ESCUELA POLITECNICA NACIONAL

FACULTAD DE INGENIERIA ELECTRICA

" SISTEMAS DE CONTROL DE ESTRUCTURA VARIABLE Y SU APLICACIÓN A DRIVERS PARA DISCOS MAGNETICOS "

TESIS PREVIA A LA OBTENCION DEL TITULO DE INGENIERO

EN ELECTRONICA Y CONTROL

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QUITO, JULIO, 1999

ANEXOS

DESCRIPCION BASICA DE LAS RUTINAS IMPLEMENTADAS

Las principales rutinas implementadas para el desarrollo de este programa se presentan a continuación :

Rutina para desplegar la pantalla principal del archivo ***dskdemo***

```
function dskdemo(operation);
global fig_dsk dsk_col dsk_color

if nargin == 0,
    operation = 'show';
end;

if strcmp(operation,'show'),
    [existFlag,figNumber]=figflag('Modelos de Sistemas de Control para
Discos Duros!');
    if ~existFlag,
        dskdemo('winit_dsk');
        dskdemo('init_dsk');
        [existFlag,figNumber]=figflag('Modelos de Sistemas de Control para
Discos Duros');
    else
        clf;
        dskdemo('init_dsk');
    end;
elseif strcmp(operation,'dsk_i1'),
  ttlStr='Info...';
  hlpStr1= ...
    ['                                    '];
   hlpStr2= ...
    ['                                    '];

   helpwin(ttlStr,hlpStr1,hlpStr2);

elseif strcmp(operation,'winit_dsk'),
fig_dsk = figure('Name', 'CONTROL DE ESTRUCTURA VARIABLE
    APLICADA A DRIVERS DE DISCOS MAGNETICOS', ...
    'Units', 'Normalized', ...
    'Position', [0.2561 0.4400 0.4861 0.4667 ],...
    'NumberTitle', 'Off', 'BackingStore', 'Off');

    if strcmp(computer,'pcwin'),
```

```
        set(fig_dsk,'Color',[1 1 1]);
    else
        set(fig_dsk,'Color',[0.8 0.8 0.8]);
    end;

elseif strcmp(operation,'init_dsk'),

    watchon;
    int1_axes = axes('position',[0.06 0.026 0.4 0.3],'Visible','off');
    dsk_col = 1;
    cla reset;
    xxx=[0.2487,0.5563,0.5685,0.2701,0.2518]-0.05;
    yyy=[0.4433,0.556,0.5316,0.4037,0.4433];
    fill(xxx,yyy,'w');
    hold on
    dskwheel(.5,.64,.168);
    xxxx=[0.2487,0.5563,0.5685,0.2701,0.2518]-0.05;
    yyyy=[0.5633,0.676,0.6516,0.5237,0.5633];
    fill(xxxx,yyyy,'w');
    dskwheel(.5,.76,.168);
    xx=[0.2487,0.5563,0.5685,0.2701,0.2518]-0.05;
    yy=[0.6833,0.796,0.7716,0.6437,0.6833];
    fill(xx,yy,'w');
    hold on
    x1=0.2209;
    y1=0.785;
    dskwheel(x1,y1,0.06);
    hold on
    x5=0.2209;
    y5=0.725;
    dskwheel(x5,y5,0.06);
    hold on
    dskwheel(.5,.88,.168);
    x=[0.2487,0.5563,0.5685,0.2701,0.2518]-0.05;
    y=[0.8033,0.916,0.8916,0.7637,0.8033];
    fill(x,y,'w');
    hold on
    x2=0.2209;
    y2=0.665;
    dskwheel(x2,y2,0.06);
    hold on
    x4=0.2209;
    y4=0.425;
    dskwheel(x4,y4,0.06);
    hold on
    x3=0.2209;
    y3=0.545;
    dskwheel(x3,y3,0.06);
```

```
    hold on
    x6=0.2209;
    y6=0.605;
    dskwheel(x6,y6,0.06);
    hold on
    x7=0.2209;
    y7=0.485;
    dskwheel(x7,y7,0.06);
    hold on
    x8=0.2209;
    y8=0.695;
    dskwheel(x3,y3,0.06);
    hold on
    x9=0.2209;
    y9=0.635;
    dskwheel(x6,y6,0.06);
    hold on
    x10=0.2209;
    y10=0.575;
    dskwheel(x7,y7,0.06);
    hold on
    x11=0.2209;
    y11=0.515;
    dskwheel(x6,y6,0.06);
    hold on
    x12=0.2209;
    y12=0.455;
    dskwheel(x7,y7,0.06);
    title('UNIDAD DE DISCO
    DURO','FontName','algerian','Fontsize',14,'Color',[0.9 0.2 0.2]);
    set(gca,'XTick',[],'YTick',[],'box','on','Ylim',[0 1.5],'Xlim',[0.062 .76]);

%---------- FRAME ----------------------------------------

frame_middle = uicontrol(fig_dsk,'Style','Frame',...
  'Units','normalized','Position',[0.032 0.41 0.46 0.9524]);

label_dsk = uicontrol(fig_dsk,'Style','text',...
  'String','ESCUELA POLITECNICA NACIONAL',...
  'Units','normalized',...
  'Position',[0.035 0.862 0.44 0.072],...
  'FontName','Algerian',...
  'Fontsize',14);

label_dsk = uicontrol(fig_dsk,'Style','text',...
  'String','FACULTAD DE INGENIERIA ELECTRICA',...
  'Units','normalized',...
  'Position',[0.04 0.802 0.44 0.072],...
```

```
  'FontName','Algerian',...
  'Fontsize',14);

label_dsk = uicontrol(fig_dsk,'Style','text',...
  'String','DEPARTAMENTO DE ELECTRONICA Y',...
  'Units','normalized',...
  'Position',[0.035 0.742 0.44 0.072],...
  'FontName','Algerian',...
  'Fontsize',14);

label_dsk = uicontrol(fig_dsk,'Style','text',...
  'String','CONTROL',...
  'Units','normalized',...
  'Position',[0.035 0.702 0.44 0.072],...
  'FontName','Algerian',...
  'Fontsize',14);
label_dsk = uicontrol(fig_dsk,'Style','text',...
  'String','' SISTEMAS DE CONTROL DE',...
  'Units','normalized',...
  'Position',[0.035 0.642 0.44 0.062],...
  'FontName','algerian',...
  'Fontsize',14);

label_dsk = uicontrol(fig_dsk,'Style','text',...
  'String','ESTRUCTURA VARIABLE Y SU',...
  'Units','normalized',...
  'Position',[0.035 0.602 0.44 0.066],...
  'FontName','algerian',...
  'Fontsize',14);

label_dsk = uicontrol(fig_dsk,'Style','text',...
  'String','APLICACION A DRIVERS PARA',...
  'Units','normalized',...
  'Position',[0.035 0.562 0.44 0.066],...
  'FontName','algerian',...
  'Fontsize',14);

label_dsk = uicontrol(fig_dsk,'Style','text',...
  'String','DISCOS MAGNETICOS '',...
  'Units','normalized',...
  'Position',[0.035 0.522 0.44 0.066],...
  'FontName','algerian',...
  'Fontsize',14);

label_dsk = uicontrol(fig_dsk,'Style','text',...
  'String','NOEMI ELIZABETH JARA',...
  'Units','normalized',...
  'Position',[0.035 0.462 0.42 0.07],...
```

```
  'FontName','Algerian',...
  'Fontsize',14);

label_dsk = uicontrol(fig_dsk,'Style','text',...
  'String','MAYO DE 1999',...
  'Units','normalized',...
  'Position',[0.035 0.4151 0.42 0.07],...
  'FontName','Algerian',...
  'Fontsize',14);
%%-------------- FRAME ----------------------------------------
frame_m = uicontrol(fig_dsk,'Style','Frame',...
  'Units','normalized','Position',[0.51 0.0214 0.46 0.72]);

dsk_text =
text(1.08,4.3,'DSKDEMO','FontName','algerian','Fontsize',30,'Color',[0.9 0.2
0.2]);
dsk_info1 = uicontrol(fig_dsk,'Style','push',...
    'Position', [0.53 0.0599 0.21 0.058], 'Units', 'Normalized', ...
    'BackgroundColor',[0.77 0.77 0.77],...
    'String','Info');
    set(dsk_info1,'CallBack','dskdemo("dsk_i1");');

dsk_close = uicontrol(fig_dsk,'Style','push',...
    'Position', [0.741 0.0599 0.21 0.058], 'Units', 'Normalized', ...
    'BackgroundColor',[1 0.4 0.4],...
    'String','Quit');
    set(dsk_close,'CallBack','dskdemo("close_dsk_def");');

periodo_button = uicontrol(fig_dsk,'Style','push',...
    'Position', [0.53 0.6399 0.42 0.058], 'Units', 'Normalized', ...
    'BackgroundColor',[0.3 0.8 0.3],...
    'String','Variación de Período del Sistema');
  set(periodo_button,'CallBack','dskdemo("close_dsk");, periodo');

seeking_button = uicontrol(fig_dsk,'Style','push',...
    'Position', [0.53 0.5819 0.42 0.058], 'Units', 'Normalized', ...
    'BackgroundColor',[0.3 0.8 0.3],...
    'String','Compensación del Modo de Búsqueda');
    set(seeking_button,'CallBack','dskdemo("close_dsk");, seeking');

settl_button = uicontrol(fig_dsk,'Style','push',...
    'Position', [0.53 0.5239 0.42 0.058], 'Units', 'Normalized', ...
    'BackgroundColor',[0.4 0.82 0.4],...
    'String','Compensación del Modo de Posicionamiento');
    set(settl_button,'CallBack','dskdemo("close_dsk");, settl');

following_button = uicontrol(fig_dsk,'Style','push',...
    'Position', [0.53 0.4659 0.42 0.058], 'Units', 'Normalized', ...
```

```
    'BackgroundColor',[0.5 0.84 0.5],...
    'String','Compensación del Modo de Seguimiento');
    set(following_button,'CallBack','dskdemo("close_dsk");, following');

swichsc_button = uicontrol(fig_dsk,'Style','push',...
    'Position', [0.53 0.4079 0.42 0.058], 'Units', 'Normalized', ...
    'BackgroundColor',[0.6 0.86 0.6],...
    'String','Cambio Búsqueda-Seguimiento con Condición Inicial');
    set(swichsc_button,'CallBack','dskdemo("close_dsk");, swichsc');

swichcc_button = uicontrol(fig_dsk,'Style','push',...
    'Position', [0.53 0.3499 0.42 0.058], 'Units', 'Normalized', ...
    'BackgroundColor',[0.8 0.9 0.8],...
    'String','Cambio Búsqueda-Seguimientos compensado con Jmin ');
    set(swichcc_button,...
    'CallBack','dskdemo("close_dsk");, swichcc');

swich3_button = uicontrol(fig_dsk,'Style','push',...
    'Position', [0.53 0.2919 0.42 0.058], 'Units', 'Normalized', ...
    'BackgroundColor',[0.85 0.92 0.85],...
    'String','3 Modos de Cambio con Condición Inicial');
    set(swich3_button,'CallBack','dskdemo("close_dsk");, swich3');

swich4_button = uicontrol(fig_dsk,'Style','push',...
    'Position', [0.53 0.2339 0.42 0.058], 'Units', 'Normalized', ...
    'BackgroundColor',[0.3 0.8 0.3],...
    'String','3 Modos de Cambio Compensado con Jmin');
    set(swich4_button,'CallBack','dskdemo("close_dsk");, swich4');

swcpc_button = uicontrol(fig_dsk,'Style','push',...
    'Position', [0.53 0.1759 0.42 0.058], 'Units', 'Normalized', ...
    'BackgroundColor',[0.4 0.82 0.4],...
    'String','3 Modos de Cambio Compensado con Cancelación P-Z ');
    set(swcpc_button,'CallBack',...
    'dskdemo("close_dsk");, swcpc');

compm_button = uicontrol(fig_dsk,'Style','push',...
    'Position', [0.53 0.1179 0.42 0.058], 'Units', 'Normalized', ...
    'BackgroundColor',[0.4 0.82 0.4],...
    'String','Comparación de los Métodos Analizados');
    set(compm_button,'CallBack',...
    'dskdemo("close_dsk");, compm');
watchoff;

elseif strcmp(operation, 'close_dsk'),
    [existFlag,figNumber]=figflag('Modelos de Sistemas de Control para
Discos Duros!');
```

```
    if existFlag,
        set(fig_dsk,'Visible','off');
    end;

    [existFlag,figNumber]=figflag('Modelos de Sistemas de Control para
Discos Duros');
    if existFlag,
        close;
    end;

elseif strcmp(operation, 'close_dsk_def'),
    [existFlag,figNumber]=figflag('Modelos de Sistemas de Control para
Discos Duros!');
    if existFlag,
        close(fig_dsk);
    end;

    [existFlag,figNumber]=figflag('Ayuda para modelos de sistemas de control
para discos duros');
    if existFlag,
        close;
    end;
end;
```

La rutina implementada para la variación del período del sistema es la siguiente:

```
function periodo(operation);

global fig_peri dsk_col fig_dsk fig_val_peri
global cont_axes_peri disc_axes_peri erase_peri
global polec_handle zeroc_handle
global poled_handle zerod_handle poled_handle1 poled_handle2
global polec_handle1 polec_handle2
global A B C D ac ac0 bc bc0 ad ad0 bd bd0 ad1 ad2
global x y
global sli_h_peri h_min_peri h_max h_cur_peri h_label_peri
global ex1 ex2 motor
global system_peri error_peri help_peri

if nargin == 0,
    operation = 'show';
end;

if strcmp(operation,'show'),
  [existFlag,figNumber]=figflag('Periodo del sistema');
   if ~existFlag,
    periodo('winit');
```

```
    periodo('init');
      [existFlag,figNumber]=figflag('Periodo del sistema');
   else
    clf;
    periodo('init');
   end;


%%---------- SISTEMA 1---------------------------------
%%-----------------------------------------------------

elseif strcmp(operation,'system_peri1'),
    watchon;
    set(error_peri,'Visible','off');
    bc = 1;
    ac = [0.012 0.004 10];
    bc0 = bc;
    ac0 = ac;
    subplot(224);
    t=0:.1:6.3;
    plot(sin(t),cos(t),'k-');
    subplot(222);
    cla;
    y=-35:1:35;
    plot(zeros(length(y)),y,'k');
    if dsk_col == 1,
        polec_handle = plot(real(roots(ac)),imag(roots(ac)),'rx');
     set(polec_handle,'Linewidth',2);
        zeroc_handle = plot(real(roots(bc)),imag(roots(bc)),'ro');
     set(zeroc_handle,'Linewidth',2);

    else
        polec_handle = plot(real(roots(ac)),imag(roots(ac)),'kx');
     set(polec_handle,'Linewidth',2);
        zeroc_handle = plot(real(roots(bc)),imag(roots(bc)),'ko');
     set(zeroc_handle,'Linewidth',2);
    end;

    [A,B,C,D] = tf2ss(bc,ac);

    set(sli_h_peri,'Val',0.05);
    h = get(sli_h_peri,'Val');
    set(h_cur_peri,'String',num2str(get(sli_h_peri,'Val')));

    [Phi,Gamma] = c2d(A,B,h);
    [bd,ad] = ss2tf(Phi,Gamma,C,D,1);
    bd0 = bd;
    ad0 = ad;
```

```
    subplot(224);

    set(poled_handle, 'XData', real(roots(ad)), ...
        'YData', imag(roots(ad)));
    set(zerod_handle, 'XData', real(roots(bd)), ...
        'YData', imag(roots(bd)));

    set(polec_handle,'ButtonDownFcn','periodo("move_pole")');
    set(zeroc_handle,'ButtonDownFcn','periodo("move_zero")');
    set(sli_h_peri,'CallBack','periodo("move_sli_h_peri")');
    watchoff;


%%---------- MOVIMIENTO DE POLOS ----------

elseif strcmp(operation,'moving_poles'),
    currpoint = get(cont_axes_peri, 'CurrentPoint');
    x = currpoint(1,1);
    y = currpoint(1,2);
        set(polec_handle, 'XData', [x x], 'YData', [y -y]);
     ac = [1 -2*x x^2+y^2];
     [A,B,C,D] = tf2ss(bc,ac);

    h = get(sli_h_peri,'Val');

    [Phi,Gamma] = c2d(A,B,h);
    [bd,ad] = ss2tf(Phi,Gamma,C,D,1);

    set(poled_handle, 'XData', real(roots(ad)), ...
        'YData', imag(roots(ad)));
    set(zerod_handle, 'XData', real(roots(bd)), ...
        'YData', imag(roots(bd)));

elseif strcmp(operation,'moved_poles'),
    set(fig_peri, 'WindowButtonMotionFcn', '', ...
                  'WindowButtonUpFcn', '');

elseif strcmp(operation,'move_pole'),
    set(fig_peri, 'WindowButtonMotionFcn', ...
    'periodo("moving_poles");', ...
            'WindowButtonUpFcn', ...
      'periodo("moved_poles");');


%%---------- MOVIMIENTO POLOS----------

elseif strcmp(operation,'move1'),
    set(fig_peri, 'WindowButtonMotionFcn', ...
```

```
    'periodo("moving_poles1");',...
            'WindowButtonUpFcn', ...
    'periodo("moved_poles1");');

elseif strcmp(operation,'moving_poles1'),
    currpoint = get(cont_axes_peri, 'CurrentPoint');
    x = currpoint(1,1);
    set(polec_handle1, 'XData',x, 'YData',0);
    x2 = get(polec_handle2,'XData');
    y2 = get(polec_handle2,'YData');
    ac1 = [1 -x];
    ac2 = [1 -2*x2(1) x2(1)^2+y2(1)^2];
    ac = conv(ac1,ac2);
    [A,B,C,D] = tf2ss(bc,ac);
    h = get(sli_h_peri,'Val');

    [Phi,Gamma] = c2d(A,B,h);
    [bd,ad] = ss2tf(Phi,Gamma,C,D,1);

    set(poled_handle, 'XData', real(roots(ad)), ...
        'YData', imag(roots(ad)));
    set(zerod_handle, 'XData', real(roots(bd)), ...
        'YData', imag(roots(bd)));

elseif strcmp(operation,'moved_poles1'),

    set(fig_peri, 'WindowButtonMotionFcn', ...
        '', ...
                'WindowButtonUpFcn', ...
        '');


%%---------- MOVIMIENTO DE POLOS----------

elseif strcmp(operation,'move2'),
    set(fig_peri, 'WindowButtonMotionFcn', ...
    'periodo("moving_poles2");', ...
            'WindowButtonUpFcn', ...
      'periodo("moved_poles2");');

elseif strcmp(operation,'moving_poles2'),
    currpoint = get(cont_axes_peri, 'CurrentPoint');
    x = currpoint(1,1);
    y = currpoint(1,2);
    set(polec_handle2, 'XData', [x x], 'YData', [y -y]);

    x1 = get(polec_handle1,'XData');
    ac1 = [1 -x1];
```

```
    ac2 = [1 -2*x x^2+y^2];
    ac = conv(ac1,ac2);
    [A,B,C,D] = tf2ss(bc,ac);
    h = get(sli_h_peri,'Val');

    [Phi,Gamma] = c2d(A,B,h);
    [bd,ad] = ss2tf(Phi,Gamma,C,D,1);

    set(poled_handle, 'XData', real(roots(ad)), ...
        'YData', imag(roots(ad)));
    set(zerod_handle, 'XData', real(roots(bd)), ...
        'YData', imag(roots(bd)));

elseif strcmp(operation,'moved_poles2'),

    set(fig_peri, 'WindowButtonMotionFcn', ...
        '', ...
                'WindowButtonUpFcn', ...
        '');

%%---------- MOVIMIENTO DE CEROS ----------------------------------
%%-----------------------------------------------------------

elseif strcmp(operation,'move_zero'),
    set(fig_peri, 'WindowButtonMotionFcn', ...
    'periodo("moving_zeros");', ...
            'WindowButtonUpFcn', ...
      'periodo("moved_zeros");');

elseif strcmp(operation,'moving_zeros'),
    currpoint = get(cont_axes_peri, 'CurrentPoint');
    x = currpoint(1,1);
    y = currpoint(1,2);
    set(zeroc_handle, 'XData',x, 'YData',0);

    set(zeroc_handle, 'XData',x, 'YData',0);
    bc = [1 -x];
    [A,B,C,D] = tf2ss(bc,ac);

    h = get(sli_h_peri,'Val');
    [Phi,Gamma] = c2d(A,B,h);
    [bd,ad] = ss2tf(Phi,Gamma,C,D,1);

    set(poled_handle, 'XData', real(roots(ad)), ...
        'YData', imag(roots(ad)));
    set(zerod_handle, 'XData', real(roots(bd)), ...
        'YData', imag(roots(bd)));
```

```
elseif strcmp(operation,'moved_zeros'),

    set(fig_peri, 'WindowButtonMotionFcn', ...
        '', ...
                'WindowButtonUpFcn', ...          '');
%%---------GRAFICAS ----------
%%-----------------------------------------------------

elseif strcmp(operation,'recalc');
    watchon;
    if get(system_peri,'Value') ==2
        subplot(224);
        cla;
        t=0:.1:6.3;
        plot(sin(t),cos(t),'k-');
        if dsk_col == 1,
            p = plot(real(roots(ad)),imag(roots(ad)),'rx');
            set(p,'Linewidth',2);
            z = plot(real(roots(bd)),imag(roots(bd)),'ro');
            set(z,'Linewidth',2);
        else
            p = plot(real(roots(ad)),imag(roots(ad)),'kx');
            set(p,'Linewidth',2);
            z = plot(real(roots(bd)),imag(roots(bd)),'ko');
            set(z,'Linewidth',2);
        end;

    end;
    watchoff;



%%------------------- SLIDER -----------------------------
%%------------------------------------------------------

elseif strcmp(operation,'move_sli_h_peri'),

    set(h_cur_peri,'String',num2str(get(sli_h_peri,'Val')));
    h = get(sli_h_peri,'Val');

    [Phi,Gamma] = c2d(A,B,h);
    [bd,ad] = ss2tf(Phi,Gamma,C,D,1);

    set(poled_handle, 'XData', real(roots(ad)), ...
        'YData', imag(roots(ad)));
    set(zerod_handle, 'XData', real(roots(bd)), ...
        'YData', imag(roots(bd)));
```

```
elseif strcmp(operation,'popup'),

    set(error_peri,'Visible','off');

    if get(system_peri,'value')==1
        subplot(222);cla;
        subplot(224);cla;t=0:.1:6.3;plot(sin(t),cos(t),'k-');
        set(sli_h_peri,'CallBack','periodo("wrong");');
        if dsk_col == 1,
            poled_handle = plot(NaN, NaN, 'rx');
       set(poled_handle, 'LineWidth', 2);
            zerod_handle = plot(NaN, NaN, 'ro');
       set(zerod_handle, 'LineWidth', 2);
        else
            poled_handle = plot(NaN, NaN, 'kx');
       set(poled_handle, 'LineWidth', 2);
            zerod_handle = plot(NaN, NaN, 'ko');
       set(zerod_handle, 'LineWidth', 2);
        end;
        set(erase_peri,'Value',1);

    elseif get(system_peri,'value')==2,
        periodo('system_peri1');
    end;
%%------------ BORRAR--------------------------------
%%-----------------------------------------------------

elseif strcmp(operation,'popup_erase'),

    if get(erase_peri,'value')==1
        subplot(224);
        cla;
        t=0:.1:6.3;
        plot(sin(t),cos(t),'k-');
        if dsk_col == 1,
            poled_handle =...
             plot(real(roots(ad)), imag(roots(ad)), 'rx');
     set(poled_handle, 'LineWidth', 2);
            zerod_handle =...
             plot(real(roots(bd)), imag(roots(bd)), 'ro');
     set(zerod_handle, 'LineWidth', 2);
       else
            poled_handle =...
             plot(real(roots(ad)), imag(roots(ad)), 'kx');
     set(poled_handle, 'LineWidth', 2);
            zerod_handle =...
             plot(real(roots(bd)), imag(roots(bd)), 'ko');
    set(zerod_handle, 'LineWidth', 2);
```

```
        end;

    elseif get(erase_peri,'value')==2,
     set(poled_handle);
     set(zerod_handle);
    end;

elseif strcmp(operation,'wrong'),

    set(error_peri,'Visible','on');


%%------------------Ayuda --------------------------------
%%--------------------------------------------------------

elseif strcmp(operation,'help_peri'),
  ttlStr='Sampling help...';
   hlpStr1= ...
      ['                    '];

  hlpStr2= ...
       ['                              '];

   helpwin(ttlStr,hlpStr1,hlpStr2);


%%------------------ Teoria ------------------------------
%%--------------------------------------------------------

elseif strcmp(operation,'theory_peri'),
  ttlStr='Sampling theory...';
   hlpStr= ...
      ['               '];

   helpwin(ttlStr,hlpStr);



%%------------------ VALORES -----------------------------
%%--------------------------------------------------------

elseif strcmp(operation,'values_peri'),

        [existFlag,figNumber]=figflag('Values');
    if ~existFlag,
        fig_val_peri = figure('Name','Values','NumberTitle'...
        ,'Off','BackingStore','Off',...
        'Units','Normalized',...
```

```
    'Position',[0.05 0.05 0.3 0.3]);
    [existFlag,figNumber]=figflag('Values');

else
    clf;
  end;

figure(fig_val_peri);
  axes('Visible','off');
  close_val = uicontrol(fig_val_peri,'Style','Push','String','close',...
  'Units','normalized','Position',[0.8 0.03 0.17 0.07],...
  'Callback','close;');

if get(system_peri,'Value')~=1,

    text(0.01,0.95,...
    'Continuous time system:','Color','g');
    text(0.01,0.55,...
    'Discrete time system:','Color','g');
    ac2_str = num2str(ac(2));
    ac3_str = num2str(ac(3));
    ad2_str = num2str(ad(2));
    ad3_str = num2str(ad(3));
    bd2_str = num2str(bd(2));
    bd3_str = num2str(bd(3));
    if get(system_peri','Value')==2,
        text(0.01,0.85,'B(s)= 1');
        text(0.01,0.75,'A(s)=[1');
        text(0.23,0.75,ac2_str);
        text(0.48,0.75,ac3_str);
        text(0.73,0.75,']');
        text(0.01,0.45,'B(q)= [');
        text(0.20,0.45,bd2_str);
        text(0.50,0.45,bd3_str);
        text(0.80,0.45,']');
        text(0.01,0.35,'A(q)=[1');
        text(0.23,0.35,ad2_str);
        text(0.48,0.35,ad3_str);
        text(0.73,0.35,']');
    end;

else
    text(0.2,0.5,'No system defined.',...
    'Color','g');
end;
```

```
%%---------------- INICIO ----------------------------------------
%%----------------------------------------------------------

elseif strcmp(operation,'winit'),

    fig_peri = figure('Name','Período del sistema','NumberTitle'...
    ,'Off','BackingStore','Off');
    if strcmp(computer,'pcwin'),
        set(fig_peri,'Color',[1 1 1]);
    else
        set(fig_peri,'Color',[0.8 0.8 0.8]);
    end;
elseif strcmp(operation,'init'),

    watchon;


%%------------------FRAME ----------------------------------

    frame_left = uicontrol(fig_peri,'Style','Frame',...
    'Units','normalized','Position',[0.0161 0.52 0.1786 0.44]);
    main_peri = uicontrol(fig_peri,'Style','Push',...
    'String','Menu Inicio',...
    'Units','normalized',...
    'Position',[0.0339 0.819 0.1429 0.0595],...
    'BackgroundColor',[0.6 0.6 1],...
    'Callback','periodo("close_dsk");');

    help_peri = uicontrol(fig_peri,'Style','Push','String','Ayuda',...
    'Units','normalized','Position',[0.0339 0.7295 0.1429 0.0595],...
    'BackgroundColor',[1 1 0.3],...
    'Callback','periodo("help_peri");');

    theory_peri = uicontrol(fig_peri,'Style','Push','String','Teoria',...
    'Units','normalized','Position',[0.0339 0.64 0.1429 0.0595],...
    'BackgroundColor',[1 1 0.5],...
    'Callback','periodo("theory_peri");');


    close_peri = uicontrol(fig_peri,'Style','Push','String','Quit',...
    'Units','normalized','Position',[0.0339 0.0690 0.1429 0.0595],...
    'BackgroundColor',[1 0.4 0.4],...
    'Callback','periodo("close_dsk_def");');


%%--------------- FRAME  ----------------------------------------

    frame_middle = uicontrol(fig_peri,'Style','Frame',...
```

```
'Units','normalized','Position',[0.2036 0.52 0.3214 0.44]);

system_peri = uicontrol(fig_peri,'Style','popup',...
'Units','normalized',...
'Position',[0.2304 0.819 0.2679 0.0595],'String',...
'Sistema|1/(s^2+a1s+a2)',...
'Callback','periodo("popup");');

frame_h = uicontrol(fig_peri,'Style','Frame',...
'Units','normalized','Position',[0.210 0.58 0.31 0.16]);

sli_h_peri = uicontrol(fig_peri,'Style','slider',...
'Units','normalized','Position',[0.27 0.61 0.2 0.048],...
'Min',0.001,'Max',1,...
'Value',1,'CallBack','periodo("wrong");');

h_cur_peri = uicontrol(fig_peri,'Style','text',...
'Units','normalized','Pos',[0.42 0.663 0.09 0.048],...
'String',num2str(get(sli_h_peri,'Val')));

h_min_peri = uicontrol(fig_peri,'Style','text',...
'Units','normalized','Position',[0.214 0.6 0.052 0.048],...
'String',num2str(get(sli_h_peri,'Min')));

h_max_peri = uicontrol(fig_peri,'Style','text',...
'Units','normalized','Position',[0.484 0.6 0.031 0.048],...
'String',num2str(get(sli_h_peri,'Max')));

h_label_peri = uicontrol(fig_peri,'Style','text',...
'Units','normalized','Position',[0.22 0.663 0.194 0.048],...
'String','Period.h=');

%%---------- DIAGRAMAS ----------

cont_axes_peri = subplot(222);
grid on;
hold on;
y=-35:1:35;
plot(zeros(length(y)),y,'k');
title('Sistema en Tiempo Continuo','Color','k',...
'FontName','New Century Schoolbook');
disc_axes_peri = subplot(224);
grid on;
hold on;
t=0:.1:6.3;
plot(sin(t),cos(t),'k-');
axis('equal');
title('Sistema en Tiempo Discreto','Color','k',...
```

```
    'FontName','New Century Schoolbook');
    set(cont_axes_peri,'XLim',[-0.3 0.2],'YLim',[-35 35],'Clipping'...
    ,'Off','XLimMode','Manual','YLimMode','Manual','DrawMode',...
    'Fast','Xcolor','k','Ycolor','k',...
    'FontName','New Century Schoolbook');
    set(disc_axes_peri,'XLim',[-1.05 1.5],'YLim',[-1.2 1.2],...
    'Clipping','Off','XLimMode','Manual','YLimMode'...
    ,'Manual','DrawMode', 'Fast','Xcolor','k','Ycolor','k',...
    'FontName','New Century Schoolbook');

    if dsk_col == 1,
        poled_handle = plot(NaN, NaN, 'rx');
     set(poled_handle, 'LineWidth', 2);
        zerod_handle = plot(NaN, NaN, 'ro');
     set(zerod_handle, 'LineWidth', 2);
    else
        poled_handle = plot(NaN, NaN, 'kx');
     set(poled_handle, 'LineWidth', 2);
        zerod_handle = plot(NaN, NaN, 'ko');
     set(zerod_handle, 'LineWidth', 2);
    end;



%%----------------MENSAJE DE ERROR ----------------------------

    error_peri = uicontrol(fig_peri,'Style','text',...
    'Units','normalized','Position',[0.23 0.20 0.27 0.1],'String',...
    'NO, select system first!',...
    'BackgroundColor','r');
    set(error_peri,'Visible','off');

    watchoff;


%%----------------- CLOSE ---------------------------
%%-------------------------------------------------

elseif strcmp(operation, 'close_dsk'),
    [existFlag,figNumber]=figflag('Modelos de Sistemas de Control para
Discos Duros!');
    if existFlag,
        set(fig_dsk,'Visible','off');
    end;
    [existFlag,figNumber]=figflag('Modelos de Sistemas de Control para
Discos Duros');
    if existFlag,
        close;
```

```
    end;

elseif strcmp(operation, 'close_dsk_def'),
    [existFlag,figNumber]=figflag('Modelos de Sistemas de Control para
Discos Duros!');
    if existFlag,
        close(fig_dsk);
    end;

    [existFlag,figNumber]=figflag('Ayuda para modelos de sistemas de control
para discos duros');
    if existFlag,
        close;
    end;
end;
```

Para el menú de las demás subpantallas la rutina implementada es similar y se presenta a continuación:

```
function slide=settl;

%========== Slide 1 ==========
if nargout<1,
 show1 settl
else
 %========== Slide 1 ==========
 slide(1).code={
    'cla reset;',
    'hold on',
    'z=cplxgrid(20);',
    'cplxmap(z,z);',
    'axis square',
    'hold on',
    'title("MODO DE
     POSICIONAMIENTO","FontName","algerian","Fontsize",18,"Color",[0.9
    0.3 0.3]);',
    'set(gca,"XTick",[],"YTick",[],"box","on","Ylim",[-1 1],"Xlim",[-1 1])'};

 slide(1).text={
    '',
    ' MEDIANTE ESTE PROGRAMA SE REALIZA EL ANALISIS Y
     COMPENSACION',
    ' PARA EL MODO DE POSICIONAMIENTO EN UNA
     DETERMINADA PISTA DE',
    ' UNA UNIDAD DE DISCO DURO, PARA LO CUAL SE DISEÑA
     UN CONTROL',
```

```
    ' QUE PERMITA OBTENER LA POSICION EXACTA DE LAS
     CABEZAS',
    ' DE LECTURA/ESCRITURA SOBRE LA PISTA REQUERIDA.'};

%========== Slide 2 ==========
slide(2).code={
    'cla reset;',
    'hold on',
    'z=cplxgrid(20);',
    'cplxmap(z,z);',
    'axis square',
    'hold on',
    'title("MODO DE
     POSICIONAMIENTO","FontName","algerian","Fontsize",18,"Color",[0.9
    0.3 0.3]);',
    'set(gca,"XTick",[],"YTick",[],"box","on","Ylim",[-1 1],"Xlim",[-1 1])'};

slide(2).text={
    ' AQUI SE PRESENTA EL MODELO MATEMATICO DE LA PLANTA
      ANALIZADA',
    ' LA PLANTA ES UN SISTEMA DE SEGUNDO ORDEN',
    ' Gp(s) = 1 / mS^2+bS+k',
    ' m = 12 g MASA,',
    ' b = 0.004 N-m/(rad/seg) CONSTANTE DE AMORTIGUAMIENTO,',
    ' k = 10 N-m/rad CONSTANTE DE RESORTE',
    ' >> m = 0.012; b = 0.004; k = 10;'};
 %========== Slide 3 ==========
 slide(3).code={
     ' cla reset;',
     ' m = 0.012; b = 0.004; k = 10; ts = 0.005;',
     ' nump = [1];'
     ' denp = [m b k];'
     ' ka=2; kf=2.8;',
     ' kt=conv(ka,kf);',
     ' numk=conv(nump,kt);',
     ' l=10e-6; n=1;',
     ' [num1,den1]=pade(l,n);'
     ' num=conv(numk,num1);'
     ' den=conv(denp,den1);'
     ' hp=tf(num,den);'
     ' hpd = c2d(hp,ts);',
     ' w = logspace(0,3);',
     ' cla reset',
     ' step(hpd);',
     '   title(" ");',
     ' drawnow'};
 slide(3).text={
    ' ARRIBA SE OBSERVA LA RESPUESTA A UNA ENTRADA
```

```
     PASO DEL',
    ' SISTEMA DISCRETO PARA EL RETARDO DE TRANSPORTE
     SE UTILIZA',
    ' LA APROXIMACION DE PADE DE PRIMER ORDEN,
     POSTERIORMENTE',
    ' SE REALIZA LA DISCRETIZACION DE LA PLANTA CON
     RETARDO',
    ' DE TRANSPORTE UTILIZANDO UN CONVERSOR A/D ESTO
     ES UN',
    ' (ZOH) CONECTADO A LA SALIDA',

    ' >> HPD = C2D( HP,ts );',
    ' >> STEP( HPD );                                    '};

 %========== Slide 4 ==========

slide(4).code={
    'ax = findobj(gcf,"Type","axes");'
    'axesPos = get(ax(end),"position");',
    'set(gca,"position",axesPos);',
    'zgrid("new"),',
    'pzmap(hpd);',
    'axis square',
    'drawnow'};

slide(4).text={
   'PARA UNA MEJOR COMPRENSION DEL COMPORTAMIENTO
    DEL SISTEMA',
    'SE UTILIZA EL METODO DE LUGAR GEOMETRIICO DE LAS
    RAICES',
    'DEL SISTEMA EN LAZO ABIERTO',
    ' >> PZMAP( HPD );                                   '};



 %========== Slide 5 ==========

 slide(5).code={
    'zgrid("new"),',
    'axis square',
    'rlocus(hpd);',
    'set(gca,"Xlim",[-1 1],"Ylim",[-1.5,1.5]);',
   'drawnow'};

slide(5).text={
    'EN LA GRAFICA ANTERIOR SE OBSERVO QUE LOS POLOS
     RAPIDAMENTE',
    'ABANDONAN EL CIRCULO UNITARIO SIENDO EL SISTEMA
```

```
     INESTABLE CON',
    'LO CUAL ES NECESARIO COLOCAR UN COMPENSADOR
    NOTCH Y UN',
    'FILTRO ADELANTO-RETARDO',
    'FILTRO NOTCH          D(z) = kd * [ z^2+az+b/z^2+cz+d ]     ',
    'FILTRO ADELANTO-RETARDO D1(z) = kd1 *
     (z+a1)*(z+b1)/(z+c1)*(z+d1)',
    ' >> RLOCUS( SYS );                          '};

%========== Slide 6 ==========

slide(6).code={
    'drawnow',
    'numct=conv(conv(1,[1 -1.97755485335692
    0.99833472145160]),conv([1 - 0.6237],[1 -0.98156]))',
    'denct=conv(conv([1 -0.998],[1 -0.6237]),conv([1 0.8409],[1 -1]))',
    ' hcd3=tf(numct,denct,0.005);',
    ' hd3=hpd*hcd3;' };

slide(6).text={
    ' CONECTAMOS EL COMPENSADOR EN SERIE CON LA
     PLANTA',
    '                                                ',
    '   >> HCD3 = TF( NUMCT,DENCT,0.005 )',
    '   >> HD3  = HPD*HCD3;',
    '                                                '};

%========== Slide 7 ==========

slide(7).code={
    'ax = findobj(gcf,"Type","axes");'
    'axesPos = get(ax(end),"position");',
    'set(gca,"position",axesPos);',
    'zgrid("new");',
    'axis square',
    'rlocus(hd3);',
    'set(gca,"Xlim",[-1 1],"Ylim",[-1.5,1.5]);',
    'drawnow'};

slide(7).text={
    'SE UTILIZA EL METODO DEL LUGAR GEOMETRICO DE LAS
     RAICES PARA',
    'EL SISTEMA COMPENSADO EN LAZO ABIERTO',
    ' >> PZMAP( HP3 );'};

%========== Slide 8 ==========

slide(8).code={
```

```
    'cla reset;',
    'sysc = feedback(hd3,1);',
    'step(sysc)',
    'drawnow' };

 slide(8).text={
    ' SE OBSERVA LA RESPUESTA PASO DE LA UNIDAD DE DISCO
      DURO',
    ' >> SYSC = FEEDBACK( HD3,1 );',
    ' >> STEP( SYSC );'};

end   % Fin del demo
```

La rutina para el *Modo de Seguimiento* utilizando el método de compensación de *Función de Mínimo Costo* se presenta a continuación y es similar para el *Modo de Búsqueda* y el *Modo de Posicionamiento*:

```
echo on
%*****************
    I = .012; C = 0.004; K = 10;
    nump = [1];
    denp = [I C K];
    printsys(nump,denp,'s');
    ka=2;
    kf=2.8;
    kt=conv(ka,kf)
    numk=conv(nump,kt)
    l=10e-4;
    n=1
    [num1,den1]=pade(l,n)
    num=conv(numk,num1)
    den=conv(denp,den1)
    hp=tf(num,den)
%******************
    ts =0.005
    hpd = c2d(hp,ts,'zoh')
    hpdlc=feedback(hpd,1)
    [nhpdlc,dhpdlc]=tfdata(hpdlc,ts)
    [numpd,denpd]=tfdata(hpd,ts)

%****************CONTROL DE SEGUIMIENTO**************
    numct=conv(conv(2,conv([1 -0.9603],[1 -0.5])),conv([1 -
    0.98877742667815+0.14371472416794*i],[1 -0.98877742667815-
    0.14371472416794*i]))
    denct=conv(conv([1 -1],[1 -0.5]),conv([1 -0.9603],[1 -0.76]))
```

```
    hcd3=tf(numct,denct,ts)
%**********************************
    h3=hcd3*hpd
    hlc3=feedback(h3,1)
    [nhlc3,dhlc3]=tfdata(hlc3,0.005)
%**********************************
    [ap,bp,cp,dp]=tf2ss(numpd,denpd)
    [ac,bc,cc,dc]=tf2ss(numct,denct)
    a=[ap-bp*dc*cp  bp*cc
    -bc*cp ac]
    r1=6e-6; r2=0; r3=0;
    r4=1; r5=0; r6=0
    qp=[r4 0 0
          0 r5 0
          0 0 r6]
    qc=[0 0 0 0
         0 0 0 0
         0 0 0 0
         0 0 0 0]
    qp1=[zeros(4,3)]
    qp2=[zeros(3,4)]
    q=[qp qp2
       qp1 qc]
    p=dlyap(a,q)
    p11=p(1:3,1:3)
    p12=p(1:3,4:7)
    p21=p(4:7,1:3)
    p22=p(4:7,4:7)
    xpo=[r1 r2 r3]'
    xco3=-1*inv(p22)*p21*xpo
    k=-1*inv(p22)*p21
    j=[xpo' xco3']*p*[xpo
                      xco3]
%**************************************************
    n=7
    q1=-1*trace(a)
    f1=a+q1*eye(7)
    q2=-1/2*trace(a*f1)
    f2=a*f1+q2*eye(7)
    q3=-1/3*trace(a*f2)
    f3=a*f2+q3*eye(7)
    q4=-1/4*trace(a*f3)
    f4=a*f3+q4*eye(7)
    q5=-1/5*trace(a*f4)
    f5=a*f4+q5*eye(7)
    q6=-1/6*trace(a*f5)
    f6=a*f5+q6*eye(7)
    q7=-1/7*trace(a*f6)
```

```
    f7=a*f6+q7*eye(7)

    adj=[eye(7) f1 f2 f3 f4 f5 f6]
    det=[1 q1 q2 q3 q4 q5 q6 q7]
    r=[cp zeros(1,4)]*adj
    Nc=r(1,22:49)
    Np=r(1,1:21)
    Np1=[Np(1,1:7)]
    Np2=[Np(1,8:14)]
    Np3=[Np(1,15:21)]
    Nc1=[Nc(1,1:7)]
    Nc2=[Nc(1,8:14)]
    Nc3=[Nc(1,15:21)]
    Nc4=[Nc(1,22:28)]

%*************************************************
    [apt1,bpt1,cpt1,dpt1]=tf2ss(nhpdlc,dhpdlc)
    [apt2,bpt2,cpt2,dpt2]=tf2ss(nhcd3lc,dhcd3lc)
    sys1=ss(apt1,bpt1,cpt1,dpt1,0.005)
    sys2=ss(apt2,bpt2,cpt2,dpt2,0.005)
    [y1,t1,x1]=initial(sys1,[xpo'],[0:0.005:0.5]);
    [y2,t2,x2]=initial(sys2,[xco3'],[0:0.005:0.5]);
    y=y1+y2
    plot(t1,y)
echo off
```

Otra rutina implementada es para el empleo del método de *Cancelación de Polos y Ceros* a continuación se presenta la subrutina implementada para el *Modo de Seguimiento* y es similar para los otros modos de control:

```
echo on

%****** PLANTA*********
    I = .012; C = 0.004; K = 10;
    nump = [1];
    denp = [I C K];
    printsys(nump,denp,'s');
    ka=2;
    kf=2.8;
    kt=conv(ka,kf)
    numk=conv(nump,kt)
    l=10e-4;
    n=1
    [num1,den1]=pade(l,n)
    num=conv(numk,num1)
```

```
    den=conv(denp,den1)
    hp=tf(num,den)
%*************
    ts =0.005
    hpd = c2d(hp,ts,'zoh')
    [numpd,denpd]=tfdata(hpd,ts)
    hpdlc=feedback(hpd,1)
    [nhpdlc,dhpdlc]=tfdata(hpdlc,ts)


%****************CONTROL DE SEGUIMIENTO*****************
    numct=conv(conv(2,conv([1 -0.9603],[1 -0.5])),conv([1 -
    0.98877742667815+0.14371472416794*i],[1 -0.98877742667815-
    0.14371472416794*i]))
    denct=conv(conv([1 -1],[1 -0.5]),conv([1 -0.9603],[1 -0.76]))
    hcd3=tf(numct,denct,ts)
    hcd3lc=feedback(hcd3,1)
    [nhcd3lc,dhcd3lc]=tfdata(hcd3lc,0.005)

%*********************************
    h3=hcd3*hpd
    hlc3=feedback(h3,1)
    [nhlc3,dhlc3]=tfdata(hlc3,0.005)
%*********************************
    [ap,bp,cp,dp]=tf2ss(numpd,denpd)
    [ac,bc,cc,dc]=tf2ss(numct,denct)
    a=[ap-bp*dc*cp  bp*cc
       -bc*cp              ac]
%************************************************
    q1=-1*trace(a)
    f1=a+q1*eye(7)
    q2=-1/2*trace(a*f1)
    f2=a*f1+q2*eye(7)
    q3=-1/3*trace(a*f2)
    f3=a*f2+q3*eye(7)
    q4=-1/4*trace(a*f3)
    f4=a*f3+q4*eye(7)
    q5=-1/5*trace(a*f4)
    f5=a*f4+q5*eye(7)
    q6=-1/6*trace(a*f5)
    f6=a*f5+q6*eye(7)
    q7=-1/7*trace(a*f6)
    f7=a*f6+q7*eye(7)
    adj=[eye(7) f1 f2 f3 f4 f5 f6]
    det=[1 q1 q2 q3 q4 q5 q6 q7]
    r=[cp zeros(1,4)]*adj
    Nc=r(1,22:49)
    Np=r(1,1:21)
```

```
    r=[cp zeros(1,4)]*adj
    Nc=r(1,22:49)
    Np=r(1,1:21)
    Np1=[Np(1,1:7)]
    Np2=[Np(1,8:14)]
    Np3=[Np(1,15:21)]
    Nc1=[Nc(1,1:7)]
    Nc2=[Nc(1,8:14)]
    Nc3=[Nc(1,15:21)]
    Nc4=[Nc(1,22:28)]

%*************************************************

roots(det)
y1=0.9603
y2=0.98877742667+0.14371472416*i
y3=0.98877742667-0.14371472416*i
Nc1y1=polyval(Nc1,y1)
Nc2y1=polyval(Nc2,y1)
Nc3y1=polyval(Nc3,y1)
Nc4y1=polyval(Nc4,y1)
Nc1y2=polyval(Nc1,y2)
Nc2y2=polyval(Nc2,y2)
Nc3y2=polyval(Nc3,y2)
Nc4y2=polyval(Nc4,y2)
Nc1y3=polyval(Nc1,y3)
Nc2y3=polyval(Nc2,y3)
Nc3y3=polyval(Nc3,y3)
Nc4y3=polyval(Nc4,y3)
Np1y1=polyval(Np1,y1)
Np1y2=polyval(Np1,y2)
Np1y3=polyval(Np1,y3)
NNc1=[Nc1y1 Nc2y1 Nc3y1
  Nc1y2 Nc2y2 Nc3y2
  Nc1y3 Nc2y3 Nc3y3]
NNp=[-Np1y1
  -Np1y2
  -Np1y3]
  k=inv(NNc1)*NNp

%*************************************************
Nt1=k(1,1)*Nc1+Np1+k(2,1)*Nc2+k(3,1)*Nc3
[apt2,bpt2,cpt2,dpt2]=tf2ss(Nt1,det);
sys2=ss(apt2,bpt2,cpt2,dpt2,0.005);
xpo=[6e-6 0 0]
[y1,t1,x1]=initial(sys2,[xpo 0 0 0 0],[0:0.005:0.5]);
y11=y2+r1
plot(t2,y11)
```

echo off

La rutina implementada para el instante de cambio del *Modo de Búsqueda* al *Modo de Seguimiento* es similar para el resto de rutinas implementadas para el resto de instantes de cambio de un modo a otro y es:

echo on

```
%*********************************
    I = .012; C = 0.004; K = 10;
    nump = [1];
    denp = [I C K];
    printsys(nump,denp,'s');
    ka=2;
    kf=2.8;
    kt=conv(ka,kf)
    numk=conv(nump,kt)
    l=10e-4;
    n=1
    [num1,den1]=pade(l,n)
    num=conv(numk,num1)
    den=conv(denp,den1)
    hp=tf(num,den)

%*******************************
    ts =0.005
    hpd = c2d(hp,ts,'zoh')
    [numpd,denpd]=tfdata(hpd,ts)

%**************CONTROL DE BUSQUEDA******************
    t=[0:.1:9.9]';
    ut=[t,ones(size(t))];
    [tt,xx,yy]=sim('ssst1',10,[],[],ut);

%***************CONTROL DE SEGUIMIENTO*****************
    numct=conv(conv(2,conv([1 -0.9603],[1 -0.5])),conv([1 -
    0.98877742667815+0.14371472416794*i],[1 -0.98877742667815-
    0.14371472416794*i]))
    denct=conv(conv([1 -1],[1 -0.5]),conv([1 -0.9603],[1 -0.76]))
    h3=hcd3*hpd;
    hlc3=feedback(h3,1);
    [nhlc3,dhlc3]=tfdata(hlc3,0.005);
    [ap,bp,cp,dp]=tf2ss(numpd,denpd);
    [ac,bc,cc,dc]=tf2ss(numct,denct);
    a=[ap-bp*dc*cp  bp*cc
        -bc*cp              ac]
    xpo=[6e-6 0 0]';
```

```
%************************************************

    q1=-1*trace(a)
    f1=a+q1*eye(7)
    q2=-1/2*trace(a*f1)
    f2=a*f1+q2*eye(7)
    q3=-1/3*trace(a*f2)
    f3=a*f2+q3*eye(7)
    q4=-1/4*trace(a*f3)
    f4=a*f3+q4*eye(7)
    q5=-1/5*trace(a*f4)
    f5=a*f4+q5*eye(7)
    q6=-1/6*trace(a*f5)
    f6=a*f5+q6*eye(7)
    q7=-1/7*trace(a*f6)
    f7=a*f6+q7*eye(7)
    adj=[eye(7) f1 f2 f3 f4 f5 f6]
    det=[1 q1 q2 q3 q4 q5 q6 q7]
    r=[cp zeros(1,4)]*adj
    Nc=r(1,22:49)
    Np=r(1,1:21)
    Np1=[Np(1,1:7)]
    [apc1,bpc1,cpc1,dpc1]=tf2ss(Np1,det)
    sys1=ss(apc1,bpc1,cpc1,dpc1,0.005)
    [y1,t1,x1]=initial(sys1,[xpo' 0 0 0 0]);

%*************************SWICH*********************

 n=1;
    while yy(n)<=6e-6, n=n+1; end
            tf1=tt(n);
            yy(n);
            tf2=[0:0.005:tf1]';
            r=size(tf2);
            r1=r(1:1);
            r2=yy(1:r1,1);
            axes('position',[0.05,0.446,tf1+0.05,0.49])
            plot(tf2,r2)
            hold on
            axes('position',[0.42,0.446,0.37,0.49])
            plot(t1,y1)
            hold off

echo off
```