Table of Contents

Using ode15s

```
%clc; clear all; close all

global Load_spline
C = psconstants_will;

% ps = case9_ps_lk_perm;
% ps = updateps(ps);
```

Set up 2 area, 39bus per area case.

```
ps = case39_ps_will;
ps = replicate_case_parallel_gencost_change(ps,2);
ps = updateps(ps);
ps.bus(40:end,C.bu.area) = 2;
ps.gov(:,C.gov.R)        = ps.gen(:,C.ge.Pmax).*0.05/ps.baseMVA % reg constant is
ps.mac(:,C.ma.Tg)        = ps.gov(:,C.gov.Tg);
ps.mac(:,C.ma.R)         = ps.gov(:,C.gov.R);

load_buses = ps.bus_i(ps.shunt(:,1));
bus_areas  = ps.bus(load_buses,C.bu.area);
```

```
ps =

      baseMVA: 100
          bus: [78x19 double]
       branch: [94x22 double]
          gen: [28x22 double]
        shunt: [38x10 double]
          mac: [28x15 double]
          gov: [28x9 double]
        areas: []
      gencost: [28x7 double]
    frequency: 60
        bus_i: [239x1 double]
```

Set up long term

```
day_in_s     = 24*60*60; %24hrs*60min/hr*60s/min
fivemin_in_s = 5*60;
day_in_5min  = day_in_s/fivemin_in_s;
tmax=60;
tmin=1;

perc_reg  = 1;
ps0       = ps;
nmacs     = size(ps.gen,1);
n         = size(ps.bus,1);
ix        = get_indices_will(n,nmacs); % index to help us find stuff
ps        = find_areas(ps);
ps        = set_ramp_rates(ps);
```

Set up x0/y0 by running one time step of ED to get PGs

```
initial_load      = ps.shunt(:,C.sh.P);
%timestep_check   = [initial_load,initial_load*1.2,initial_load*0.8, initial_load*
[Pgs_sbs,Rgs_sbs] = Econ_Dispatch_fn(ps,(initial_load),perc_reg);
ps.gen(:,C.ge.Pg) = Pgs_sbs %Use first time step's optimized Pg's for
ps                = dcpf(ps)

% prepare the machine state variables
ps.mac = get_mac_state(ps,'linear');
```

```
Optimization terminated.
Optimization terminated.

ps =

          baseMVA: 100
              bus: [78x19 double]
           branch: [94x22 double]
              gen: [28x22 double]
            shunt: [38x10 double]
              mac: [28x23 double]
              gov: [28x9 double]
            areas: []
          gencost: [28x7 double]
        frequency: 60
            bus_i: [239x1 double]
     tie_lines_T: {[2x1 double]  [0x1 double]}
     tie_lines_F: {[0x1 double]  [2x1 double]}
  bus_tie_locs_T: {[2x1 double]  [0x1 double]}
  bus_tie_locs_F: {[0x1 double]  [2x1 double]}


ps =
```

```
    baseMVA: 100
        bus: [78x19 double]
     branch: [94x22 double]
        gen: [28x22 double]
      shunt: [38x10 double]
        mac: [28x23 double]
        gov: [28x9 double]
      areas: []
    gencost: [28x7 double]
  frequency: 60
      bus_i: [239x1 double]
 tie_lines_T: {[2x1 double]  [0x1 double]}
 tie_lines_F: {[0x1 double]  [2x1 double]}
bus_tie_locs_T: {[2x1 double]  [0x1 double]}
bus_tie_locs_F: {[0x1 double]  [2x1 double]}
           B: [78x78 double]
```

Set limits for Diffeq Limiter

```
ps.gen(:,C.ge.reg_ramp_up)   = Rgs_sbs;
ps.gen(:,C.ge.reg_ramp_down) = -Rgs_sbs;
ps.gov(:,C.gov.LCmax)        = ones(nmacs,1); %include the rest of ps.gov?
ps.gov(:,C.gov.LCmin)        = -ones(nmacs,1);
```

form the load

```
[Load_spline,ps] = Load_Type(4,ps,tmax,bus_areas);
total_load = ppval(Load_spline,0:tmax);
ps         = get_ps_areas_libby(ps,bus_areas,load_buses,total_load);
```

Simulate the steady state

```
[t,theta,delta,omega,Pm,ps] = simgrid_lti_lk_perm(ps,[tmin,tmax],1);
```

```
k =

    0.0060


num_pos_evals =

     0
```

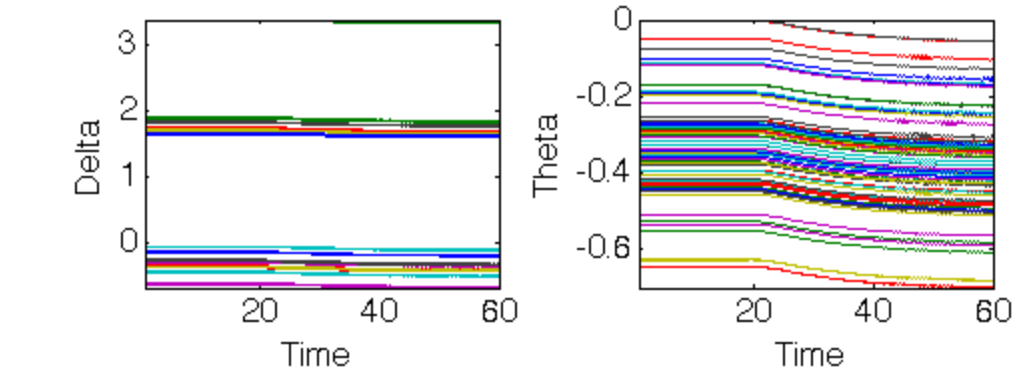
do some plots

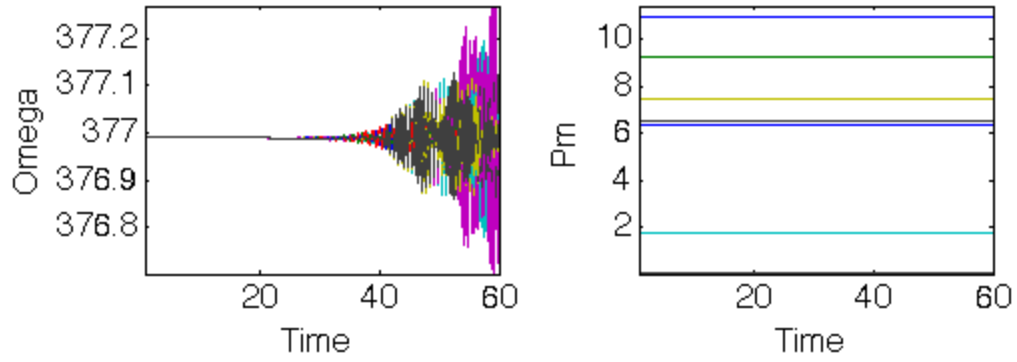
```
subplot_row = 2;
```

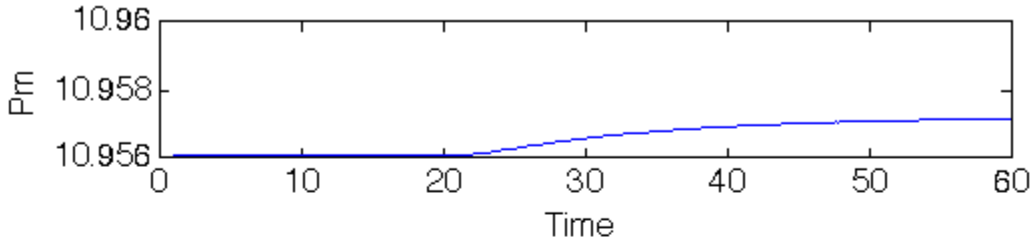
```
subplot_col = 2;
fontsize = 16;

figure(7); clf;
subplot(subplot_row,subplot_col,1)
plot(t,delta);
axis([tmin tmax -Inf Inf])
set(gca,'FontSize',fontsize)
xlabel('Time')
ylabel('Delta')


%figure(2);clf;
subplot(subplot_row,subplot_col,2)
plot(t,theta);
axis([tmin tmax -Inf Inf])
set(gca,'FontSize',fontsize)
xlabel('Time')
ylabel('Theta')

%figure(3);clf
subplot(subplot_row,subplot_col,3)
plot(t,omega);
axis([tmin tmax -Inf Inf])
set(gca,'FontSize',fontsize)
xlabel('Time')
ylabel('Omega')

%figure(4);clf;
subplot(subplot_row,subplot_col,4)
plot(t,Pm);
axis([tmin tmax -Inf Inf])
set(gca,'FontSize',fontsize)
xlabel('Time')
ylabel('Pm')

figure(3);clf;
subplot(3,1,1)
plot(t,Pm(:,1))
set(gca,'FontSize',fontsize)
xlabel('Time')
ylabel('Pm')
subplot(3,1,2)
plot(t,Pm(:,2),'g')
set(gca,'FontSize',fontsize)
xlabel('Time')
ylabel('Pm')
subplot(3,1,3)
plot(t,Pm(:,3),'r')
set(gca,'FontSize',fontsize)
xlabel('Time')
ylabel('Pm')

figure(4);clf;
```

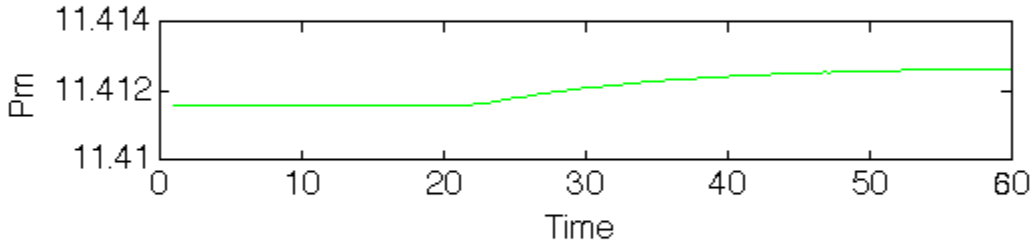
```
%subplot(subplot_row,subplot_col,5)
plot(t, ppval(Load_spline(1),t),'k')
axis([tmin tmax -Inf Inf])
set(gca,'FontSize',fontsize)
xlabel('Time')
ylabel('Load')

figure;clf;
libby=[5 19];
plot(t,omega(:,libby));
axis([tmin tmax -Inf Inf])
set(gca,'FontSize',fontsize)
xlabel('Time')
ylabel('Omega')
title(['K = ',num2str(ps.areas(1,1))])
ylim([376.988,376.992])


ps.gen(libby,:)
```

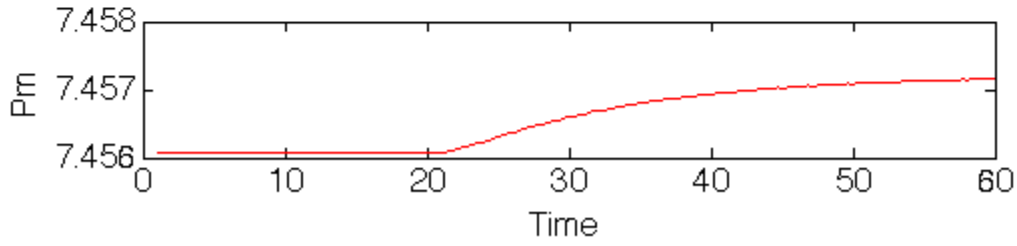
```
ans =

   1.0e+03 *

  Columns 1 through 7

    0.1340    0.0044         0    9.9990   -9.9990    0.0010    0.1000
    0.2340    0.0044         0    9.9990   -9.9990    0.0010    0.1000

  Columns 8 through 14

    0.0010    0.6080         0         0         0         0         0
    0.0010    0.6080         0         0         0         0         0

  Columns 15 through 21

    0.0020    0.0082         0    0.1824   -0.1824    0.0044   -0.0044
    0.0020    0.0082         0    0.1824   -0.1824    0.0044   -0.0044

  Column 22

    0.0030
    0.0030
```

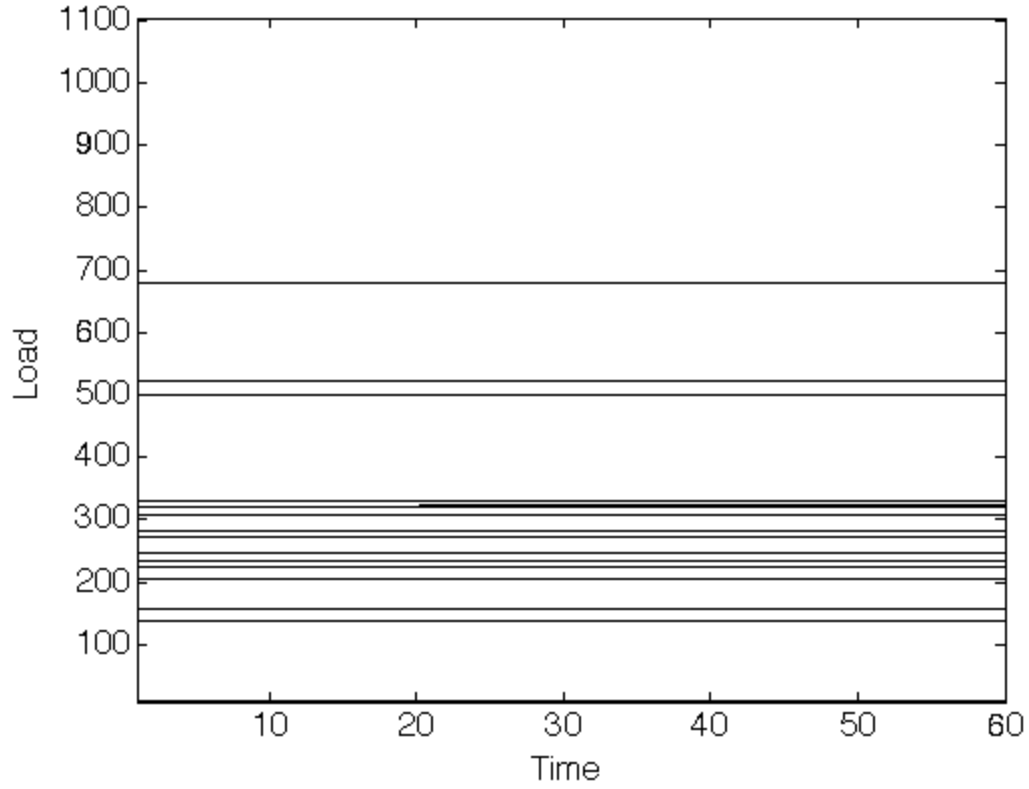

Delta
Time
Theta
Time

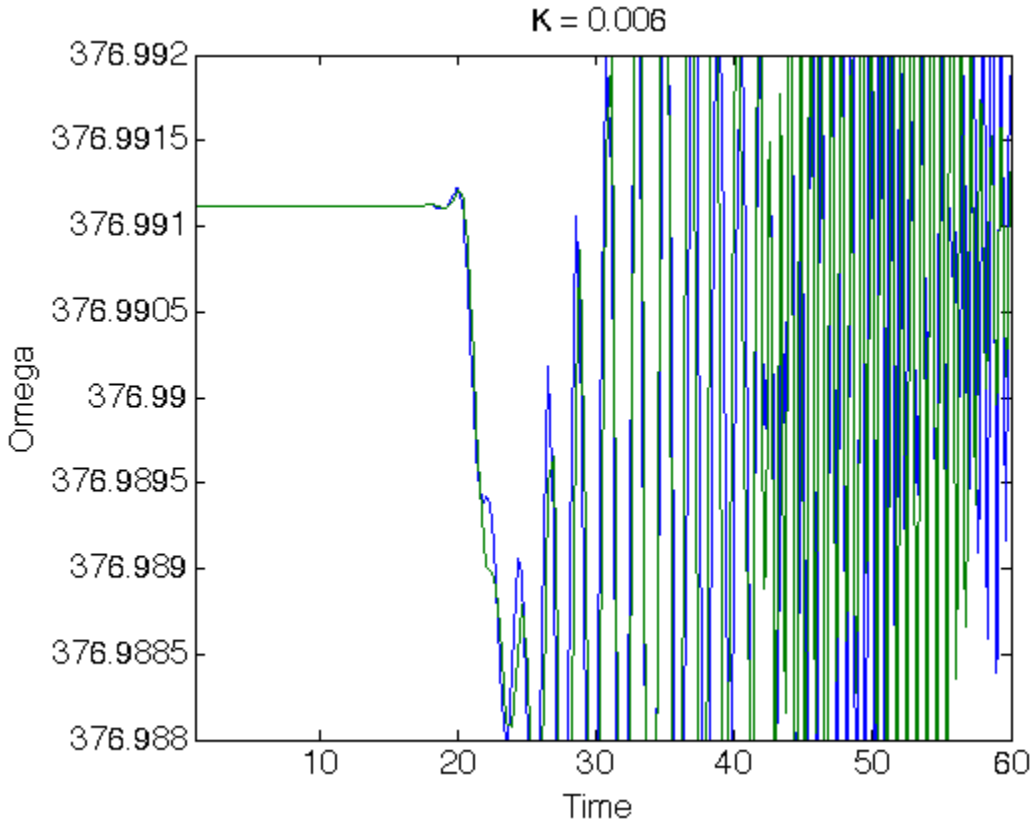

Omega
Time
Pm
Time


Pm
Time


Pm
Time


Pm
Time


1100
1000
900
800
700
600
500
400
300
200
100
Load
10
20
30
40
50
60
Time


K = 0.006
376.992
376.9915
376.991
376.9905
376.99
376.9895
376.989
376.9885
376.988
Omega
10
20
30
40
50
60
Time

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