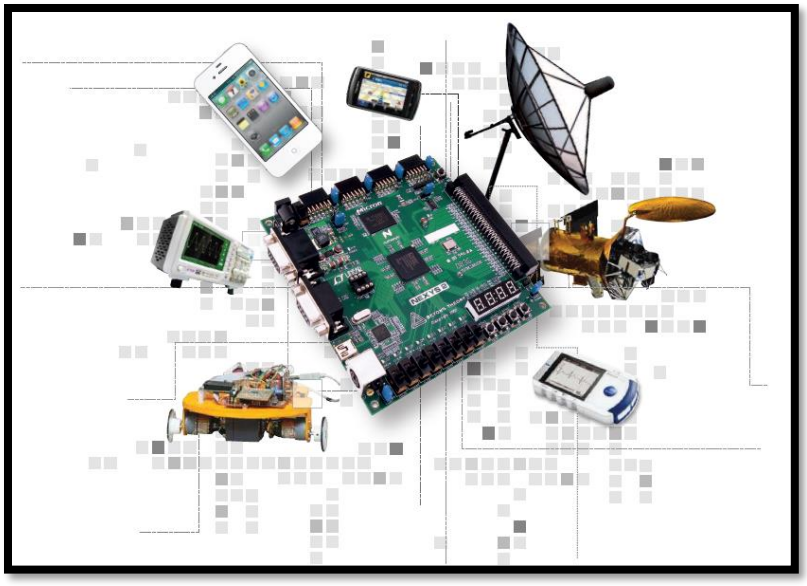
21-4-2024

Tarea 9

Sistemas embebidos



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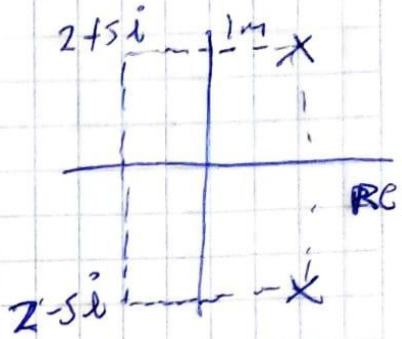
Controlador PID

Controlador PID

$$\frac{Y(s)}{U(s)} = \frac{14.5}{(s^2-4s+29)}$$

$b = 14.5$
$a_1 = -4$
$a_2 = 29$

$s = 2+5i$
$s = 2-5i$



$s = -2+5i$
$s = -2-5i$
$s = -5$

$$(s^2+4s+29)(s+5) =$$

$$s^3+4s^2+29s+5s^2+20s+145 =$$

$$s^3+9s^2+49s+145$$
$$am_1 \quad am_2 \quad am_3$$

$$Kd = \frac{9-(-4)}{14.5} = 0.896$$

$$Kp = \frac{49-29}{14.5} = 1.379$$

$$Ki = \frac{145}{14.5} = 10$$

Código en C++

```c
#include <stdio.h>
#include <math.h>

main(){
    //TIEMPO DE SIMULACION
    double tfin=10;
    double h=0.01;

    //PASO DE INTEGRACION
    int n=tfin/h;

    //DECLARACION DE VECTORES
    double y[n], u[n], t[n];

    //PARAMETROS DE LA PLANTA
    double b0=0, b1=14.5, a1=-4, a2=29;

    //PARAMETROS DEL CONTROLADOR

    double kd=0.896, kp=1.379, ki=10;
    double I=0, e, e_1=0, ref=1;

    printf( format: "t \t\t y(t) \n\n");

    for(int i=0; i<n; i++){
        //VECTOR DE TIEMPO
        t[i]=i*h;

        //CONTROLADOR PID
        e=ref-y[i];
        u[i]=kp*e+ki*I+kd*(e-e_1)/h;
        I=I+h*e;
        e_1=e;

        //PLANTA O SISTEMA A CONTROLAR
        y[i+1]=2*y[i]-y[i-1]-a1*h*(y[i]-y[i-1])-a2*pow( x: h, y: 2)*y[i-1]+b0*h*(u[i]-u[i-1])+b1*pow( x: h, y: 2)*u[i-1];

        printf( format: "%f \t\t %0.16f\n", t[i] ,y[i]);
    }
}
```

Salida en C++

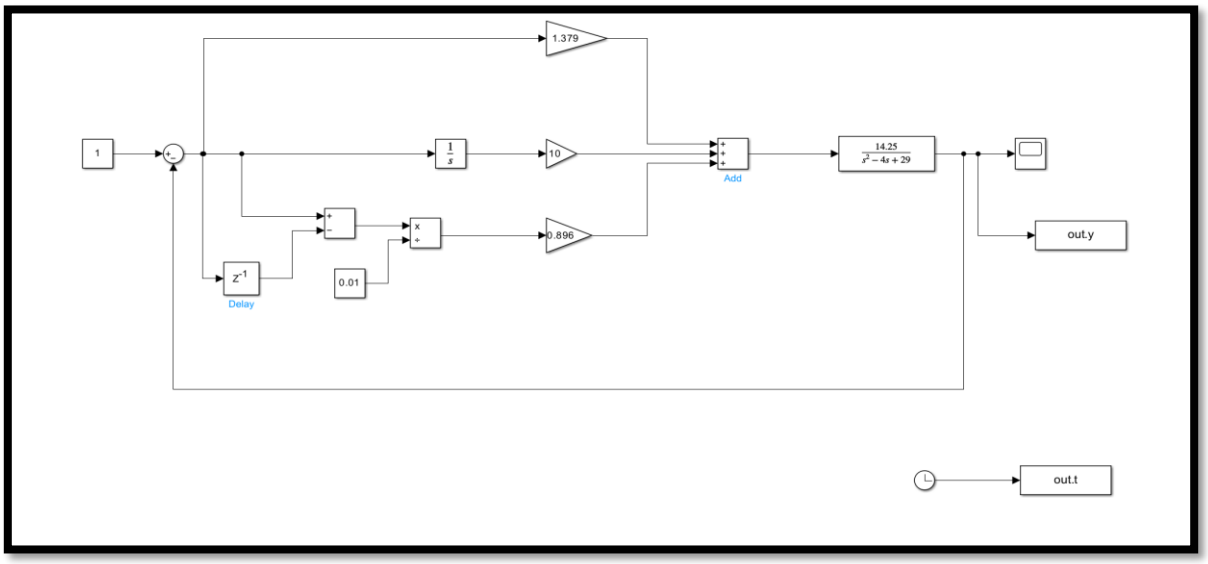
```
"C:\Users\Nacho Andrade\Desktop\IELC\7mo_semestre\Sistemas embebidos\CONTROLADOR_PID_2.exe"
t               y(t)

0.000000                0.0000000000000000
0.010000                -0.0000000000000000
0.020000                0.1319195500000000
0.030000                0.2712604320000000
0.040000                0.4006791649127975
0.050000                0.5182578473683114
0.060000                0.6242835366421766
0.070000                0.7193431912500002
0.080000                0.8040495091255503
0.090000                0.8790017933798010
0.100000                0.9447806605736792
0.110000                1.0019475984297079
0.120000                1.0510451980100570
0.130000                1.0925974621771171
0.140000                1.1271101073973366
0.150000                1.1550708499401252
0.160000                1.1769496779290549
0.170000                1.1931991119561249
0.180000                1.2042544569167837
0.190000                1.2105340474941124
0.200000                1.2124394894776507
0.210000                1.2103558988688630
0.220000                1.2046521405042045
0.230000                1.1956810677182286
0.240000                1.1837797643728845
```

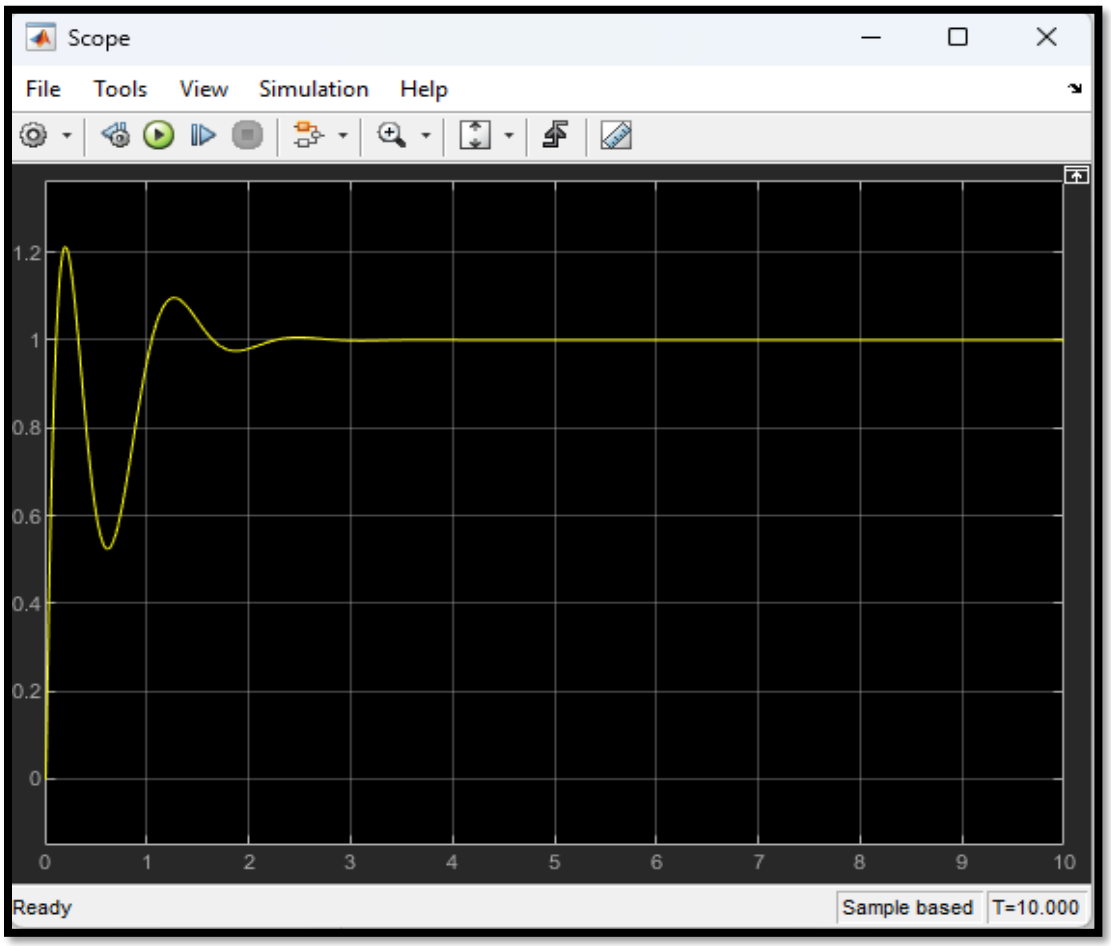
```
9.750000                0.9999999999920173
9.760000                1.0000000000115656
9.770000                1.0000000000302049
9.780000                1.0000000000479199
9.790000                1.0000000000646985
9.800000                1.0000000000805322
9.810000                1.0000000000954157
9.820000                1.0000000001093468
9.830000                1.0000000001223264
9.840000                1.0000000001343579
9.850000                1.0000000001454474
9.860000                1.0000000001556042
9.870000                1.0000000001648393
9.880000                1.0000000001731661
9.890000                1.0000000001806004
9.900000                1.0000000001871596
9.910000                1.0000000001928633
9.920000                1.0000000001977323
9.930000                1.0000000002017895
9.940000                1.0000000002050591
9.950000                1.0000000002075664
9.960000                1.0000000002093381
9.970000                1.0000000002104017
9.980000                1.0000000002107856
9.990000                1.0000000002105192

Process finished with exit code 0
```

Diagrama de simulink



Grafica saliente



Salida en Matlab

```
>> disp([out.t,out.y]);
                   0                   0
   0.010000000000000                   0
   0.020000000000000   0.129645075000000
   0.030000000000000   0.266583528000000
   0.040000000000000   0.394065777930744
   0.050000000000000   0.510240167899007
   0.060000000000000   0.615346052654348
   0.070000000000000   0.709905628054631
   0.080000000000000   0.794468711235038
   0.090000000000000   0.869576769046434
   0.100000000000000   0.935757885306790
   0.110000000000000   0.993526081867472
   0.120000000000000   1.043381243053952
   0.130000000000000   1.085809116930975
   0.140000000000000   1.121281321797767
   0.150000000000000   1.150255350321953
   0.160000000000000   1.173174572532800
   0.170000000000000   1.190468239923018
   0.180000000000000   1.202551492847453
   0.190000000000000   1.209825373201507
   0.200000000000000   1.212676844145444
   0.210000000000000   1.211478818431452
   0.220000000000000   1.206590196691015
   0.230000000000000   1.198355916851018
   0.240000000000000   1.187107015667922
   0.250000000000000   1.173160703200121
   0.260000000000000   1.156820450879084
   0.270000000000000   1.138376093689910
   0.280000000000000   1.118103946831189
   0.290000000000000   1.096266937092505
```

```
 9.720000000000001   1.000000000303956
 9.730000000000000   1.000000000316824
 9.740000000000000   1.000000000328143
 9.750000000000000   1.000000000337946
 9.760000000000000   1.000000000346272
 9.770000000000000   1.000000000353159
 9.779999999999999   1.000000000358650
 9.790000000000001   1.000000000362790
 9.800000000000001   1.000000000365626
 9.810000000000000   1.000000000367208
 9.820000000000000   1.000000000367585
 9.830000000000000   1.000000000366811
 9.840000000000000   1.000000000364939
 9.850000000000000   1.000000000362024
 9.859999999999999   1.000000000358120
 9.870000000000001   1.000000000353283
 9.880000000000001   1.000000000347571
 9.890000000000001   1.000000000341038
 9.900000000000000   1.000000000333743
 9.910000000000000   1.000000000325741
 9.920000000000000   1.000000000317088
 9.930000000000000   1.000000000307840
 9.940000000000000   1.000000000298052
 9.950000000000001   1.000000000287778
 9.960000000000001   1.000000000277071
 9.970000000000001   1.000000000265984
 9.980000000000000   1.000000000254567
 9.990000000000000   1.000000000242872
10.000000000000000   1.000000000230944
```