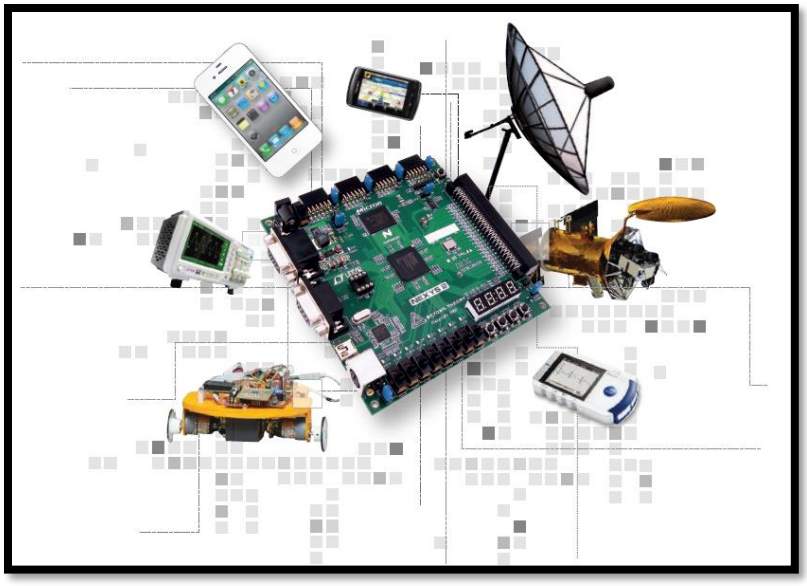
26-2-2024

Tarea 5

Sistemas embebidos



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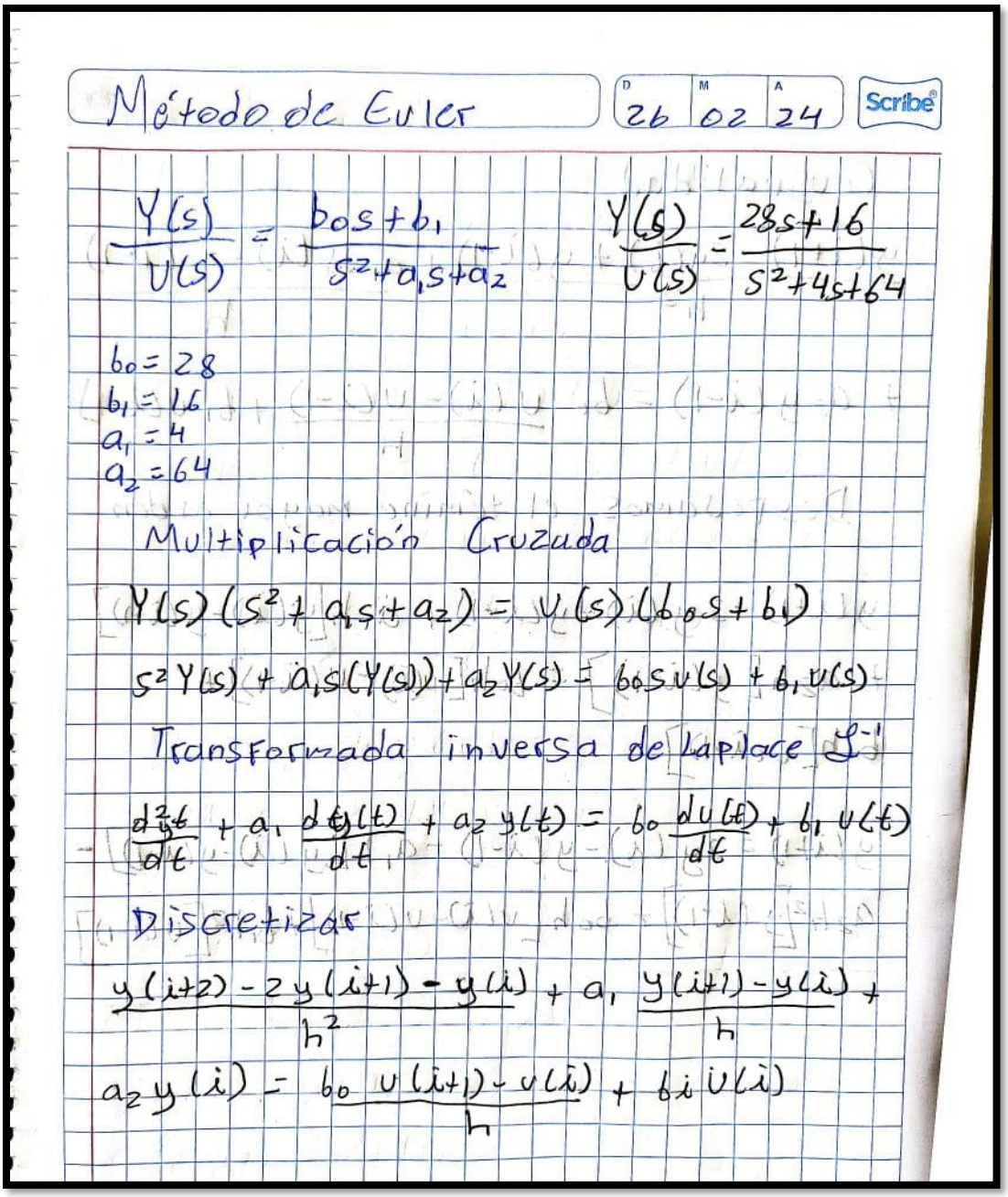
Procedimiento



Método de Euler

D 26 M 02 A 24

$$\frac{Y(s)}{U(s)} = \frac{b_0 s + b_1}{s^2 + a_1 s + a_2} \qquad \frac{Y(s)}{U(s)} = \frac{28s + 16}{s^2 + 4s + 64}$$

$b_0 = 28$
$b_1 = 16$
$a_1 = 4$
$a_2 = 64$

Multiplicación Cruzada

$$Y(s)(s^2 + a_1 s + a_2) = U(s)(b_0 s + b_1)$$

$$s^2 Y(s) + a_1 s(Y(s)) + a_2 Y(s) = b_0 s U(s) + b_1 U(s)$$

Transformada inversa de Laplace $\mathcal{L}^{-1}$

$$\frac{d^2 y(t)}{dt} + a_1 \frac{dy(t)}{dt} + a_2 y(t) = b_0 \frac{du(t)}{dt} + b_1 u(t)$$

Discretizar

$$\frac{y(i+2) - 2y(i+1) - y(i)}{h^2} + a_1 \frac{y(i+1) - y(i)}{h} +$$

$$a_2 y(i) = b_0 \frac{u(i+1) - u(i)}{h} + b_i u(i)$$

Causualidad

$$\frac{y(i+1) - 2y(i) + y(i-1)}{h^2} + a_1 \frac{y(i) - y(i-1)}{h}$$

$$+ a_2 y(i-1) = b_0 \frac{u(i) - u(i-1)}{h} + b_1 u(i-1)$$

Despesamos el témino mayor orden

$$y(i+1) - 2y(i) + y(i-1) + a_1 h[y(i) - y(i-1)]$$

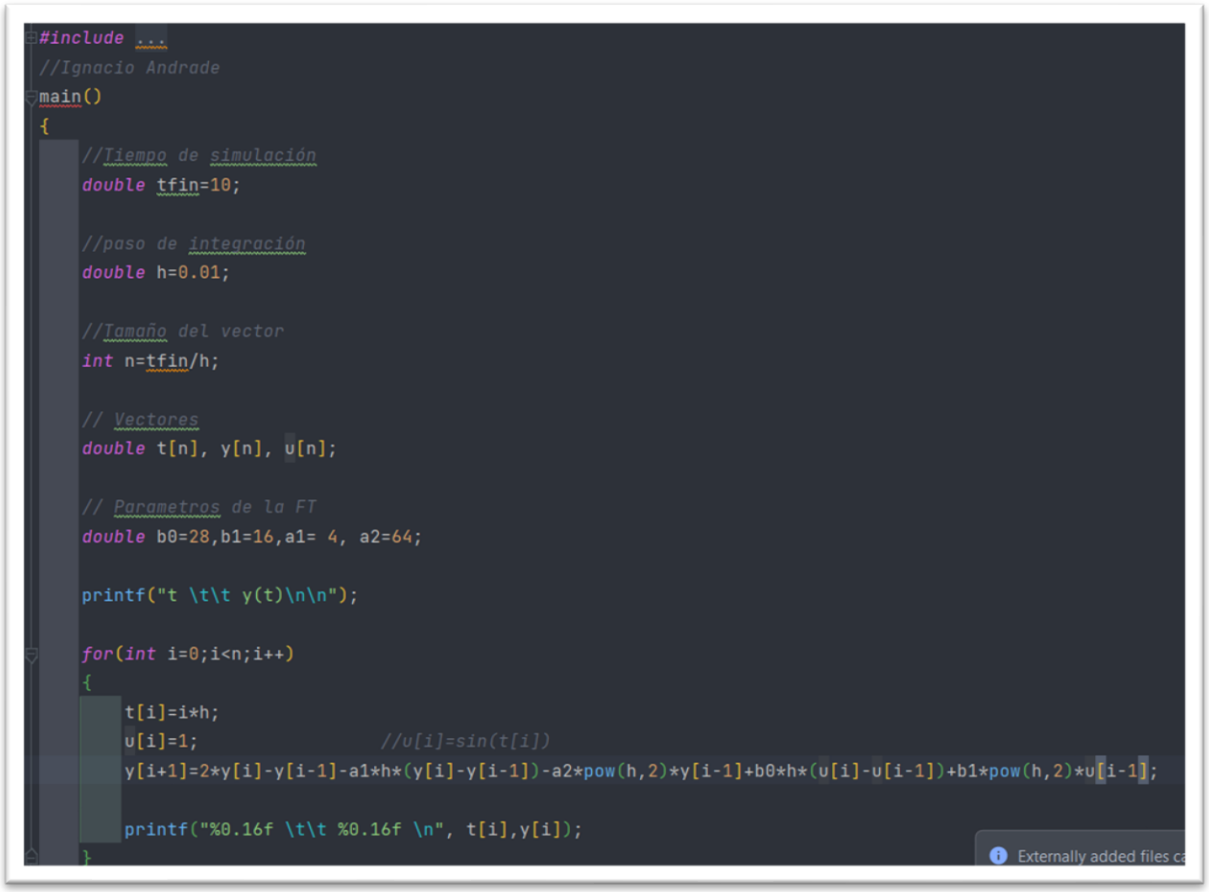
$$+ a_2 h[y(i-1)] = b_0 h[u(i) - u(i-1)] +$$

$$b_1 h[u(i-1)]$$

$$y(i+1) = 2y(i) - y(i-1) - a_1 h[y(i) - y(i-1)] -$$

$$a_2 h^2[y(i-1)] + b_0 h[u(i) - u(i-1)] + b_1 h^2[u(i-1)]$$

Código en C



```c
#include ...
//Ignacio Andrade
main()
{
    //Tiempo de simulación
    double tfin=10;

    //paso de integración
    double h=0.01;

    //Tamaño del vector
    int n=tfin/h;

    // Vectores
    double t[n], y[n], u[n];

    // Parametros de la FT
    double b0=28,b1=16,a1= 4, a2=64;

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

    for(int i=0;i<n;i++)
    {
        t[i]=i*h;
        u[i]=1;                 //u[i]=sin(t[i])
        y[i+1]=2*y[i]-y[i-1]-a1*h*(y[i]-y[i-1])-a2*pow(h,2)*y[i-1]+b0*h*(u[i]-u[i-1])+b1*pow(h,2)*u[i-1];

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

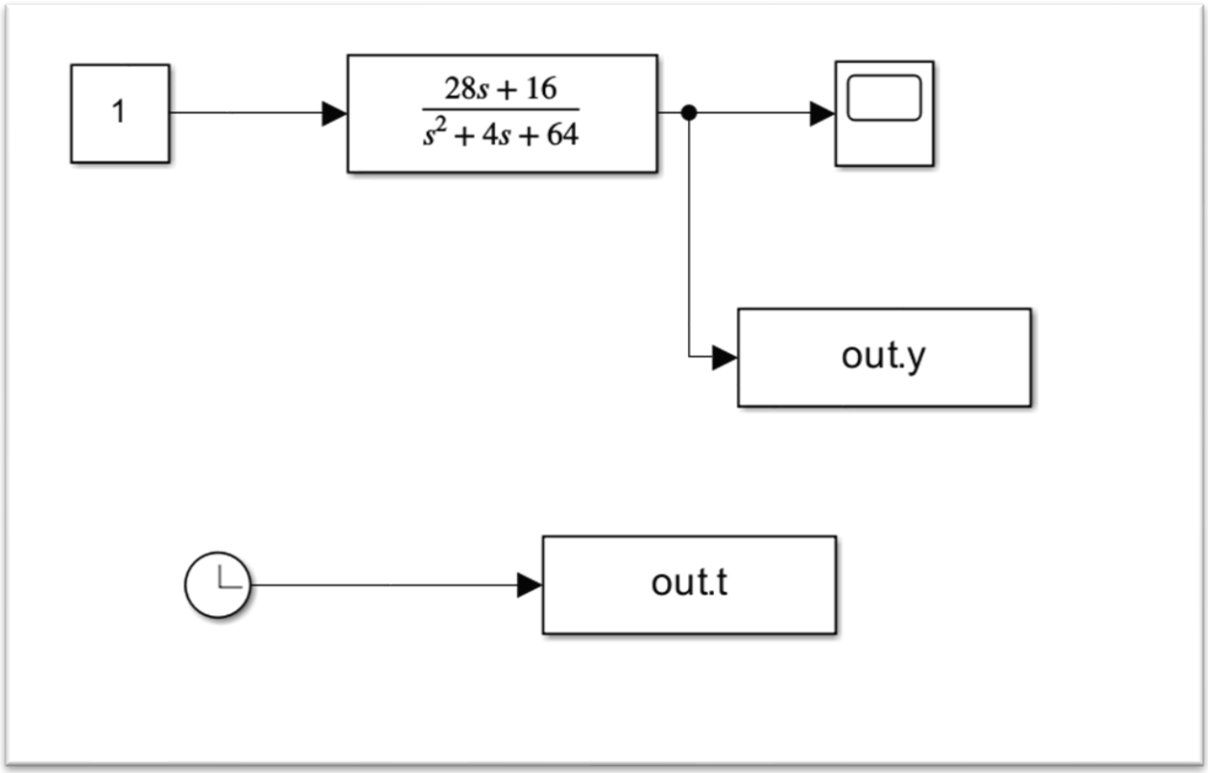
Externally added files ca

Resultados en C

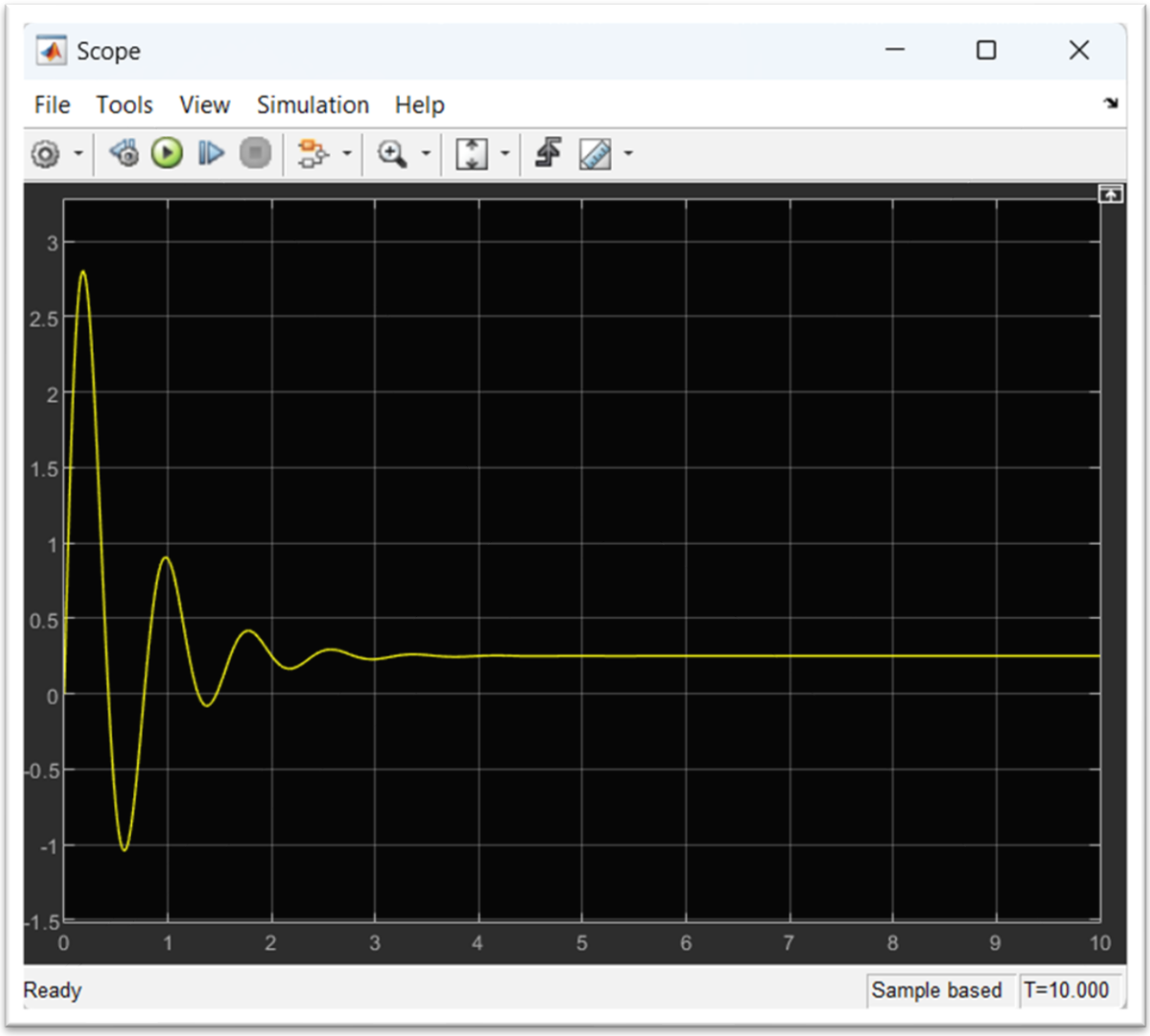
```
"C:\Users\Nacho Andrade\Desktop\Ingeniería en electrónic
t               y(t)

0.0000000000000000              0.0000000000000000
0.0100000000000000              0.2800000000000000
0.0200000000000000              0.5504000000000001
0.0300000000000000              0.8097920000000002
0.0400000000000000              1.0568857600000003
0.0500000000000000              1.2905131008000004
0.0600000000000000              1.5096312791040003
0.0700000000000000              1.7133254464307202
0.0800000000000000              1.9008102068781056
0.0900000000000000              2.0714302940504390
0.1000000000000000              2.2246603924118591
0.1100000000000000              2.3601041329568995
0.1200000000000000              2.4774922973687024
0.1300000000000000              2.5766802687531087
0.1400000000000000              2.6576447705789792
0.1500000000000000              2.7204799386117946
0.1600000000000000              2.7653927733915920
0.1700000000000000              2.7926980231730818
0.1800000000000000              2.8028125492136056
0.1900000000000000              2.7962492268642003
0.2000000000000000              2.7736104370938039
0.2100000000000000              2.7355812038622926
0.2200000000000000              2.6829220331626411
```

```
0.4200000000000000                0.0750723626459987
0.4300000000000000                -0.0552385538390632
0.4400000000000000                -0.1792174967856570
0.4500000000000000                -0.2962837552698171
0.4600000000000000                -0.4059203714351826
0.4700000000000000                -0.5076753069202067
0.4800000000000000                -0.6011621546086445
0.4900000000000000                -0.6860604064252556
0.5000000000000000                -0.7621152903797067
0.5100000000000000                -0.8291371923748581
0.5200000000000000                -0.8870006804317732
0.5300000000000000                -0.9356431509352126
0.5400000000000000                -0.9750631182637509
0.5500000000000000                -1.0053181707331622
0.5600000000000001                -1.0265226171469091
0.5700000000000001                -1.0388448494114138
0.5800000000000000                -1.0425044476355980
0.5900000000000000                -1.0377690548945819
0.6000000000000000                -1.0249510493983387
0.6100000000000000                -1.0044040421706200
0.6200000000000000                -0.9765192285158606
0.6300000000000000                -0.9417216215373996
0.6400000000000000                -0.9004661957755755
0.6500000000000000                -0.8532339686663850
0.6600000000000000                -0.8005280469885984
0.6700000000000000                -0.7428696647784583
```

Diagrama a bloques Simulink



Gráfica en Simulink



Resultados en Matlab

```
>> disp([out.t, out.y]);
                   0                   0
   0.010000000000000   0.280000000000000
   0.020000000000000   0.550400000000000
   0.030000000000000   0.809792000000000
   0.040000000000000   1.056885760000000
   0.050000000000000   1.290513100800000
   0.060000000000000   1.509631279104000
   0.070000000000000   1.713325446430720
   0.080000000000000   1.900810206878106
   0.090000000000000   2.071430294050439
   0.100000000000000   2.224660392411860
   0.110000000000000   2.360104132956900
   0.120000000000000   2.477492297368704
   0.130000000000000   2.576680268753111
   0.140000000000000   2.657644770578982
   0.150000000000000   2.720479938611798
   0.160000000000000   2.765392773391596
   0.170000000000000   2.792698023173086
   0.180000000000000   2.802812549213611
   0.190000000000000   2.796249226864207
   0.200000000000000   2.773610437093812
   0.210000000000000   2.735581203862302
   0.220000000000000   2.682922033162652
   0.230000000000000   2.616461509586269
   0.240000000000000   2.537088705940701
   0.250000000000000   2.445745460779603
   0.260000000000000   2.343418577706928
   0.270000000000000   2.231131999008172
   0.280000000000000   2.109939004560041
```

0.410000000000000	0.211072417865519
0.420000000000000	0.075072362646015
0.430000000000000	-0.055238553839048
0.440000000000000	-0.179217496785643
0.450000000000000	-0.296283755269804
0.460000000000000	-0.405920371435170
0.470000000000000	-0.507675306920195
0.480000000000000	-0.601162154608635
0.490000000000000	-0.686060406425247
0.500000000000000	-0.762115290379699
0.510000000000000	-0.829137192374852
0.520000000000000	-0.887000680431769
0.530000000000000	-0.935643150935210
0.540000000000000	-0.975063118263750
0.550000000000000	-1.005318170733163
0.560000000000000	-1.026522617146911
0.570000000000000	-1.038844849411417
0.580000000000000	-1.042504447635603
0.590000000000000	-1.037769054894588
0.600000000000000	-1.024951049398346
0.610000000000000	-1.004404042170629
0.620000000000000	-0.976519228515870
0.630000000000000	-0.941721621537410
0.640000000000000	-0.900466195775587
0.650000000000000	-0.853233968666398
0.660000000000000	-0.800528046988612
0.670000000000000	-0.742869664778472
0.680000000000000	-0.680794238356011
0.690000000000000	-0.614847463135867
0.700000000000000	-0.545581475799049