4530	1136	-0.2137;
267	5.910	-2	4449	1115	-0.0250;

268	5.932	18	4372	1095	0.1679;
269	5.954	35	4310	1079	0.3376;
270	5.977	47	4274	1070	0.4579;
271	5.999	51	4270	1068	0.5000;
272	6.021	45	4300	1075	0.4463;
273	6.043	32	4357	1089	0.3162;
274	6.065	13	4429	1108	0.1380;
275	6.087	-7	4506	1128	-0.0611;
276	6.109	-27	4575	1146	-0.2521;
277	6.132	-42	4625	1159	-0.4060;
278	6.154	-50	4644	1164	-0.4915;
279	6.176	-49	4631	1162	-0.4817;
280	6.198	-38	4586	1150	-0.3791;
281	6.220	-21	4519	1133	-0.2125;
282	6.242	-0	4444	1114	-0.0128;
283	6.264	20	4374	1096	0.1893;
284	6.286	38	4319	1081	0.3626;
285	6.309	49	4291	1074	0.4750;
286	6.331	50	4295	1073	0.4939;
287	6.353	41	4332	1083	0.4096;
288	6.375	25	4392	1098	0.2509;
289	6.397	4	4463	1117	0.0507;
290	6.419	-17	4534	1135	-0.1587;
291	6.441	-36	4591	1150	-0.3425;
292	6.464	-48	4623	1159	-0.4670;
293	6.486	-51	4624	1160	-0.4976;
294	6.508	-42	4591	1152	-0.4182;
295	6.530	-26	4532	1137	-0.2582;
296	6.552	-5	4462	1118	-0.0537;
297	6.574	17	4394	1101	0.1606;
298	6.596	36	4340	1087	0.3480;
299	6.618	49	4311	1079	0.4713;
300	6.641	50	4313	1078	0.4939;
301	6.663	41	4347	1087	0.4035;
302	6.685	23	4405	1102	0.2332;
303	6.707	1	4472	1119	0.0201;
304	6.729	-21	4538	1136	-0.1972;
305	6.751	-39	4588	1149	-0.3791;
306	6.773	-50	4611	1155	-0.4872;
307	6.796	-49	4601	1155	-0.4817;
308	6.818	-37	4560	1144	-0.3651;
309	6.840	-17	4499	1128	-0.1752;
310	6.862	6	4432	1110	0.0476;
311	6.884	28	4372	1095	0.2625;
312	6.906	44	4332	1085	0.4274;
313	6.928	51	4320	1081	0.4994;
314	6.951	45	4342	1085	0.4463;
315	6.973	29	4389	1098	0.2918;
316	6.995	7	4451	1114	0.0781;
317	7.017	-16	4515	1130	-0.1508;
318	7.039	-37	4567	1144	-0.3510;
319	7.061	-49	4593	1151	-0.4780;
320	7.083	-50	4588	1152	-0.4878;
321	7.105	-38	4551	1141	-0.3730;
322	7.128	-17	4493	1126	-0.1764;

323	7.150	7	4429	1110	0.0556;
324	7.172	29	4372	1095	0.2772;
325	7.194	46	4337	1086	0.4414;
326	7.216	51	4329	1083	0.4994;
327	7.238	43	4355	1088	0.4225;
328	7.260	24	4404	1101	0.2442;
329	7.283	0	4464	1117	0.0140;
330	7.305	-23	4523	1132	-0.2198;
331	7.327	-42	4565	1143	-0.4078;
332	7.349	-51	4579	1148	-0.4982;
333	7.371	-46	4561	1144	-0.4505;
334	7.393	-29	4515	1132	-0.2869;
335	7.415	-5	4455	1117	-0.0586;
336	7.438	20	4396	1101	0.1825;
337	7.460	40	4352	1090	0.3846;
338	7.482	51	4335	1085	0.4933;
339	7.504	47	4348	1087	0.4615;
340	7.526	30	4389	1098	0.3046;
341	7.548	7	4446	1112	0.0757;
342	7.570	-18	4504	1128	-0.1703;
343	7.592	-39	4550	1140	-0.3791;
344	7.615	-51	4569	1145	-0.4933;
345	7.637	-47	4557	1144	-0.4621;
346	7.659	-30	4516	1133	-0.3016;
347	7.681	-6	4459	1118	-0.0678;
348	7.703	20	4402	1103	0.1819;
349	7.725	41	4361	1092	0.3895;
350	7.747	51	4346	1088	0.4957;
351	7.770	46	4362	1091	0.4505;
352	7.792	27	4407	1102	0.2759;
353	7.814	2	4466	1118	0.0330;
354	7.836	-23	4524	1133	-0.2186;
355	7.858	-43	4566	1144	-0.4170;
356	7.880	-51	4580	1148	-0.5000;
357	7.902	-43	4561	1144	-0.4243;
358	7.924	-22	4516	1133	-0.2271;
359	7.947	4	4460	1118	0.0269;
360	7.969	29	4410	1105	0.2753;
361	7.991	47	4379	1097	0.4530;
362	8.013	50	4378	1095	0.4939;
363	8.035	38	4408	1103	0.3742;
364	8.057	14	4460	1116	0.1496;
365	8.079	-13	4518	1131	-0.1136;
366	8.102	-37	4566	1144	-0.3486;
367	8.124	-50	4590	1150	-0.4872;
368	8.146	-47	4582	1150	-0.4658;
369	8.168	-29	4544	1140	-0.2955;
370	8.190	-3	4490	1125	-0.0433;
371	8.212	24	4436	1112	0.2198;
372	8.234	44	4400	1102	0.4249;
373	8.257	51	4391	1099	0.4994;
374	8.279	40	4414	1104	0.3999;
375	8.301	17	4461	1116	0.1789;
376	8.323	-10	4516	1131	-0.0916;
377	8.345	-35	4563	1143	-0.3376;

378	8.367	-50	4586	1149	-0.4853;
379	8.389	-47	4579	1149	-0.4652;
380	8.411	-28	4541	1139	-0.2875;
381	8.434	-2	4487	1125	-0.0263;
382	8.456	26	4436	1111	0.2430;
383	8.478	46	4402	1102	0.4426;
384	8.500	50	4396	1100	0.4945;
385	8.522	37	4424	1106	0.3669;
386	8.544	12	4472	1119	0.1239;
387	8.566	-17	4525	1133	-0.1551;
388	8.589	-41	4566	1144	-0.3901;
389	8.611	-51	4581	1148	-0.4994;
390	8.633	-42	4564	1145	-0.4219;
391	8.655	-20	4521	1134	-0.2015;
392	8.677	9	4469	1120	0.0788;
393	8.699	35	4424	1108	0.3370;
394	8.721	50	4403	1102	0.4878;
395	8.743	46	4412	1104	0.4548;
396	8.766	25	4450	1113	0.2576;
397	8.788	-3	4501	1127	-0.0208;
398	8.810	-31	4549	1139	-0.2930;
399	8.832	-49	4577	1147	-0.4731;
400	8.854	-48	4574	1148	-0.4750;
401	8.876	-29	4541	1139	-0.2961;
402	8.898	-1	4492	1126	-0.0214;
403	8.921	28	4444	1113	0.2607;
404	8.943	48	4415	1105	0.4591;
405	8.965	49	4414	1104	0.4835;
406	8.987	32	4445	1112	0.3168;
407	9.009	3	4494	1124	0.0433;
408	9.031	-26	4542	1137	-0.2442;
409	9.053	-47	4574	1146	-0.4530;
410	9.076	-50	4577	1148	-0.4872;
411	9.098	-32	4548	1141	-0.3242;
412	9.120	-4	4500	1128	-0.0488;
413	9.142	26	4453	1116	0.2430;
414	9.164	47	4423	1108	0.4530;
415	9.186	49	4421	1106	0.4853;
416	9.208	31	4451	1113	0.3162;
417	9.230	2	4498	1126	0.0348;
418	9.253	-28	4546	1138	-0.2582;
419	9.275	-48	4574	1146	-0.4628;
420	9.297	-49	4575	1147	-0.4786;
421	9.319	-29	4543	1139	-0.2937;
422	9.341	1	4496	1127	-0.0043;
423	9.363	31	4451	1115	0.2875;
424	9.385	49	4427	1108	0.4768;
425	9.408	47	4431	1108	0.4628;
426	9.430	25	4465	1117	0.2540;
427	9.452	-6	4513	1130	-0.0464;
428	9.474	-35	4555	1141	-0.3309;
429	9.496	-51	4576	1147	-0.4921;
430	9.518	-44	4566	1146	-0.4347;
431	9.540	-19	4528	1136	-0.1966;
432	9.563	13	4481	1123	0.1129;

433	9.585	40	4443	1113	0.3822;
434	9.607	51	4430	1109	0.4994;
435	9.629	39	4448	1112	0.3871;
436	9.651	11	4489	1123	0.1172;
437	9.673	-21	4536	1136	-0.1954;
438	9.695	-45	4568	1144	-0.4365;
439	9.717	-50	4574	1147	-0.4902;
440	9.740	-31	4547	1140	-0.3162;
441	9.762	-1	4503	1129	-0.0183;
442	9.784	31	4460	1117	0.2875;
443	9.806	50	4437	1111	0.4811;
444	9.828	46	4443	1110	0.4505;
445	9.850	21	4477	1120	0.2173;
446	9.872	-12	4523	1132	-0.1007;
447	9.895	-40	4561	1143	-0.3816;
448	9.917	-51	4574	1146	-0.5006;
449	9.939	-38	4556	1143	-0.3761;
450	9.961	-8	4515	1132	-0.0910;
451	9.983	25	4471	1120	0.2295;
452	10.005	48	4443	1113	0.4591;
453	10.027	48	4443	1111	0.4725;
454	10.049	25	4474	1119	0.2589;
455	10.072	-8	4518	1131	-0.0611;
456	10.094	-38	4557	1141	-0.3578;
457	10.116	-51	4573	1146	-0.5000;
458	10.138	-39	4558	1143	-0.3895;
459	10.160	-9	4518	1133	-0.1044;
460	10.182	24	4475	1121	0.2228;
461	10.204	48	4448	1114	0.4585;
462	10.227	48	4448	1113	0.4707;
463	10.249	24	4478	1120	0.2479;
464	10.271	-10	4522	1132	-0.0800;
465	10.293	-39	4559	1142	-0.3755;
466	10.315	-51	4572	1146	-0.5000;
467	10.337	-36	4554	1142	-0.3632;
468	10.359	-5	4514	1132	-0.0598;
469	10.382	29	4473	1121	0.2686;
470	10.404	50	4450	1114	0.4805;
471	10.426	45	4456	1114	0.4426;
472	10.448	17	4490	1123	0.1832;
473	10.470	-17	4533	1135	-0.1557;
474	10.492	-45	4565	1144	-0.4280;
475	10.514	-50	4572	1146	-0.4878;
476	10.536	-28	4546	1140	-0.2875;
477	10.559	6	4504	1129	0.0440;
478	10.581	38	4467	1119	0.3565;
479	10.603	51	4453	1115	0.4994;
480	10.625	37	4470	1118	0.3675;
481	10.647	4	4508	1128	0.0568;
482	10.669	-30	4549	1139	-0.2796;
483	10.691	-50	4571	1145	-0.4866;
484	10.714	-43	4563	1145	-0.4267;
485	10.736	-14	4529	1136	-0.1459;
486	10.758	22	4487	1124	0.2015;
487	10.780	47	4460	1117	0.4567;

488	10.802	47	4461	1116	0.4652;
489	10.824	21	4490	1123	0.2186;
490	10.846	-15	4532	1135	-0.1306;
491	10.868	-44	4564	1143	-0.4206;
492	10.891	-50	4571	1146	-0.4884;
493	10.913	-27	4545	1140	-0.2778;
494	10.935	8	4505	1129	0.0678;
495	10.957	40	4471	1120	0.3822;
496	10.979	51	4460	1117	0.4976;
497	11.001	32	4480	1121	0.3223;
498	11.023	-3	4519	1131	-0.0165;
499	11.046	-37	4556	1141	-0.3474;
500	11.068	-51	4570	1145	-0.5000;
501	11.090	-35	4554	1142	-0.3553;
502	11.112	-1	4517	1132	-0.0244;
503	11.134	34	4479	1122	0.3181;
504	11.156	51	4463	1117	0.4976;
505	11.178	38	4476	1119	0.3773;
506	11.201	4	4512	1129	0.0525;
507	11.223	-32	4550	1139	-0.2979;
508	11.245	-51	4568	1145	-0.4951;
509	11.267	-39	4557	1144	-0.3913;
510	11.289	-6	4522	1134	-0.0702;
511	11.311	31	4484	1124	0.2857;
512	11.333	51	4465	1118	0.4927;
513	11.355	40	4475	1120	0.3962;
514	11.378	6	4510	1129	0.0751;
515	11.400	-30	4548	1139	-0.2839;
516	11.422	-51	4568	1144	-0.4933;
517	11.444	-39	4558	1144	-0.3944;
518	11.466	-6	4523	1134	-0.0696;
519	11.488	31	4487	1124	0.2912;
520	11.510	51	4469	1119	0.4951;
521	11.533	38	4480	1121	0.3840;
522	11.555	4	4515	1130	0.0513;
523	11.577	-33	4551	1140	-0.3083;
524	11.599	-51	4568	1145	-0.4982;
525	11.621	-36	4555	1143	-0.3669;
526	11.643	-1	4520	1133	-0.0226;
527	11.665	35	4485	1124	0.3333;
528	11.688	51	4471	1119	0.4994;
529	11.710	33	4486	1122	0.3382;
530	11.732	-4	4522	1132	-0.0189;
531	11.754	-39	4555	1141	-0.3663;
532	11.776	-51	4567	1144	-0.4982;
533	11.798	-29	4548	1141	-0.2991;
534	11.820	9	4511	1130	0.0708;
535	11.842	42	4480	1122	0.4029;
536	11.865	49	4472	1120	0.4866;
537	11.887	24	4496	1125	0.2460;
538	11.909	-15	4533	1135	-0.1343;
539	11.931	-46	4561	1143	-0.4414;
540	11.953	-47	4563	1144	-0.4640;
541	11.975	-17	4536	1137	-0.1801;
542	11.997	23	4499	1128	0.2057;

543	12.020	49	4476	1121	0.4744;
544	12.042	42	4481	1120	0.4237;
545	12.064	8	4511	1129	0.0977;
546	12.086	-30	4547	1139	-0.2839;
547	12.108	-51	4565	1144	-0.4969;
548	12.130	-36	4554	1143	-0.3639;
549	12.152	1	4520	1133	-0.0024;
550	12.174	38	4487	1124	0.3608;
551	12.197	51	4477	1121	0.4963;
552	12.219	27	4496	1125	0.2814;
553	12.241	-12	4532	1135	-0.1050;
554	12.263	-45	4560	1142	-0.4316;
555	12.285	-47	4564	1144	-0.4670;
556	12.307	-17	4537	1138	-0.1777;
557	12.329	24	4501	1128	0.2186;
558	12.352	50	4480	1122	0.4823;
559	12.374	40	4487	1123	0.4023;
560	12.396	4	4518	1131	0.0519;
561	12.418	-35	4551	1140	-0.3303;
562	12.440	-51	4565	1144	-0.5000;
563	12.462	-30	4548	1141	-0.3034;
564	12.484	11	4513	1131	0.0873;
565	12.507	45	4486	1124	0.4255;
566	12.529	47	4482	1122	0.4670;
567	12.551	16	4508	1128	0.1709;
568	12.573	-25	4543	1137	-0.2314;
569	12.595	-50	4563	1143	-0.4884;
570	12.617	-38	4555	1143	-0.3834;
571	12.639	0	4523	1134	-0.0147;
572	12.661	38	4492	1125	0.3639;
573	12.684	50	4482	1122	0.4933;
574	12.706	24	4502	1127	0.2503;
575	12.728	-18	4537	1136	-0.1557;
576	12.750	-48	4561	1143	-0.4640;
577	12.772	-43	4558	1144	-0.4274;
578	12.794	-7	4530	1136	-0.0806;
579	12.816	34	4497	1127	0.3175;
580	12.839	51	4484	1123	0.4994;
581	12.861	29	4500	1126	0.2943;
582	12.883	-13	4533	1135	-0.1111;
583	12.905	-46	4559	1142	-0.4457;
584	12.927	-45	4560	1143	-0.4463;
585	12.949	-10	4532	1136	-0.1111;
586	12.971	32	4499	1128	0.2967;
587	12.993	51	4485	1123	0.4994;
588	13.016	30	4499	1125	0.3065;
589	13.038	-12	4532	1135	-0.1013;
590	13.060	-46	4558	1142	-0.4426;
591	13.082	-45	4559	1143	-0.4457;
592	13.104	-9	4532	1136	-0.1056;
593	13.126	33	4499	1128	0.3053;
594	13.148	51	4486	1123	0.5000;
595	13.171	28	4501	1126	0.2900;
596	13.193	-15	4534	1135	-0.1258;
597	13.215	-48	4558	1142	-0.4573;

598	13.237	-43	4557	1143	-0.4274;
599	13.259	-5	4529	1136	-0.0659;
600	13.281	36	4498	1127	0.3407;
601	13.303	50	4488	1124	0.4951;
602	13.326	23	4506	1127	0.2418;
603	13.348	-21	4539	1136	-0.1844;
604	13.370	-50	4559	1143	-0.4817;
605	13.392	-38	4553	1143	-0.3840;
606	13.414	3	4524	1134	0.0104;
607	13.436	42	4496	1126	0.3980;
608	13.458	48	4489	1124	0.4731;
609	13.480	14	4514	1129	0.1575;
610	13.503	-29	4546	1138	-0.2711;
611	13.525	-51	4561	1143	-0.5000;
612	13.547	-30	4548	1141	-0.3040;
613	13.569	14	4516	1132	0.1215;
614	13.591	48	4493	1125	0.4603;
615	13.613	41	4495	1124	0.4151;
616	13.635	2	4523	1132	0.0324;
617	13.658	-40	4552	1140	-0.3742;
618	13.680	-49	4560	1143	-0.4829;
619	13.702	-17	4538	1138	-0.1783;
620	13.724	28	4507	1129	0.2582;
621	13.746	51	4491	1125	0.4988;
622	13.768	30	4504	1127	0.3034;
623	13.790	-15	4534	1135	-0.1294;
624	13.813	-48	4557	1142	-0.4664;
625	13.835	-40	4554	1143	-0.4023;
626	13.857	2	4526	1134	-0.0037;
627	13.879	42	4499	1127	0.3980;
628	13.901	47	4494	1125	0.4676;
629	13.923	11	4517	1130	0.1288;
630	13.945	-33	4547	1139	-0.3083;
631	13.967	-51	4559	1143	-0.4988;
632	13.990	-23	4543	1139	-0.2418;
633	14.012	23	4512	1131	0.2045;
634	14.034	51	4494	1125	0.4921;
635	14.056	33	4503	1127	0.3358;
636	14.078	-12	4533	1135	-0.0983;
637	14.100	-48	4556	1141	-0.4573;
638	14.122	-41	4554	1143	-0.4103;
639	14.145	1	4527	1135	-0.0067;
640	14.167	42	4500	1128	0.4017;
641	14.189	46	4495	1125	0.4609;
642	14.211	9	4519	1131	0.1038;
643	14.233	-36	4549	1139	-0.3358;
644	14.255	-50	4558	1142	-0.4915;
645	14.277	-18	4540	1138	-0.1929;
646	14.299	28	4510	1130	0.2613;
647	14.322	51	4496	1126	0.4994;
648	14.344	26	4509	1128	0.2692;
649	14.366	-21	4539	1136	-0.1862;
650	14.388	-51	4557	1142	-0.4908;
651	14.410	-33	4549	1142	-0.3339;
652	14.432	13	4520	1133	0.1123;

653	14.454	49	4499	1127	0.4676;
654	14.477	38	4502	1126	0.3852;
655	14.499	-6	4530	1134	-0.0433;
656	14.521	-46	4554	1141	-0.4377;
657	14.543	-43	4555	1142	-0.4261;
658	14.565	-0	4529	1135	-0.0208;
659	14.587	42	4503	1128	0.4017;
660	14.609	46	4499	1126	0.4554;
661	14.632	6	4522	1132	0.0769;
662	14.654	-39	4549	1139	-0.3657;
663	14.676	-48	4557	1142	-0.4768;
664	14.698	-11	4536	1137	-0.1270;
665	14.720	35	4508	1129	0.3297;
666	14.742	50	4498	1126	0.4890;
667	14.764	15	4517	1130	0.1691;
668	14.786	-32	4545	1138	-0.2967;
669	14.809	-51	4557	1142	-0.4969;
670	14.831	-19	4540	1139	-0.2045;
671	14.853	29	4512	1131	0.2662;
672	14.875	51	4499	1126	0.4994;
673	14.897	22	4514	1129	0.2320;
674	14.919	-26	4542	1137	-0.2411;
675	14.941	-51	4556	1142	-0.5000;
676	14.964	-24	4543	1140	-0.2546;
677	14.986	24	4515	1132	0.2210;
678	15.008	51	4500	1127	0.4988;
679	15.030	26	4511	1129	0.2692;
680	15.052	-23	4539	1136	-0.2070;
681	15.074	-51	4555	1141	-0.4982;
682	15.096	-27	4545	1140	-0.2796;
683	15.118	22	4517	1132	0.1984;
684	15.141	51	4501	1127	0.4969;
685	15.163	27	4511	1129	0.2827;
686	15.185	-22	4539	1136	-0.1966;
687	15.207	-51	4556	1142	-0.4976;
688	15.229	-27	4545	1141	-0.2821;
689	15.251	22	4518	1132	0.1996;
690	15.273	51	4502	1128	0.4976;
691	15.296	26	4513	1129	0.2747;
692	15.318	-23	4541	1137	-0.2094;
693	15.340	-51	4556	1142	-0.4994;
694	15.362	-25	4545	1140	-0.2625;
695	15.384	25	4517	1132	0.2247;
696	15.406	51	4503	1128	0.4994;
697	15.428	23	4515	1130	0.2430;
698	15.451	-27	4542	1137	-0.2460;
699	15.473	-51	4555	1141	-0.5000;
700	15.495	-20	4541	1139	-0.2186;
701	15.517	30	4514	1131	0.2723;
702	15.539	51	4502	1127	0.4969;
703	15.561	17	4518	1130	0.1862;
704	15.583	-33	4544	1138	-0.3028;
705	15.605	-50	4554	1141	-0.4908;
706	15.628	-13	4537	1138	-0.1477;
707	15.650	36	4511	1130	0.3364;

708	15.672	48	4503	1128	0.4780;
709	15.694	8	4523	1132	0.1007;
710	15.716	-40	4548	1139	-0.3736;
711	15.738	-46	4555	1141	-0.4591;
712	15.760	-3	4533	1136	-0.0476;
713	15.783	43	4509	1129	0.4096;
714	15.805	43	4506	1128	0.4298;
715	15.827	-4	4530	1134	-0.0134;
716	15.849	-47	4552	1140	-0.4444;
717	15.871	-39	4551	1141	-0.3913;
718	15.893	10	4526	1134	0.0800;
719	15.915	49	4507	1129	0.4731;
720	15.938	33	4511	1128	0.3407;
721	15.960	-18	4537	1136	-0.1526;
722	15.982	-51	4554	1141	-0.4939;
723	16.004	-27	4545	1140	-0.2784;
724	16.026	25	4519	1132	0.2271;
725	16.048	51	4505	1128	0.4994;
726	16.070	19	4518	1131	0.2021;
727	16.092	-33	4544	1138	-0.3022;
728	16.115	-49	4554	1141	-0.4872;
729	16.137	-10	4536	1137	-0.1160;
730	16.159	40	4512	1130	0.3724;
731	16.181	45	4506	1128	0.4524;
732	16.203	-0	4528	1133	0.0183;
733	16.225	-46	4551	1140	-0.4347;
734	16.247	-39	4551	1141	-0.3962;
735	16.270	11	4527	1135	0.0849;
736	16.292	50	4508	1129	0.4792;
737	16.314	31	4514	1130	0.3175;
738	16.336	-22	4539	1136	-0.1923;
739	16.358	-51	4554	1141	-0.5000;
740	16.380	-20	4542	1139	-0.2192;
741	16.402	32	4517	1132	0.2955;
742	16.424	49	4507	1129	0.4860;
743	16.447	8	4525	1132	0.1032;
744	16.469	-41	4548	1139	-0.3883;
745	16.491	-43	4553	1141	-0.4365;
746	16.513	5	4530	1136	0.0238;
747	16.535	48	4510	1129	0.4597;
748	16.557	34	4513	1129	0.3523;
749	16.579	-18	4537	1136	-0.1569;
750	16.602	-51	4553	1141	-0.4976;
751	16.624	-22	4543	1140	-0.2387;
752	16.646	31	4518	1132	0.2845;
753	16.668	49	4508	1129	0.4872;
754	16.690	8	4525	1132	0.1007;
755	16.712	-42	4548	1139	-0.3956;
756	16.734	-42	4551	1141	-0.4267;
757	16.757	7	4529	1135	0.0507;
758	16.779	49	4510	1129	0.4725;
759	16.801	31	4515	1129	0.3193;
760	16.823	-23	4539	1136	-0.2051;
761	16.845	-51	4552	1141	-0.5000;
762	16.867	-16	4540	1138	-0.1770;

763	16.889	37	4516	1132	0.3437;
764	16.911	46	4509	1129	0.4591;
765	16.934	-1	4529	1134	0.0104;
766	16.956	-47	4550	1140	-0.4505;
767	16.978	-35	4548	1141	-0.3584;
768	17.000	19	4524	1134	0.1624;
769	17.022	51	4510	1129	0.4988;
770	17.044	19	4521	1131	0.2070;
771	17.066	-35	4544	1138	-0.3236;
772	17.089	-47	4552	1141	-0.4683;
773	17.111	-0	4533	1137	-0.0256;
774	17.133	47	4512	1130	0.4457;
775	17.155	35	4514	1129	0.3596;
776	17.177	-19	4538	1136	-0.1661;
777	17.199	-51	4552	1140	-0.5000;
778	17.221	-18	4540	1139	-0.1947;
779	17.243	36	4517	1132	0.3388;
780	17.266	46	4510	1129	0.4573;
781	17.288	-3	4530	1134	-0.0061;
782	17.310	-48	4550	1140	-0.4628;
783	17.332	-32	4546	1140	-0.3284;
784	17.354	24	4523	1133	0.2106;
785	17.376	51	4511	1129	0.4976;
786	17.398	12	4524	1132	0.1368;
787	17.421	-41	4547	1139	-0.3864;
788	17.443	-42	4550	1141	-0.4212;
789	17.465	11	4529	1135	0.0830;
790	17.487	51	4512	1130	0.4890;
791	17.509	24	4520	1131	0.2534;
792	17.531	-32	4543	1138	-0.2949;
793	17.553	-48	4551	1140	-0.4762;
794	17.576	-1	4534	1137	-0.0317;
795	17.598	47	4513	1130	0.4499;
796	17.620	33	4516	1129	0.3413;
797	17.642	-23	4539	1136	-0.2033;
798	17.664	-51	4551	1140	-0.4988;
799	17.686	-11	4537	1138	-0.1270;
800	17.708	42	4516	1131	0.3987;
801	17.730	40	4514	1130	0.4029;
802	17.753	-15	4535	1135	-0.1221;
803	17.775	-51	4551	1140	-0.4982;
804	17.797	-18	4541	1139	-0.2015;
805	17.819	37	4519	1132	0.3474;
806	17.841	44	4513	1130	0.4432;
807	17.863	-8	4533	1135	-0.0549;
808	17.885	-50	4550	1140	-0.4860;
809	17.908	-24	4543	1140	-0.2558;
810	17.930	33	4521	1133	0.3028;
811	17.952	47	4513	1130	0.4664;
812	17.974	-3	4531	1134	-0.0055;
813	17.996	-49	4549	1140	-0.4713;
814	18.018	-28	4544	1140	-0.2924;
815	18.040	30	4522	1133	0.2705;
816	18.063	48	4513	1130	0.4786;
817	18.085	0	4530	1134	0.0256;

818	18.107	-48	4548	1139	-0.4609;
819	18.129	-30	4544	1140	-0.3120;
820	18.151	28	4523	1133	0.2527;
821	18.173	49	4513	1130	0.4841;
822	18.195	2	4529	1133	0.0391;
823	18.217	-48	4548	1139	-0.4567;
824	18.240	-30	4544	1140	-0.3162;
825	18.262	28	4523	1133	0.2509;
826	18.284	49	4513	1130	0.4835;
827	18.306	1	4529	1134	0.0336;
828	18.328	-48	4548	1139	-0.4603;
829	18.350	-29	4544	1140	-0.3065;
830	18.372	29	4523	1133	0.2643;
831	18.395	48	4514	1130	0.4774;
832	18.417	-1	4530	1134	0.0104;
833	18.439	-49	4549	1139	-0.4707;
834	18.461	-27	4544	1140	-0.2814;
835	18.483	32	4522	1133	0.2937;
836	18.505	46	4515	1130	0.4640;
837	18.527	-6	4532	1135	-0.0311;
838	18.549	-50	4549	1140	-0.4853;
839	18.572	-22	4542	1140	-0.2393;
840	18.594	36	4521	1133	0.3352;
841	18.616	44	4515	1130	0.4383;
842	18.638	-12	4534	1135	-0.0904;
843	18.660	-51	4549	1140	-0.4976;
844	18.682	-16	4540	1139	-0.1777;
845	18.704	41	4519	1132	0.3858;
846	18.727	39	4517	1130	0.3950;
847	18.749	-19	4537	1136	-0.1654;
848	18.771	-51	4549	1140	-0.4988;
849	18.793	-7	4536	1137	-0.0958;
850	18.815	46	4517	1132	0.4383;
851	18.837	32	4519	1130	0.3297;
852	18.859	-28	4540	1137	-0.2534;
853	18.882	-48	4549	1140	-0.4774;
854	18.904	3	4533	1137	0.0067;
855	18.926	50	4516	1131	0.4817;
856	18.948	22	4523	1131	0.2369;
857	18.970	-37	4544	1138	-0.3462;
858	18.992	-42	4549	1140	-0.4243;
859	19.014	16	4530	1135	0.1276;
860	19.036	51	4517	1131	0.5000;
861	19.059	9	4528	1133	0.1166;
862	19.081	-46	4547	1139	-0.4316;
863	19.103	-32	4546	1140	-0.3333;
864	19.125	29	4525	1134	0.2570;
865	19.147	47	4517	1131	0.4725;
866	19.169	-6	4533	1135	-0.0299;
867	19.191	-51	4549	1140	-0.4902;
868	19.214	-18	4541	1139	-0.2021;
869	19.236	41	4521	1133	0.3803;
870	19.258	38	4518	1131	0.3895;
871	19.280	-22	4538	1136	-0.1905;
872	19.302	-50	4548	1140	-0.4927;

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   873   19.324             -1           4534          1137         -0.0348;
   874   19.346             49           4517          1132          0.4725;
   875   19.368             23           4522          1131          0.2497;
   876   19.391            -37           4543          1138         -0.3462;
   877   19.413            -41           4548          1140         -0.4170;
   878   19.435             18           4528          1135          0.1532;
   879   19.457             51           4517          1131          0.4969;
   880   19.479              4           4530          1134          0.0623;
   881   19.501            -49           4547          1139         -0.4646;
   882   19.523            -25           4543          1140         -0.2662;
   883   19.546             36           4523          1133          0.3358;
   884   19.568             42           4518          1131          0.4206;
   885   19.590            -18           4537          1136         -0.1520;
   886   19.612            -50           4549          1140         -0.4976;
   887   19.634             -3           4536          1137         -0.0549;
   888   19.656             49           4519          1132          0.4689;
   889   19.678             23           4524          1131          0.2497;
   890   19.701            -38           4543          1138         -0.3535;
   891   19.723            -40           4547          1140         -0.4048;
   892   19.745             21           4528          1135          0.1825;
   893   19.767             50           4518          1131          0.4902;
   894   19.789             -1           4531          1134          0.0116;
   895   19.811            -50           4547          1139         -0.4847;
   896   19.833            -18           4540          1139         -0.2027;
   897   19.855             42           4521          1133          0.3932;
   898   19.878             35           4520          1131          0.3620;
   899   19.900            -27           4540          1137         -0.2454;
   900   19.922            -47           4548          1140         -0.4683;
   901   19.944              9           4532          1136          0.0665;
   902   19.966             51           4519          1132          0.4988;
   903   19.988              9           4528          1133          0.1166;
   904   20.010            -47           4546          1139         -0.4475;
   905   20.033            -27           4543          1140         -0.2851;
   906   20.055             36           4524          1133          0.3315;
   907   20.077             41           4519          1131          0.4145;
   908   20.099            -21           4538          1136         -0.1783;
   909   20.121            -49           4548          1140         -0.4890;
   910   20.143              3           4534          1137          0.0061;
   911   20.165             51           4519          1132          0.4915;
   912   20.188             14           4527          1132          0.1630;
   913   20.210            -45           4546          1139         -0.4261;
   914   20.232            -30           4544          1140         -0.3132;
   915   20.254             34           4525          1134          0.3095;
   916   20.276             42           4519          1132          0.4267;
   917   20.298            -19           4537          1136         -0.1642;
   918   20.320            -50           4547          1139         -0.4915;
   919   20.342              3           4534          1137          0.0037];
time = data(:,2);
y = data(:,4);
u = data(:,6);
dy = diff(y);
dy(end+1) = dy(end);
zf = iddata(dy,u,0.00884);
tf1 = tfest(zf,1,0)
```

raw_data_cl_step1

```
% Sample   Time     Commanded Pos   Encoder 1 Pos

data = [    0    0.000            1000               0;
     1    0.009            1000              23;
     2    0.018            1000              78;
     3    0.027            1000             160;
     4    0.035            1000             271;
     5    0.044            1000             420;
     6    0.053            1000             610;
     7    0.062            1000             834;
     8    0.071            1000            1066;
     9    0.080            1000            1288;
    10    0.089            1000            1488;
    11    0.097            1000            1657;
    12    0.106            1000            1797;
    13    0.115            1000            1898;
    14    0.124            1000            1949;
    15    0.133            1000            1957;
    16    0.142            1000            1927;
    17    0.151            1000            1857;
    18    0.159            1000            1743;
    19    0.168            1000            1590;
    20    0.177            1000            1406;
    21    0.186            1000            1189;
    22    0.195            1000             954;
    23    0.204            1000             724;
    24    0.213            1000             522;
    25    0.221            1000             360;
    26    0.230            1000             226;
    27    0.239            1000             118;
    28    0.248            1000              51;
    29    0.257            1000              30;
    30    0.266            1000              46;
    31    0.274            1000              93;
    32    0.283            1000             173;
    33    0.292            1000             292;
    34    0.301            1000             451;
    35    0.310            1000             646;
    36    0.319            1000             867;
    37    0.328            1000            1098;
    38    0.336            1000            1322;
    39    0.345            1000            1522;
    40    0.354            1000            1689;
    41    0.363            1000            1823;
    42    0.372            1000            1919;
    43    0.381            1000            1966;
    44    0.390            1000            1972;
    45    0.398            1000            1937;
    46    0.407            1000            1863;
    47    0.416            1000            1746;
    48    0.425            1000            1590;
    49    0.434            1000            1401;
```

```
 50    0.443           1000           1182;
 51    0.452           1000            944;
 52    0.460           1000            713;
 53    0.469           1000            510;
 54    0.478           1000            345;
 55    0.487           1000            210;
 56    0.496           1000            102;
 57    0.505           1000             35;
 58    0.514           1000             14;
 59    0.522           1000             29;
 60    0.531           1000             74;
 61    0.540           1000            152;
 62    0.549           1000            270;
 63    0.558           1000            428;
 64    0.567           1000            621;
 65    0.576           1000            843;
 66    0.584           1000           1077;
 67    0.593           1000           1305;
 68    0.602           1000           1512;
 69    0.611           1000           1686;
 70    0.620           1000           1827;
 71    0.629           1000           1929;
 72    0.638           1000           1984;
 73    0.646           1000           1996;
 74    0.655           1000           1968;
 75    0.664           1000           1900;
 76    0.673           1000           1790;
 77    0.682           1000           1640;
 78    0.691           1000           1456;
 79    0.699           1000           1240;
 80    0.708           1000           1001;
 81    0.717           1000            763;
 82    0.726           1000            550;
 83    0.735           1000            374;
 84    0.744           1000            230;
 85    0.753           1000            112;
 86    0.761           1000             31;
 87    0.770           1000             -2;
 88    0.779           1000              3;
 89    0.788           1000             38;
 90    0.797           1000            104;
 91    0.806           1000            209;
 92    0.815           1000            355;
 93    0.823           1000            536;
 94    0.832           1000            749;
 95    0.841           1000            984;
 96    0.850           1000           1220;
 97    0.859           1000           1438;
 98    0.868           1000           1626;
 99    0.877           1000           1781;
100    0.885           1000           1903;
101    0.894           1000           1979;
102    0.903           1000           2007;
103    0.912           1000           1996;
104    0.921           1000           1946;
```

```
105    0.930           1000           1854;
106    0.939           1000           1720;
107    0.947           1000           1550;
108    0.956           1000           1348;
109    0.965           1000           1116;
110    0.974           1000            872;
111    0.983           1000            643;
112    0.992           1000            448;
113    1.001           1000            290;
114    1.009           1000            157;
115    1.018           1000             55;
116    1.027           1000             -3;
117    1.036           1000            -17;
118    1.045           1000              3;
119    1.054           1000             52;
120    1.063           1000            135;
121    1.071           1000            259;
122    1.080           1000            422;
123    1.089           1000            618;
124    1.098           1000            843;
125    1.107           1000           1083;
126    1.116           1000           1315;
127    1.124           1000           1524;
128    1.133           1000           1701;
129    1.142           1000           1845;
130    1.151           1000           1951;
131    1.160           1000           2008;
132    1.169           1000           2022;
133    1.178           1000           1998;
134    1.186           1000           1933;
135    1.195           1000           1825;
136    1.204           1000           1677;
137    1.213           1000           1495;
138    1.222           1000           1281;
139    1.231           1000           1040;
140    1.240           1000            796;
141    1.248           1000            576;
142    1.257           1000            391;
143    1.266           1000            239;
144    1.275           1000            112;
145    1.284           1000             20;
146    1.293           1000            -25;
147    1.302           1000            -31;
148    1.310           1000             -4;
149    1.319           1000             51;
150    1.328           1000            143;
151    1.337           1000            276;
152    1.346           1000            446;
153    1.355           1000            648;
154    1.364           1000            879;
155    1.372           1000           1120;
156    1.381           1000           1353;
157    1.390           1000           1558;
158    1.399           1000           1731;
159    1.408           1000           1872;
```

```
160    1.417          1000          1973;
161    1.426          1000          2025;
162    1.434          1000          2035;
163    1.443          1000          2007;
164    1.452          1000          1938;
165    1.461          1000          1826;
166    1.470          1000          1674;
167    1.479          1000          1489;
168    1.488          1000          1272;
169    1.496          1000          1028;
170    1.505          1000           782;
171    1.514          1000           564;
172    1.523          1000           380;
173    1.532          1000           228;
174    1.541          1000           100;
175    1.549          1000             9;
176    1.558          1000           -35;
177    1.567          1000           -41;
178    1.576          1000           -15;
179    1.585          1000            39;
180    1.594          1000           130;
181    1.603          1000           263;
182    1.611          1000           431;
183    1.620          1000           632;
184    1.629          1000           864;
185    1.638          1000          1107;
186    1.647          1000          1341;
187    1.656          1000          1549;
188    1.665          1000          1724;
189    1.673          1000          1869;
190    1.682          1000          1974;
191    1.691          1000          2030;
192    1.700          1000          2043;
193    1.709          1000          2018;
194    1.718          1000          1953;
195    1.727          1000          1845;
196    1.735          1000          1697;
197    1.744          1000          1516;
198    1.753          1000          1301;
199    1.762          1000          1057;
200    1.771          1000           811;
201    1.780          1000           587;
202    1.789          1000           398;
203    1.797          1000           242;
204    1.806          1000           110;
205    1.815          1000            12;
206    1.824          1000           -39;
207    1.833          1000           -49;
208    1.842          1000           -30;
209    1.851          1000            18;
210    1.859          1000           103;
211    1.868          1000           228;
212    1.877          1000           389;
213    1.886          1000           582;
214    1.895          1000           809;
```

```
215    1.904          1000          1052;
216    1.913          1000          1291;
217    1.921          1000          1506;
218    1.930          1000          1689;
219    1.939          1000          1842;
220    1.948          1000          1958;
221    1.957          1000          2026;
222    1.966          1000          2048;
223    1.974          1000          2034;
224    1.983          1000          1980;
225    1.992          1000          1883;
226    2.001             0          1744;
227    2.010             0          1573;
228    2.019             0          1368;
229    2.028             0          1128;
230    2.036             0           852;
231    2.045             0           544;
232    2.054             0           204;
233    2.063             0          -147;
234    2.072             0          -479;
235    2.081             0          -772;
236    2.090             0         -1032;
237    2.098             0         -1269;
238    2.107             0         -1474;
239    2.116             0         -1630;
240    2.125             0         -1731;
241    2.134             0         -1795;
242    2.143             0         -1829;
243    2.152             0         -1827;
244    2.160             0         -1774;
245    2.169             0         -1679;
246    2.178             0         -1552;
247    2.187             0         -1393;
248    2.196             0         -1199;
249    2.205             0          -961;
250    2.214             0          -685;
251    2.222             0          -379;
252    2.231             0           -48;
253    2.240             0           286;
254    2.249             0           591;
255    2.258             0           864;
256    2.267             0          1115;
257    2.276             0          1343;
258    2.284             0          1524;
259    2.293             0          1651;
260    2.302             0          1744;
261    2.311             0          1809;
262    2.320             0          1830;
263    2.329             0          1801;
264    2.338             0          1733;
265    2.346             0          1635;
266    2.355             0          1498;
267    2.364             0          1322;
268    2.373             0          1115;
269    2.382             0           879;
```

```
270    2.391              0             605;
271    2.399              0             296;
272    2.408              0              -32;
273    2.417              0             -350;
274    2.426              0             -633;
275    2.435              0             -879;
276    2.444              0            -1101;
277    2.453              0            -1296;
278    2.461              0            -1448;
279    2.470              0            -1547;
280    2.479              0            -1604;
281    2.488              0            -1631;
282    2.497              0            -1629;
283    2.506              0            -1583;
284    2.515              0            -1495;
285    2.523              0            -1375;
286    2.532              0            -1223;
287    2.541              0            -1034;
288    2.550              0             -804;
289    2.559              0             -536;
290    2.568              0             -238;
291    2.577              0               77;
292    2.585              0              382;
293    2.594              0              655;
294    2.603              0              898;
295    2.612              0             1121;
296    2.621              0             1313;
297    2.630              0             1454;
298    2.639              0             1550;
299    2.647              0             1618;
300    2.656              0             1654;
301    2.665              0             1647;
302    2.674              0             1594;
303    2.683              0             1509;
304    2.692              0             1394;
305    2.701              0             1242;
306    2.709              0             1054;
307    2.718              0              835;
308    2.727              0              583;
309    2.736              0              297;
310    2.745              0               -12;
311    2.754              0             -315;
312    2.763              0             -585;
313    2.771              0             -815;
314    2.780              0            -1019;
315    2.789              0            -1196;
316    2.798              0            -1332;
317    2.807              0            -1417;
318    2.816              0            -1459;
319    2.824              0            -1472;
320    2.833              0            -1458;
321    2.842              0            -1403;
322    2.851              0            -1307;
323    2.860              0            -1177;
324    2.869              0            -1014;
```

```
325    2.878              0            -813;
326    2.886              0            -572;
327    2.895              0            -295;
328    2.904              0               3;
329    2.913              0             295;
330    2.922              0             559;
331    2.931              0             791;
332    2.940              0            1003;
333    2.948              0            1187;
334    2.957              0            1324;
335    2.966              0            1415;
336    2.975              0            1475;
337    2.984              0            1507;
338    2.993              0            1501;
339    3.002              0            1452;
340    3.010              0            1370;
341    3.019              0            1262;
342    3.028              0            1117;
343    3.037              0             935;
344    3.046              0             719;
345    3.055              0             474;
346    3.064              0             196;
347    3.072              0             -98;
348    3.081              0            -380;
349    3.090              0            -626;
350    3.099              0            -835;
351    3.108              0           -1016;
352    3.117              0           -1166;
353    3.126              0           -1273;
354    3.134              0           -1329;
355    3.143              0           -1346;
356    3.152              0           -1334;
357    3.161              0           -1288;
358    3.170              0           -1201;
359    3.179              0           -1072;
360    3.188              0            -906;
361    3.196              0            -707;
362    3.205              0            -472;
363    3.214              0            -202;
364    3.223              0              86;
365    3.232              0             361;
366    3.241              0             604;
367    3.249              0             815;
368    3.258              0            1005;
369    3.267              0            1164;
370    3.276              0            1275;
371    3.285              0            1343;
372    3.294              0            1385;
373    3.303              0            1400;
374    3.311              0            1372;
375    3.320              0            1308;
376    3.329              0            1217;
377    3.338              0            1094;
378    3.347              0             932;
379    3.356              0             735;
```

```
380    3.365              0             507;
381    3.373              0             248;
382    3.382              0              -34;
383    3.391              0            -309;
384    3.400              0            -554;
385    3.409              0            -761;
386    3.418              0            -937;
387    3.427              0           -1085;
388    3.435              0           -1190;
389    3.444              0           -1246;
390    3.453              0           -1259;
391    3.462              0           -1239;
392    3.471              0           -1186;
393    3.480              0           -1093;
394    3.489              0            -956;
395    3.497              0            -781;
396    3.506              0            -574;
397    3.515              0            -332;
398    3.524              0             -60;
399    3.533              0             217;
400    3.542              0             469;
401    3.551              0             688;
402    3.559              0             879;
403    3.568              0            1047;
404    3.577              0            1174;
405    3.586              0            1253;
406    3.595              0            1297;
407    3.604              0            1317;
408    3.613              0            1306;
409    3.621              0            1252;
410    3.630              0            1168;
411    3.639              0            1055;
412    3.648              0             908;
413    3.657              0             721;
414    3.666              0             499;
415    3.674              0             249;
416    3.683              0             -21;
417    3.692              0            -290;
418    3.701              0            -530;
419    3.710              0            -733;
420    3.719              0            -904;
421    3.728              0           -1044;
422    3.736              0           -1143;
423    3.745              0           -1194;
424    3.754              0           -1202;
425    3.763              0           -1174;
426    3.772              0           -1113;
427    3.781              0           -1012;
428    3.790              0            -868;
429    3.798              0            -685;
430    3.807              0            -471;
431    3.816              0            -223;
432    3.825              0              46;
433    3.834              0             310;
434    3.843              0             544;
```

```
   435    3.852                0             744;
   436    3.860                0             920;
   437    3.869                0            1066;
   438    3.878                0            1166;
   439    3.887                0            1222;
   440    3.896                0            1248;
   441    3.905                0            1249;
   442    3.914                0            1210;
   443    3.922                0            1133;
   444    3.931                0            1026;
   445    3.940                0             888;
   446    3.949                0             712;
   447    3.958                0             497;
   448    3.967                0             252;
   449    3.976                0             -10;
   450    3.984                0            -271];
time = data(:,2);
y = data(:,4);
u = data(:,3);
zf = iddata(y,u,0.00884);
tfd2 = tfest(zf,2,0)
```

raw_data_cl_step2

```
% Sample   Time     Commanded Pos   Encoder 1 Pos

data = [    0    0.000            1000               0;
     1    0.009            1000              25;
     2    0.018            1000              87;
     3    0.027            1000             172;
     4    0.035            1000             281;
     5    0.044            1000             423;
     6    0.053            1000             606;
     7    0.062            1000             804;
     8    0.071            1000             989;
     9    0.080            1000            1158;
    10    0.089            1000            1299;
    11    0.097            1000            1408;
    12    0.106            1000            1483;
    13    0.115            1000            1513;
    14    0.124            1000            1503;
    15    0.133            1000            1460;
    16    0.142            1000            1381;
    17    0.151            1000            1270;
    18    0.159            1000            1143;
    19    0.168            1000            1015;
    20    0.177            1000             897;
    21    0.186            1000             802;
    22    0.195            1000             736;
    23    0.204            1000             703;
    24    0.213            1000             701;
    25    0.221            1000             732;
```

```
26    0.230           1000            789;
27    0.239           1000            864;
28    0.248           1000            946;
29    0.257           1000           1025;
30    0.266           1000           1093;
31    0.274           1000           1144;
32    0.283           1000           1174;
33    0.292           1000           1182;
34    0.301           1000           1171;
35    0.310           1000           1141;
36    0.319           1000           1098;
37    0.328           1000           1049;
38    0.336           1000            998;
39    0.345           1000            952;
40    0.354           1000            916;
41    0.363           1000            892;
42    0.372           1000            882;
43    0.381           1000            884;
44    0.390           1000            900;
45    0.398           1000            925;
46    0.407           1000            955;
47    0.416           1000            987;
48    0.425           1000           1016;
49    0.434           1000           1040;
50    0.443           1000           1057;
51    0.452           1000           1066;
52    0.460           1000           1067;
53    0.469           1000           1058;
54    0.478           1000           1044;
55    0.487           1000           1026;
56    0.496           1000           1007;
57    0.505           1000            988;
58    0.514           1000            972;
59    0.522           1000            961;
60    0.531           1000            955;
61    0.540           1000            953;
62    0.549           1000            957;
63    0.558           1000            965;
64    0.567           1000            975;
65    0.576           1000            987;
66    0.584           1000            999;
67    0.593           1000           1009;
68    0.602           1000           1016;
69    0.611           1000           1021;
70    0.620           1000           1022;
71    0.629           1000           1022;
72    0.638           1000           1016;
73    0.646           1000           1010;
74    0.655           1000           1003;
75    0.664           1000            996;
76    0.673           1000            990;
77    0.682           1000            986;
78    0.691           1000            983;
79    0.699           1000            981;
80    0.708           1000            981;
```

81	0.717	1000	984;
82	0.726	1000	987;
83	0.735	1000	991;
84	0.744	1000	995;
85	0.753	1000	999;
86	0.761	1000	1002;
87	0.770	1000	1004;
88	0.779	1000	1005;
89	0.788	1000	1005;
90	0.797	1000	1005;
91	0.806	1000	1003;
92	0.815	1000	1001;
93	0.823	1000	998;
94	0.832	1000	996;
95	0.841	1000	994;
96	0.850	1000	993;
97	0.859	1000	992;
98	0.868	1000	991;
99	0.877	1000	991;
100	0.885	1000	993;
101	0.894	1000	993;
102	0.903	1000	995;
103	0.912	1000	996;
104	0.921	1000	997;
105	0.930	1000	998;
106	0.939	1000	999;
107	0.947	1000	999;
108	0.956	1000	999;
109	0.965	1000	999;
110	0.974	1000	999;
111	0.983	1000	999;
112	0.992	1000	998;
113	1.001	1000	998;
114	1.009	1000	998;
115	1.018	1000	997;
116	1.027	1000	996;
117	1.036	1000	996;
118	1.045	1000	996;
119	1.054	1000	996;
120	1.063	1000	996;
121	1.071	1000	996;
122	1.080	1000	996;
123	1.089	1000	996;
124	1.098	1000	996;
125	1.107	1000	996;
126	1.116	1000	996;
127	1.124	1000	996;
128	1.133	1000	996;
129	1.142	1000	996;
130	1.151	1000	996;
131	1.160	1000	996;
132	1.169	1000	996;
133	1.178	1000	996;
134	1.186	1000	996;
135	1.195	1000	996;

```
136    1.204          1000           996;
137    1.213          1000           996;
138    1.222          1000           996;
139    1.231          1000           996;
140    1.240          1000           996;
141    1.248          1000           996;
142    1.257          1000           996;
143    1.266          1000           996;
144    1.275          1000           996;
145    1.284          1000           996;
146    1.293          1000           996;
147    1.302          1000           996;
148    1.310          1000           996;
149    1.319          1000           996;
150    1.328          1000           996;
151    1.337          1000           996;
152    1.346          1000           996;
153    1.355          1000           996;
154    1.364          1000           996;
155    1.372          1000           996;
156    1.381          1000           996;
157    1.390          1000           996;
158    1.399          1000           996;
159    1.408          1000           996;
160    1.417          1000           996;
161    1.426          1000           996;
162    1.434          1000           996;
163    1.443          1000           996;
164    1.452          1000           996;
165    1.461          1000           996;
166    1.470          1000           996;
167    1.479          1000           996;
168    1.488          1000           996;
169    1.496          1000           996;
170    1.505          1000           996;
171    1.514          1000           996;
172    1.523          1000           996;
173    1.532          1000           996;
174    1.541          1000           996;
175    1.549          1000           996;
176    1.558          1000           996;
177    1.567          1000           996;
178    1.576          1000           996;
179    1.585          1000           996;
180    1.594          1000           996;
181    1.603          1000           996;
182    1.611          1000           996;
183    1.620          1000           996;
184    1.629          1000           996;
185    1.638          1000           996;
186    1.647          1000           996;
187    1.656          1000           996;
188    1.665          1000           996;
189    1.673          1000           996;
190    1.682          1000           996;
```

```
191    1.691          1000           996;
192    1.700          1000           996;
193    1.709          1000           996;
194    1.718          1000           996;
195    1.727          1000           996;
196    1.735          1000           996;
197    1.744          1000           996;
198    1.753          1000           996;
199    1.762          1000           996;
200    1.771          1000           996;
201    1.780          1000           996;
202    1.789          1000           996;
203    1.797          1000           996;
204    1.806          1000           996;
205    1.815          1000           996;
206    1.824          1000           996;
207    1.833          1000           996;
208    1.842          1000           996;
209    1.851          1000           996;
210    1.859          1000           996;
211    1.868          1000           996;
212    1.877          1000           996;
213    1.886          1000           996;
214    1.895          1000           996;
215    1.904          1000           996;
216    1.913          1000           996;
217    1.921          1000           996;
218    1.930          1000           996;
219    1.939          1000           996;
220    1.948          1000           996;
221    1.957          1000           996;
222    1.966          1000           996;
223    1.974          1000           996;
224    1.983          1000           996;
225    1.992          1000           996;
226    2.001             0           996;
227    2.010             0           969;
228    2.019             0           891;
229    2.028             0           790;
230    2.036             0           663;
231    2.045             0           494;
232    2.054             0           290;
233    2.063             0            87;
234    2.072             0           -97;
235    2.081             0          -257;
236    2.090             0          -384;
237    2.098             0          -479;
238    2.107             0          -535;
239    2.116             0          -546;
240    2.125             0          -513;
241    2.134             0          -443;
242    2.143             0          -341;
243    2.152             0          -214;
244    2.160             0           -77;
245    2.169             0            58;
```

```
246    2.178              0             176;
247    2.187              0             267;
248    2.196              0             329;
249    2.205              0             361;
250    2.214              0             359;
251    2.222              0             321;
252    2.231              0             260;
253    2.240              0             180;
254    2.249              0              90;
255    2.258              0              -1;
256    2.267              0             -81;
257    2.276              0            -143;
258    2.284              0            -186;
259    2.293              0            -205;
260    2.302              0            -203;
261    2.311              0            -177;
262    2.320              0            -135;
263    2.329              0             -82;
264    2.338              0             -25;
265    2.346              0              30;
266    2.355              0              77;
267    2.364              0             113;
268    2.373              0             135;
269    2.382              0             143;
270    2.391              0             138;
271    2.399              0             119;
272    2.408              0              92;
273    2.417              0              58;
274    2.426              0              22;
275    2.435              0             -12;
276    2.444              0             -41;
277    2.453              0             -63;
278    2.461              0             -75;
279    2.470              0             -79;
280    2.479              0             -74;
281    2.488              0             -60;
282    2.497              0             -41;
283    2.506              0             -19;
284    2.515              0               3;
285    2.523              0              23;
286    2.532              0              39;
287    2.541              0              51;
288    2.550              0              56;
289    2.559              0              57;
290    2.568              0              51;
291    2.577              0              42;
292    2.585              0              29;
293    2.594              0              15;
294    2.603              0               2;
295    2.612              0              -9;
296    2.621              0             -18;
297    2.630              0             -24;
298    2.639              0             -26;
299    2.647              0             -26;
300    2.656              0             -21;
```

301	2.665	0	-14;
302	2.674	0	-6;
303	2.683	0	2;
304	2.692	0	10;
305	2.701	0	16;
306	2.709	0	20;
307	2.718	0	23;
308	2.727	0	23;
309	2.736	0	22;
310	2.745	0	19;
311	2.754	0	14;
312	2.763	0	9;
313	2.771	0	5;
314	2.780	0	1;
315	2.789	0	-2;
316	2.798	0	-4;
317	2.807	0	-4;
318	2.816	0	-4;
319	2.824	0	-4;
320	2.833	0	-2;
321	2.842	0	1;
322	2.851	0	3;
323	2.860	0	6;
324	2.869	0	8;
325	2.878	0	9;
326	2.886	0	10;
327	2.895	0	10;
328	2.904	0	10;
329	2.913	0	10;
330	2.922	0	9;
331	2.931	0	7;
332	2.940	0	6;
333	2.948	0	5;
334	2.957	0	4;
335	2.966	0	4;
336	2.975	0	4;
337	2.984	0	4;
338	2.993	0	4;
339	3.002	0	4;
340	3.010	0	4;
341	3.019	0	6;
342	3.028	0	6;
343	3.037	0	6;
344	3.046	0	6;
345	3.055	0	6;
346	3.064	0	6;
347	3.072	0	6;
348	3.081	0	6;
349	3.090	0	6;
350	3.099	0	6;
351	3.108	0	6;
352	3.117	0	6;
353	3.126	0	6;
354	3.134	0	6;
355	3.143	0	6;

356 3.152 0 6;
357 3.161 0 6;
358 3.170 0 6;
359 3.179 0 6;
360 3.188 0 6;
361 3.196 0 6;
362 3.205 0 6;
363 3.214 0 6;
364 3.223 0 6;
365 3.232 0 6;
366 3.241 0 6;
367 3.249 0 6;
368 3.258 0 6;
369 3.267 0 6;
370 3.276 0 6;
371 3.285 0 6;
372 3.294 0 6;
373 3.303 0 6;
374 3.311 0 6;
375 3.320 0 6;
376 3.329 0 6;
377 3.338 0 6;
378 3.347 0 6;
379 3.356 0 6;
380 3.365 0 6;
381 3.373 0 6;
382 3.382 0 6;
383 3.391 0 6;
384 3.400 0 6;
385 3.409 0 6;
386 3.418 0 6;
387 3.427 0 6;
388 3.435 0 6;
389 3.444 0 6;
390 3.453 0 6;
391 3.462 0 6;
392 3.471 0 6;
393 3.480 0 6;
394 3.489 0 6;
395 3.497 0 6;
396 3.506 0 6;
397 3.515 0 6;
398 3.524 0 6;
399 3.533 0 6;
400 3.542 0 6;
401 3.551 0 6;
402 3.559 0 6;
403 3.568 0 6;
404 3.577 0 6;
405 3.586 0 6;
406 3.595 0 6;
407 3.604 0 6;
408 3.613 0 6;
409 3.621 0 6;
410 3.630 0 6;

```
   411    3.639               0               6;
   412    3.648               0               6;
   413    3.657               0               6;
   414    3.666               0               6;
   415    3.674               0               6;
   416    3.683               0               6;
   417    3.692               0               6;
   418    3.701               0               6;
   419    3.710               0               6;
   420    3.719               0               6;
   421    3.728               0               6;
   422    3.736               0               6;
   423    3.745               0               6;
   424    3.754               0               6;
   425    3.763               0               6;
   426    3.772               0               6;
   427    3.781               0               6;
   428    3.790               0               6;
   429    3.798               0               6;
   430    3.807               0               6;
   431    3.816               0               6;
   432    3.825               0               6;
   433    3.834               0               6;
   434    3.843               0               6;
   435    3.852               0               6;
   436    3.860               0               6;
   437    3.869               0               6;
   438    3.878               0               6;
   439    3.887               0               6;
   440    3.896               0               6;
   441    3.905               0               6;
   442    3.914               0               6;
   443    3.922               0               6;
   444    3.931               0               6;
   445    3.940               0               6;
   446    3.949               0               6;
   447    3.958               0               6;
   448    3.967               0               6;
   449    3.976               0               6;
   450    3.984               0               6];
time = data(:,2);
y = data(:,4);
u = data(:,3);
zf = iddata(y,u,0.00884);
tfd2 = tfest(zf,2,0)
```