LAMPIRAN

LAMPIRAN 1: M-file Metode Lyapunov

```
%-------------------------------------------------------------------------------
%MENENTUKAN KURVA AYUNAN SELAMA 1,4 DETIK  DAN WAKTU PEMUTUSAN GANGGUAN PADA 0,20 DETIK MELALUI PENYELESAIAN SECARA NUMERIK DENGAN METODE RUNGE-KUTTA ORDE KE-4 PADA MESIN MAJEMUK
%-------------------------------------------------------------------------------
format short g
delta_t = 0.01;
fo = 60;
%Data pada masing-masing generator :
Xd1 = j*0.067;
H1 = 11.2;
Xd2 = j*0.10;
H2 = 8.0;
a=8.39;
b=6.473;
Vcr=19.6326;
%Data saluran dan transformator :
%-------------------------------------------------------------------------
%**   Impedansi          !    Y-shunt    !    Bus ke bus     **
%**   (perunit)          !    (perunit)  !                   **
%-------------------------------------------------------------------------
  X_T14  = j*0.022;                          % Transformator 1-4 %
  X_T25  = j*0.040;                          % Transformator 2-5 %
  X_34   = j*0.040;    Ysh_34  =j*0.082;     % Saluran 3_4       %
  X_35_1 = j*0.047;   Ysh_35_1=j*0.098;  % Saluran 3_5(1)     %
```

```
   X_35_2 = j*0.047;   Ysh_35_2=j*0.098;  % Saluran 3_5(2)     %
   X_45   = j*0.110;    Ysh_45  =j*0.226;   % Saluran 4_5        %
%-------------------------------------------------------------------------------
%**       Data harga-harga aliran daya sebelum gangguan            **
%-------------------------------------------------------------------------------
%**       Tegangan            !          Pembangkitan      !          *
%**       (per-unit)          !            (per-unit)        !   Bus    *
%-------------------------------------------------------------------------------
%**       Magnitude    ! Sudut/derajat !     P   !  Q      !          *
%-------------------------------------------------------------------------------
  V1 = 1.030;      sd_V1=8.88;   P1=1.5;     Q1=j*0.712;  %     1     *
  V2 = 1.020;      sd_V2=6.38;   P2=1.85;    Q2=j*0.298;  %     2     *
  V3 = 1.000;      sd_V3=0  ;                                %     3     *
  V4 = 1.018;      sd_V4=4.68;                               %     4     *
  V5 = 1.011;      sd_V5=2.27;                               %     5     *
%-------------------------------------------------------------------------------
% Arus yang mengalir ke jala-jala dari bus 1 dan 2 :
I1 = (P1-Q1)/conj(V1*(cos(sd_V1)+j*sin(sd_V1)));
I2 = (P2-Q2)/conj(V2*(cos(sd_V2)+j*sin(sd_V2)));
% Tegangan pada masing-masing generator dan infinite bus :
E1 = V1*(cos(sd_V1)+j*sin(sd_V1))+Xd1*I1;
E2 = V2*(cos(sd_V2)+j*sin(sd_V2))+Xd2*I2;
% Kondisi awal  :
delta1 = 180/pi* (imag(E1),real(E1));
delta2 = 180/pi* (imag(E2),real(E2));
omega1 = 0;
omega2 = 0;
d10=180/pi*(imag(E1),real(E1));
delta1 = 180/pi*(imag(E1),real(E1));
d20 = 180/pi*(imag(E2),real(E2));
```

```
delta2 = 180/pi*(imag(E2),real(E2));
x3=0;
x4=0;
VL=(1/2*(H1/180*fo)*x3^2)+1/2*(H2/180*fo)*x4^2)*0.05+a*(cos(d10)-
cos(x1+d10)-x1*sin(d10))+b*(cos(d20)-cos(x2+d20)-x2*sin(d20));
disp('                                                                    ')
disp('------------------------------------------------------------------------')
disp('HARGA KESTABILAN LYAPUNOV DENGAN HARGA
     DELTA1(X1),DELTA2(X2),OMEGA1(X3) ')
disp('OMEGA2(X4)MODEL MULTI MACHINE INFINITE BUS')
disp('------------------------------------------------------------------------')
disp('WAKTU  !  x1  !  x2  !  x3   !  x4   !  VL   ! VL<=Vcr  ')
disp(' (detik)  ! (rad)  !  (rad)  !(rad/dtk) !(rad/dtk)! (satuan)!(kondisi) ')
disp('------------------------------------------------------------------------')
tp = input('              Waktu pemutusan (detik) =                  ');
disp('------------------------------------------------------------------------')
% Harga delta dan omega selama gangguan:
for t=0 : 0.01 : (tp-0.01)
   K1_m1 = x3*delta_t;
   K1_m2 = x4*delta_t;
   L1_m1 = (pi*fo/H1)*(P1)*delta_t;
   L1_m2 = (pi*fo/H2)*(P2-(5.5*cos((-delta2)))*delta_t;
   K2_m1 = (x3+0.5*L1_m1)*delta_t;
   K2_m2 = (x4+0.5*L1_m2)*delta_t;
   L2_m1 = (pi*fo/H1)*(P1)*delta_t;
   L2_m2=(pi*fo/H2)*(P2-(5.5*cos((-((-(delta2+(0.5*K1_m2*180/pi))))*delta_t;
   K3_m1 = (x3+0.5*L2_m1)*delta_t;
   K3_m2 = (x4+0.5*L2_m2)*delta_t;
   L3_m1 = (pi*fo/H1)*(P1)*delta_t;
L3_m2=(pi*fo/H2)*(P2-(5.5*cos((-(delta2+(0.5*K2_m2*180/pi)))*delta_t;
```

```
   K4_m1 = (x3+L3_m1)*delta_t;
   K4_m2 = (x4+L3_m2)*delta_t;
   L4_m1 = (pi*fo/H1)*(P1)*delta_t;
   L4_m2=(pi*fo/H2)*(P2-(5.5*cos((-(delta2+(K3_m2*180/pi)))*delta_t;
   x1 = (delta1 - d10);
   x2 = (delta2 - d20);
 delta1=delta1+ ((1/6)*((K1_m1+2*K2_m1+2*K3_m1+K4_m1));
 delta2=delta2+    ((1/6)*((K1_m2+2*K2_m2+2*K3_m2+K4_m2));    fprintf('!%7.2f
!%7.3f  !%7.3f  !%8.3f  !%7.3f  !%7.3f   !%\n',t,x1,x2,x3,x4,VL,VL<=Vcr)
 if VL<=Vcr
    disp(' Stabil');
    x3=x3 + ((1/6)*(L1_m1+2*L2_m1+2*L3_m1+L4_m1));
    x4=x4                +                ((1/6)*(L1_m2+2*L2_m2+2*L3_m2+L4_m2));
VL=(1/2*(H1/180*fo)*x3^2+1/2*(H2/180*fo)*x4^2)*0.05+a*(cos(d10)-
cos(x1+d10)-x1*sin(d10))+b*(cos(d20)-cos(x2+d20)-x2*sin(d20));
 elseif VL>Vcr
    disp('Tidak Stabil');
   x3=x3 + ((1/6)*(L1_m1+2*L2_m1+2*L3_m1+L4_m1));
   x4=x4 + ((1/6)*(L1_m2+2*L2_m2+2*L3_m2+L4_m2));
VL=(1/2*(H1/180*fo)*x3^2)+1/2*(H2/180*fo)*x4^2)*0.05+a*(cos(d10)-
cos(x1+d10)-x1*sin(d10))+b*(cos(d20)-cos(x2+d20)-x2*sin(d20));
 end
end
disp(['----------------------Waktu Pemutusan-------------------------------'])
```

LAMPIRAN 2: M-file Metode Konvensional

```
%----------------------------------------------------------------------------MENENTUKAN
KURVA AYUNAN SELAMA 1,4 DETIK DAN  WAKTU PEMUTUSAN GANGGUAN
PADA 0,20 DETIK MELALUI PENYELESAIAN SECARA NUMERIK DENGAN METODE
KONVENSIONAL PADA MESIN MAJEMUK
%-------------------------------------------------------------------------------
format short g
delta_t = 0.01;
fo = 60;
%Data pada masing-masing generator :
Xd1 = j*0.067;
H1 = 11.2;
Xd2 = j*0.10;
H2 = 8.0;
%Data saluran dan transformator :
%-------------------------------------------------------------------------------
%**    Impedansi          !     Y-shunt     !     Bus ke bus          **
%**    (perunit)          !     (perunit)   !                         **
%-------------------------------------------------------------------------------
   X_T14  = j*0.022;                          %Transformator 1-4 %
   X_T25  = j*0.040;                          % Transformator 2-5 %
   X_34   = j*0.040;        Ysh_34  =j*0.082;  % Saluran 3_4        %
   X_35_1 = j*0.047;        Ysh_35_1=j*0.098; % Saluran 3_5(1)     %
   X_35_2 = j*0.047;        Ysh_35_2=j*0.098;  % Saluran 3_5(2)     %
   X_45   = j*0.110;        Ysh_45  =j*0.226;     % Saluran 4_5        %
%-------------------------------------------------------------------------------
%**        Data harga-harga aliran daya sebelum gangguan              **
%-------------------------------------------------------------------------------
%**        Tegangan          !       Pembangkitan        !    *
%**       (per-unit)         !       (per-unit)          ! Bus *
```

```
%-------------------------------------------------------------------------------
%**  Magnitude  !  Sudut/derajat  !        P        !            Q     !
%-------------------------------------------------------------------------
  V1 = 1.030;      sd_V1=8.88;      P1=1.5;      Q1=j*0.712;  %  1  *
  V2 = 1.020;      sd_V2=6.38;      P2=1.85;     Q2=j*0.298;  %  2  *
  V3 = 1.000;      sd_V3=0   ;                                %  3  *
  V4 = 1.018;      sd_V4=4.68;                                %  4  *
  V5 = 1.011;      sd_V5=2.27;                                %  5  *
%-------------------------------------------------------------------------------
% Arus yang mengalir ke jala-jala dari bus 1 dan 2 :
I1 = (P1-Q1)/conj(V1*(cos(sd_V1)+j*sin(sd_V1)));
I2 = (P2-Q2)/conj(V2*(cos(sd_V2)+j*sin(sd_V2)));
% Tegangan pada masing-masing generator dan infinite bus :
E1 = V1*(cos(sd_V1)+j*sin(sd_V1))+Xd1*I1;
E2 = V2*(cos(sd_V2)+j*sin(sd_V2))+Xd2*I2;
% Kondisi awal  :
delta1 = 180/pi (imag(E1),real(E1));
delta2 = 180/pi (imag(E2),real(E2));
omega1 = 0;
omega2 = 0;
disp('                                                  ')
disp('-----------------------------------------------------------------')
disp('HARGA  DELTA&OMEGA  SETIAP  MESIN  MELALUI  PENYELESAIAN  SECARA
NUMARIK ')
disp('DENGAN METODE KONVENSIONAL                  ')
disp('-----------------------------------------------------------------')
disp('WAKTU ! DELTA1 ! DELTA 2 !  OMEGA 1  !   OMEGA 2   ')
disp(' (detik)  !  (derajat)  !  (derajat)  !  (rad / dtk) ! (rad / dtk) ')
disp('-----------------------------------------------------------------')
tp = input('       Waktu pemutusan (detik) = ');
```

```
disp('------------------------------------------------------------------')
% Harga delta dan omega selama gangguan :
for t=0 : 0.01 : (tp - 0.01)
   K1_m1 = omega1*delta_t;
   K1_m2 = omega2*delta_t;
   L1_m1 = (pi*fo/H1)*(P1)*delta_t;
   L1_m2 = (pi*fo/H2)*(P2-(5.5*cos((-delta2)*pi/180)))*delta_t;
   K2_m1 = (omega1+0.5*L1_m1)*delta_t;
   K2_m2 = (omega2+0.5*L1_m2)*delta_t;
   L2_m1 = (pi*fo/H1)*(P1)*delta_t;
   L2_m2=(pi*fo/H2)*(P2-(5.5*cos((-
(delta2+(0.5*K1_m2*180/pi)))*pi/180)))*delta_t;
   K3_m1 = (omega1+0.5*L2_m1)*delta_t;
   K3_m2 = (omega2+0.5*L2_m2)*delta_t;
   L3_m1 = (pi*fo/H1)*(P1)*delta_t;
   L3_m2=(pi*fo/H2)*(P2-(5.5*cos((-(delta2+(0.5*K2_m2)))*delta_t;
   K4_m1 = (omega1+L3_m1)*delta_t;
   K4_m2 = (omega2+L3_m2)*delta_t;
   L4_m1 = (pi*fo/H1)*(P1)*delta_t;
   L4_m2=(pi*fo/H2)*(P2-(5.5*cos((-(delta2+(K3_m2)))*delta_t;
fprintf('!%7.2f  !%10.3f  !%9.3f  !%10.3f  !%10.3f  !\n',t,delta1, delta2, omega1,
omega2)
   delta1=delta1+ ((1/6)*((K1_m1+2*K2_m1+2*K3_m1+K4_m1));
   delta2=delta2 + ((1/6)*((K1_m2+2*K2_m2+2*K3_m2+K4_m2));
plot(t,delta1,'x')
plot(t,delta2,'x')
grid on
   title('KURVA AYUNAN UNTUK MESIN MAJEMUK')
   xlabel('Waktu, Detik')
   ylabel('Delta, Derajat')
```

```
hold on
   omega1=omega1 + ((1/6)*(L1_m1+2*L2_m1+2*L3_m1+L4_m1));
   omega2=omega2 + ((1/6)*(L1_m2+2*L2_m2+2*L3_m2+L4_m2));
end
disp(['----------------------Waktu Pemutusan--------------------------'])
for t = (tp + 0.01):0.01:2
   K1_m1 = omega1*delta_t;
   K1_m2 = omega2*delta_t;
   L1_m1 = (pi*fo/H1)*(P1-(8.39*cos((-delta1)*pi/180)))*delta_t;
   L1_m2 = (pi*fo/H2)*(P2-(6.473*cos((-delta2)*pi/180)))*delta_t;
   K2_m1 = (omega1+0.5*L1_m1)*delta_t;
   K2_m2 = (omega2+0.5*L1_m2)*delta_t;
   L2_m1=(pi*fo/H1)*(P1-(8.39*cos(((delta1+(0.5*K1_m1)))*delta_t;
   L2_m2=(pi*fo/H2)*(P2-(6.473*cos((-(delta2+(0.5*K1_m2)))*delta_t
   K3_m1 = (omega1+0.5*L2_m1)*delta_t;
   K3_m2 = (omega2+0.5*L2_m2)*delta_t;
   L3_m1=(pi*fo/H1)*(P1-(8.39*cos(((delta1+(0.5*K2_m1)))*delta_t;
   L3_m2=(pi*fo/H2)*(P2-(6.473*cos((-(delta2+(0.5*K2_m2)))*delta_t;
   K4_m1 = (omega1+L3_m1)*delta_t;
   K4_m2 = (omega2+L3_m2)*delta_t;
   L4_m1=(pi*fo/H1)*(P1-(8.39*cos((-(delta1+(K3_m1)))*delta_t;
   L4_m2=(pi*fo/H2)*(P2-(6.473*cos((-(delta2+(K3_m2)))*delta_t;
fprintf('!%7.2f !%10.3f !%9.3f !%10.3f !%10.3f !\n',t,delta1, delta2,
omega1,omega2)
delta1=delta1+((1/6)*((K1_m1+2*K2_m1+2*K3_m1+K4_m1delta2=delta2+((1/6)
*((K1_m2+2*K2_m2+2*K3_m2+K4_m2)*180/pi));
plot(t,delta1,'x')
plot(t,delta2,'x')
   omega1=omega1 + ((1/6)*(L1_m1+2*L2_m1+2*L3_m1+L4_m1));
   omega2=omega2 + ((1/6)*(L1_m2+2*L2_m2+2*L3_m2+L4_m2));
```

```
end
disp('------------------------------------------------------------')
text(1,70,'mesin 1=0.22 dtk')
text(1,-150,'mesin 2=0.22dtk')
```