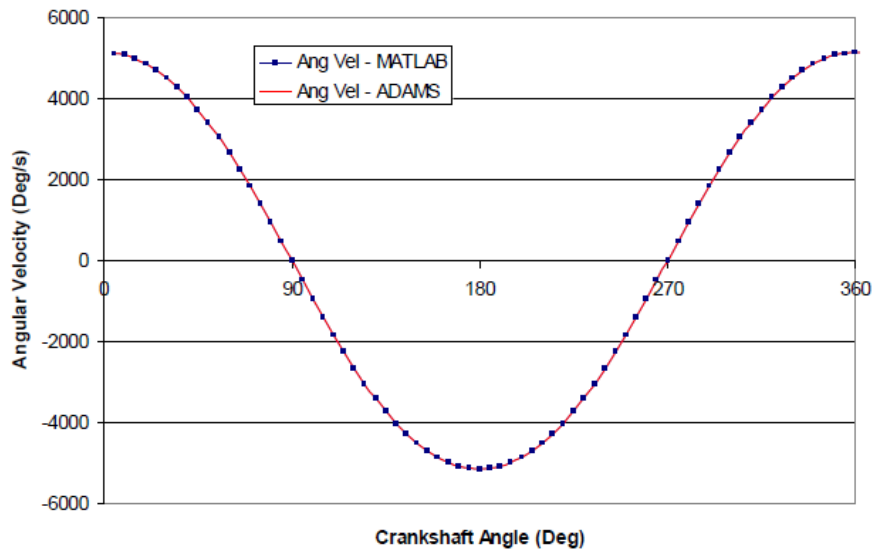
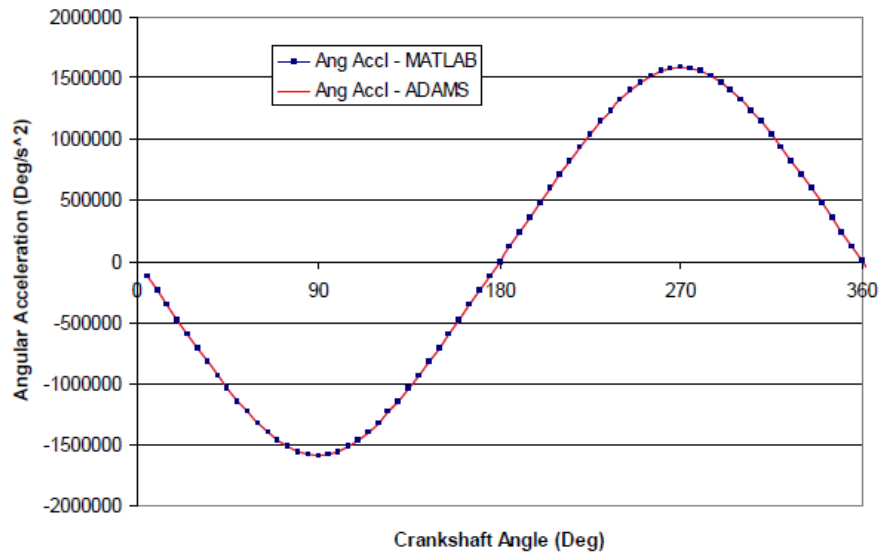


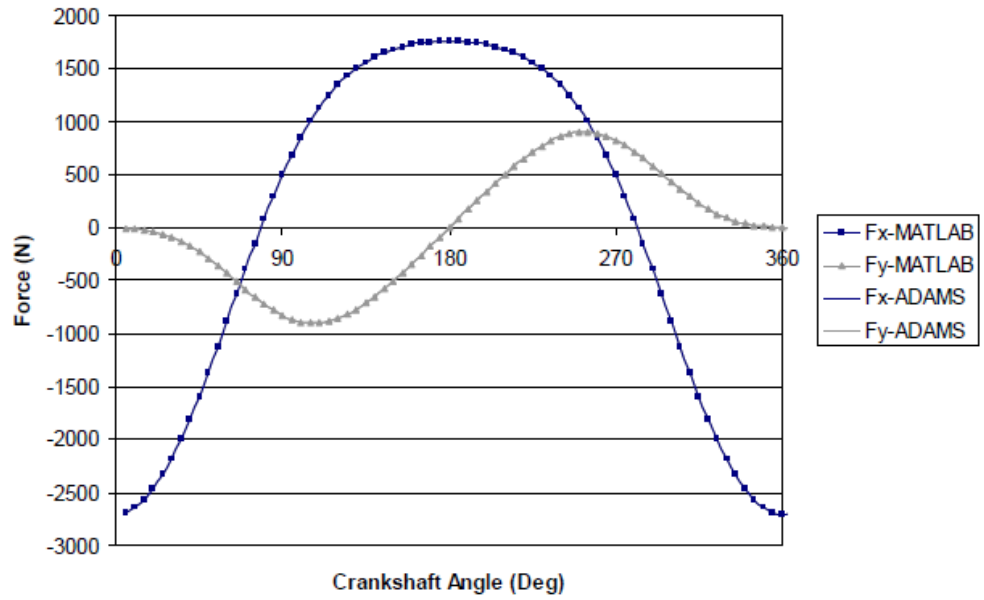
## LAMPIRAN A



Gambar 4.1 Hasil plot grafik program *Matlab* untuk analisa kecepatan angular sambungan crankshaft dan *connecting rod* pada kecepatan rotasi mesin 2800 rpm. [18]



Gambar 4.2 Hasil plot grafik program *Matlab* untuk analisa percepatan angular untuk sambungan *crankshaft* dan *connecting rod* kecepatan rotasi mesin 2800 rpm. [18]



Gambar 4.3 hasil plot grafik program *Matlab* untuk analisa gaya sambungan *crankshaft* dan *connecting rod* pada kecepatan rotasi mesin 2800 rpm. [18]

## LAMPIRAN B

### Command Program Matlab Untuk Menyelesaikan Persamaan Mekanisme *Slider Crank* pada Penelitian Ini

```

clc
clear

% measured weight of components
% piston          330.87gr
% piston+pin     417.63gr
% connecting-rod+cap 283.35gr
% connecting-rod 244.89gr
% cap            38.50gr
% pin           86.79gr

l1 = 36.98494e-3;
l2 = 120.777e-3;
mcrank = 3.7191;
mrod = 283.35e-3;
I2 = 662523.4802e-9;
lg = 28.5827e-3;
mp = 417.63e-3;
load = xlsread('load.xls');

for theta_t= 1:145
    theta = (theta_t-1)*5*pi/180;
    theta_d = 2800*2*pi/60;
    theta_dd = 0;
    beta(theta_t) = asin(l1*sin(theta)/l2);
    beta_d(theta_t) = theta_d*l1*cos(theta)/l2/sqrt(1-
(l1*sin(theta)/l2)^2);
    beta_dd(theta_t) = l1/l2*(theta_dd*cos(theta)-
theta_d^2*sin(theta))/sqrt(1-
(l1*sin(theta)/l2)^2)+theta_d^2*l1^2/l2^2*(cos(theta))^2*l1/l2*sin(theta)
/((1-(l1*sin(theta)/l2)^2)^1.5);
    v_pis(theta_t) = -l1*theta_d*sin(theta)-
l1^2/l2*theta_d*sin(theta)*cos(theta)/sqrt(1-(l1/l2*sin(theta)^2));
    a_rod_x(theta_t) = -l1*theta_dd*sin(theta)-l1*theta_d^2*cos(theta)-
theta_dd*lg*l1^2*sin(2*theta)/(l2^2*sqrt(1-(l1*sin(theta)/l2)^2))-
theta_d^2*lg*l1^2/l2^2*(2*cos(2*theta)*sqrt(1-
(l1*sin(theta)/l2)^2)+sin(2*theta)*l1^2/l2^2*sin(theta)*cos(theta)/sqrt(1-
-(l1*sin(theta)/l2)^2)/(2*(1-(l1*sin(theta)/l2)^2)));
    a_rod_y(theta_t) = l1*theta_dd*cos(theta)-l1*theta_d^2*sin(theta)-
lg*l1/l2*theta_dd*cos(theta)+lg*l1/l2*theta_d^2*sin(theta);

```

```

    a_pis_x(theta_t) = -l1*theta_dd*sin(theta)-l1*theta_d^2*cos(theta)-
    l1^2/l2*theta_dd*sin(theta)*cos(theta)/sqrt(1-(l1*sin(theta)/l2)^2)-
    theta_d^2*l1^2/l2*(2*cos(2*theta)*sqrt(1-
    (l1*sin(theta)/l2)^2)+sin(2*theta)*l1^2/l1^2*sin(theta)*cos(theta)/sqrt(1
    -(l1*sin(theta)/l2)^2)/(2*(1-l1*sin(theta)/l2)^2));
    f_pis_x(theta_t) = load(theta_t,2)*1e5*pi*.089^2/4;
    f_a_x(theta_t) = mrod*a_rod_x(theta_t)+f_pis_x(theta_t);
    f_a_y(theta_t) = 1/l2*((I2*beta_dd(theta_t)-
    (f_a_x(theta_t)*lg+f_pis_x(theta_t))*(l2-
    lg))*sin(beta(theta_t)))/cos(beta(theta_t))+1/l2*mrod*a_rod_y(theta_t)*
    (l2-lg);
    f_local_x(theta_t) =
    f_a_x(theta_t)*cos(theta)+f_a_y(theta_t)*sin(theta);
    f_local_y(theta_t) = f_a_y(theta_t)*cos(theta)-
    f_a_x(theta_t)*sin(theta);
end

figure(2)
hold off
plot(load(:,1),f_a_x,'r-')
hold on
plot(load(:,1),f_a_y,'g-')
grid
title('Force Between Piston and Connecting rod @ 2000 rpm')
xlabel('Crankshaft Angle (Degree)')
ylabel('Force N')
legend('Axial','Normal','Magnitude

```

## LAMPIRAN C

Tabel 1-A Properti Baja AISI 304 pada Komponen Pin Piston dan *Bolt-Nut Connecting Rod*

No	Sifat Material	Nilai	Satuan
1	Modulus Elastisitas	1.2258e+008	N/in <sup>2</sup>
2	Rasio Poisson	0.29	
3	<i>Shear Modulus</i>	4.8387e+007	N/in <sup>2</sup>
4	Koefisien <i>Thermal Expansion</i>	1.8e-005	
5	Massa Jenis	0.289018	lb/in <sup>3</sup>
6	Konduktivitas Termal	16	W/m.K
7	Kalor Jenis	500	J/kg.K
8	<i>Tensile Strength</i>	333559	N/in <sup>2</sup>
9	<i>Yield Strength</i>	133424	N/in <sup>2</sup>

Tabel 1-B Properti AISI 4340 *Stainless Steel Sheet* (SS) pada Komponen Snap Ring

No	Sifat Material	Nilai	Satuan
1	Modulus Elastisitas	1.24516e+008	N/in <sup>2</sup>
2	Rasio Poisson	0.27	
3	Koefisien <i>Thermal Expansion</i>	1.6e-005	
4	Massa Jenis	0.289018	lb/in <sup>3</sup>
5	Konduktivitas Termal	16.3	W/m.K
6	Kalor Jenis	500	J/kg.K
7	<i>Tensile Strength</i>	374193	N/in <sup>2</sup>
8	<i>Yield Strength</i>	111206	N/in <sup>2</sup>
9	Faktor Pengerasan (0.0-1.0; 0.0=isotropic; 1.0=kinematic)	0.000548386	N/in <sup>2</sup>

Tabel 1-C Properti Aluminium *Alloys* 4032-T6 pada Komponen Piston

No	Sifat Material	Nilai	Satuan
1	Modulus Elastisitas	5.09676e+007	N/in <sup>2</sup>
2	Rasio Poisson	0.34	
3	<i>Shear Modulus</i>	1.67742e+007	N/in <sup>2</sup>
4	Koefisien <i>Thermal Expansion</i>	1.94e-005	
5	Massa Jenis	0.0968211	lb/in <sup>3</sup>
6	Konduktivitas Termal	138	W/m.K
7	Kalor Jenis	850	J/kg.K
8	<i>Tensile Strength</i>	245161	N/in <sup>2</sup>
9	<i>Yield Strength</i>	203225	N/in <sup>2</sup>

**LAMPIRAN D**  
**GAMBAR 2D**