

DAFTAR PUSTAKA

- Achmad & Djumairi. S.H. 1990. *Hukum Perdata II*. Semarang: Dosen Fakultas Syari'ah IAIN Walisongo.
- Boyce, W. E. & DiPrima, R. C., 2012. *Elementary Differential Equations*. 10th Edition penyunt. United States: John Wiley & Sons.
- Braun, M., 1983. *Differential Equations and Their Applications*. Springer Verlag, New York.
- Driessche & Watmough, 2002. *Reproduction numbers and sub-threshold endemic equilibria for compartmental models of disease transmission*. Mathematical Biosciences.
- Finizio & Ladas, 1988. *Persamaan Diferensial Biasa dengan penerapan Modern*. Erlangga: Jakarta
- Gambrah PP, Abdul Samad A, & Adzadu Y., 2018. *Divorce Transmission Model International Journal of Statistics and Applied Mathematics*.
- Gambrah P.P & Adzadu Y., 2018. *Mathematical model of divorce epidemic in Ghana International Journal of Statistics and Applied Mathematics*.
- Hale, J. K. & Kocak , H., 1991. *Dynamics and Bifurcations*. New York: Springer-Verlag.
- Lenhart, S. & Workman, J. T., 2007. *Optimal Control Applied to Biological Models*. London: Taylor & Francis Group.
- Toaha, S., 2013. *Pemodelan Matematika dalam Dinamika Populasi*. Makassar: Dua Satu Press.
- Toni, B., 2014. *Kontrol Optimum Prinsip Minimum Pontryagin*. Departemen Matematika IPB.
- Undang-Undang Republik Indonesia Nomor 1 Tahun 1974 tentang Perkawinan dan PP Nomor 9 Tahun 1975*. Jakarta

Widowati & Sutimin. 2007. *Buku ajar pemodelan matematika*. Semarang:
Universitas Diponegoro.

LAMPIRAN

LAMPIRAN 1. Simulasi.m

```
function Kontrol
=simulasi(lamda,miu,u11,u22,beta,pele, gamma,delta, eta1,e
ta2,eta3,rho,P0,C0,R0,RR0,A,B,D,Ta,TP0)
M =599;
t=linspace(0,Ta,M+1);
h=Ta/M;
h2 = h/2;

P=zeros(1,M+1);
C=zeros(1,M+1);
R=zeros(1,M+1);
RR=zeros(1,M+1);
TP=zeros(1,M+1);

P1=zeros(1,M+1);
C1=zeros(1,M+1);
R1=zeros(1,M+1);
RR1=zeros(1,M+1);
TP1=zeros(1,M+1);

P(1)=P0;
C(1)=C0;
R(1)=R0;
RR(1)=RR0;
TP(1)= TP0;

P1(1)=P0;
C1(1)=C0;
R1(1)=R0;
RR1(1)= RR0;
TP1(1)= TP0;

lambdaP=zeros(1,M+1);
lambdaC=zeros(1,M+1);
lambdaR=zeros(1,M+1);
lambdaRR=zeros(1,M+1);

u1=zeros(1,M+1);
u2=zeros(1,M+1);
kk=0
test=-1
deta=0.0001;

%while((tempu1>deta)&&(tempu2>deta))
while (test<1)
oldu1 = u1;
oldu2 = u2;
```

```

oldP =P;
oldC =C;
oldR =R;
oldRR =RR;

oldlambdaP =lambdaP;
oldlambdaC = lambdaC;
oldlambdaR = lambdaR;
oldlambdaRR = lambdaRR;

for i = 1:M
kk=kk+1;
oldu1 = u1;
oldu2 = u2;

N = TP(i)
N1= TP1(i)
fprintf('iterasi ke = %i \n ',kk)

%program dengan kontrol%
for i = 1:M

m1P = lamda+etal1*C(i)+eta2*R(i)+eta3*RR(i) -
(C(i)+R(i)) * (1-u2(i)) *rho*beta*pelu*P(i) -
beta*pelu*P(i) * (1-rho) * (C(i)+R(i)) * (1-u1(i)) -miu*P(i);

m1C = (1-rho)*beta*pelu*P(i) * (C(i)+R(i)) * (1-u1(i)) -
etal1*C(i) -delta*C(i) -miu*C(i);

m1R = rho*beta*pelu*P(i) * (C(i)+R(i)) * (1-
u2(i)) +delta*C(i) -eta2*R(i) -gamma*R(i) -miu*R(i);

m1RR = gamma*R(i) -eta3*RR(i) -miu*RR(i);

m2P =
lamda+etal1*(C(i)+h2*m1C)+eta2*(R(i)+h2*m1R)+eta3*(RR(i)+
h2*m1RR) - ((C(i)+h2*m1C)+(R(i)+h2*m1R)) *0.5*((1-
u2(i))+(1-u2(i+1))) *rho*beta*pelu*(P(i)+h2*m1P) -
beta*pelu*(P(i)+h2*m1P) * (1-
rho) * ((C(i)+h2*m1C)+(R(i)+h2*m1R)) *0.5*((1-u1(i))+(1-
u1(i+1))) -miu*(P(i)+h2*m1P);

m2C = (1-
rho)*beta*pelu*(P(i)+h2*m1P) * ((C(i)+h2*m1C)+(R(i)+h2*m1R
)) *0.5*((1-u1(i))+(1-u1(i+1))) -etal1*(C(i)+h2*m1C) -
delta*(C(i)+h2*m1C) -miu*(C(i)+h2*m1C);

```

$$\begin{aligned}
m2R = & \\
& \rho * \beta * \text{pelu} * (P(i) + h2 * m1P) * ((C(i) + h2 * m1C) + (R(i) + h2 * m1R)) \\
& * 0.5 * ((1 - u2(i)) + (1 - u2(i+1))) + \text{delta} * (C(i) + h2 * m1C) - \\
& \text{eta}2 * (R(i) + h2 * m1R) - \text{gamma} * (R(i) + h2 * m1R) - \\
& \text{miu} * (R(i) + h2 * m1R);
\end{aligned}$$

$$\begin{aligned}
m2RR = & \text{gamma} * (R(i) + h2 * m1R) - \text{eta}3 * (RR(i) + h2 * m1RR) - \\
& \text{miu} * (RR(i) + h2 * m1RR);
\end{aligned}$$

$$\begin{aligned}
m3P = & \\
& \text{lamda} + \text{eta}1 * (C(i) + h2 * m2C) + \text{eta}2 * (R(i) + h2 * m2R) + \text{eta}3 * (RR(i) + \\
& h2 * m2RR) - ((C(i) + h2 * m2C) + (R(i) + h2 * m2R)) * 0.5 * ((1 - \\
& u2(i)) + (1 - u2(i+1))) * \rho * \beta * \text{pelu} * (P(i) + h2 * m2P) - \\
& \beta * \text{pelu} * (P(i) + h2 * m2P) * (1 - \\
& \rho) * ((C(i) + h2 * m2C) + (R(i) + h2 * m2R)) * 0.5 * ((1 - u1(i)) + (1 - \\
& u1(i+1))) - \text{miu} * (P(i) + h2 * m2P);
\end{aligned}$$

$$\begin{aligned}
m3C = & (1 - \\
& \rho) * \beta * \text{pelu} * (P(i) + h2 * m2P) * ((C(i) + h2 * m2C) + (R(i) + h2 * m2R)) \\
& * 0.5 * ((1 - u1(i)) + (1 - u1(i+1))) - \text{eta}1 * (C(i) + h2 * m2C) - \\
& \text{delta} * (C(i) + h2 * m2C) - \text{miu} * (C(i) + h2 * m2C);
\end{aligned}$$

$$\begin{aligned}
m3R = & \\
& \rho * \beta * \text{pelu} * (P(i) + h2 * m2P) * ((C(i) + h2 * m2C) + (R(i) + h2 * m2R)) \\
& * 0.5 * ((1 - u2(i)) + (1 - u2(i+1))) + \text{delta} * (C(i) + h2 * m2C) - \\
& \text{eta}2 * (R(i) + h2 * m2R) - \text{gamma} * (R(i) + h2 * m2R) - \\
& \text{miu} * (R(i) + h2 * m2R);
\end{aligned}$$

$$\begin{aligned}
m3RR = & \text{gamma} * (R(i) + h2 * m2R) - \text{eta}3 * (RR(i) + h2 * m2RR) - \\
& \text{miu} * (RR(i) + h2 * m2RR);
\end{aligned}$$

$$\begin{aligned}
m4P = & \\
& \text{lamda} + \text{eta}1 * (C(i) + h * m3C) + \text{eta}2 * (R(i) + h * m3R) + \text{eta}3 * (RR(i) + h * \\
& m3RR) - ((C(i) + h * m3C) + (R(i) + h * m3R)) * ((1 - \\
& u2(i+1))) * \rho * \beta * \text{pelu} * (P(i) + h * m3P) - \\
& \beta * \text{pelu} * (P(i) + h * m3P) * (1 - \\
& \rho) * ((C(i) + h * m3C) + (R(i) + h * m3R)) * ((1 - u1(i+1))) - \\
& \text{miu} * (P(i) + h * m3P);
\end{aligned}$$

$$\begin{aligned}
m4C = & (1 - \\
& \rho) * \beta * \text{pelu} * (P(i) + h * m3P) * ((C(i) + h * m3C) + (R(i) + h * m3R)) * \\
& ((1 - u1(i+1))) - \text{eta}1 * (C(i) + h * m3C) - \text{delta} * (C(i) + h * m3C) - \\
& \text{miu} * (C(i) + h * m3C);
\end{aligned}$$

$$\begin{aligned}
m4R = & \\
& \rho * \beta * \text{pelu} * (P(i) + h * m3P) * ((C(i) + h * m3C) + (R(i) + h * m3R)) * (
\end{aligned}$$

$$\begin{aligned}
& (1 - u2(i+1))) + \text{delta} * (C(i) + h * m3C) - \text{eta}2 * (R(i) + h * m3R) - \\
& \text{gamma} * (R(i) + h * m3R) - \text{miu} * (R(i) + h * m3R);
\end{aligned}$$

```

m4RR = gamma*(R(i)+h*m3R)-eta3*(RR(i)+h*m3RR)-
miu*(RR(i)+h*m3RR);

P(i+1) = P(i) + (h/6)*(m1P + 2*m2P + 2*m3P + m4P );
C(i+1) = C(i) + (h/6)*(m1C + 2*m2C + 2*m3C + m4C );
R(i+1) = R(i) + (h/6)*(m1R + 2*m2R + 2*m3R + m4R);
RR(i+1)= RR(i)+(h/6)*(m1RR + 2*m2RR + 2*m3RR +m4RR );

TP(i+1)= P(i+1)+ C(i+1)+ R(i+1)+ RR(i+1);

end
for i = 1:M
j = M + 2 - i;

m1P = -(lambdaP(j))*(-rho*beta*pelu*(C(j)+R(j))*(1-
u2(j))-(1-rho)*beta*pelu*(C(j)+R(j))*(1-u1(j))-miu)-
lambdaC(j)*((1-rho)*beta*pelu*(C(j)+R(j))*(1-u1(j)))-
lambdaR(j)*(rho*beta*pelu*(C(j)+R(j))*(1-u2(j)));

m1C = -(lambdaP(j))*(-rho*beta*pelu*P(j)*(1-u2(j))-(1-
rho)*beta*pelu*P(j)*(1-u1(j))+eta1)-(lambdaC(j))*((1-
rho)*beta*pelu*P(j)*(1-u1(j))-eta1-delta-miu)-
lambdaR(j)*(rho*beta*pelu*P(j)*(1-u2(j))+delta);

m1R = -A-(lambdaP(j))*(-rho*beta*pelu*P(j)*(1-u2(j))-(1-
rho)*beta*pelu*P(j)*(1-u1(j))+eta2)-lambdaC(j)*((1-
rho)*beta*pelu*P(j)*(1-u1(j)))-
lambdaR(j)*(rho*beta*pelu*P(j)*(1-u2(j))-eta2-gamma-
miu)-lambdaRR(j)*gamma;
m1RR = -lambdaP(j)*eta3-lambdaRR(j)*(-eta3-miu);

m2P = (-((lambdaP(j))-h2*m1P))*(-
rho*beta*pelu.*((C(j)+C(j-1))+(R(j)+R(j-1)))*0.5*((1-
u2(j))+(1-u2(j-1)))-(1-rho)*beta*pelu.*((C(j)+C(j-
1))+(R(j)+R(j-1)))*0.5*((1-u1(j))+(1-u1(j-1)))-miu)-
(lambdaC(j)-h2*m1C)*((1-rho)*beta*pelu*((C(j)+C(j-
1))+(R(j)+R(j-1)))*0.5*((1-u1(j))+(1-u1(j-1))))-
(lambdaR(j)-h2*m1R)*(rho*beta*pelu.*((C(j)+C(j-
1))+(R(j)+R(j-1)))*0.5*((1-u2(j))+(1-u2(j-1))));
m2C = (-lambdaP(j)-h2*m1P)*(-rho*beta*pelu*(P(j)+P(j-
1))*0.5*((1-u2(j))+(1-u2(j-1)))-(1-
rho)*beta*pelu*(P(j)+P(j-1))*0.5*((1-u1(j))+(1-u1(j-
1)))+eta1)-(lambdaC(j)-h2*m1C)*((1-
rho)*beta*pelu*(P(j)+P(j-1))*0.5*((1-u1(j))+(1-u1(j-
1)))-eta1-delta-miu)-(lambdaR(j)-
h2*m1R)*(rho*beta*pelu*(P(j)+P(j-1))*0.5*((1-u2(j))+(1-
u2(j-1)))+delta);

m2R = -A-(lambdaP(j)-h2*m1P)*(-rho*beta*pelu*(P(j)+P(j-
1))*0.5*((1-u2(j))+(1-u2(j-1)))-(1-

```

$\rho) * \beta * \text{pelu} * (P(j) + P(j-1)) * 0.5 * ((1 - u_1(j)) + (1 - u_1(j-1))) + \eta_2) - (\lambda_C(j) - h_2 * m_{1C}) * ((1 - \rho) * \beta * \text{pelu} * (P(j) + P(j-1)) * 0.5 * ((1 - u_1(j)) + (1 - u_1(j-1)))) - (\lambda_R(j) - h_2 * m_{1R}) * (\rho * \beta * \text{pelu} * (P(j) + P(j-1)) * 0.5 * ((1 - u_2(j)) + (1 - u_2(j-1)))) - \eta_2 - \gamma - \mu) - (\lambda_{RR}(j) - h_2 * m_{1RR}) * \gamma;$
 $m_{2RR} = (- (\lambda_P(j) - h_2 * m_{1P}) * \eta_3 - (\lambda_{RR}(j) - h_2 * m_{1RR}) * (-\eta_3 - \mu));$

$m_{3P} = (- ((\lambda_P(j)) - h_2 * m_{2P})) * (- \rho * \beta * \text{pelu} * ((C(j) + C(j-1)) + (R(j) + R(j-1))) * 0.5 * ((1 - u_2(j)) + (1 - u_2(j-1))) - (1 - \rho) * \beta * \text{pelu} * ((C(j) + C(j-1)) + (R(j) + R(j-1))) * 0.5 * ((1 - u_1(j)) + (1 - u_1(j-1))) - \mu) - (\lambda_C(j) - h_2 * m_{2C}) * ((1 - \rho) * \beta * \text{pelu} * ((C(j) + C(j-1)) + (R(j) + R(j-1))) * 0.5 * ((1 - u_1(j)) + (1 - u_1(j-1)))) - (\lambda_R(j) - h_2 * m_{2R}) * (\rho * \beta * \text{pelu} * ((C(j) + C(j-1)) + (R(j) + R(j-1))) * 0.5 * ((1 - u_2(j)) + (1 - u_2(j-1)))));$

$m_{3C} = (- (\lambda_P(j) - h_2 * m_{2P})) * (- \rho * \beta * \text{pelu} * (P(j) + P(j-1)) * 0.5 * ((1 - u_2(j)) + (1 - u_2(j-1)))) - (1 - \rho) * \beta * \text{pelu} * (P(j) + P(j-1)) * 0.5 * ((1 - u_1(j)) + (1 - u_1(j-1))) + \eta_1) - (\lambda_C(j) - h_2 * m_{2C}) * ((1 - \rho) * \beta * \text{pelu} * (P(j) + P(j-1)) * 0.5 * ((1 - u_1(j)) + (1 - u_1(j-1)))) - \eta_1 - \delta - \mu) - (\lambda_R(j) - h_2 * m_{2R}) * (\rho * \beta * \text{pelu} * (P(j) + P(j-1)) * 0.5 * ((1 - u_2(j)) + (1 - u_2(j-1)))) + \delta);$

$m_{3R} = -A - (\lambda_P(j) - h_2 * m_{2P}) * (- \rho * \beta * \text{pelu} * (P(j) + P(j-1)) * 0.5 * ((1 - u_2(j)) + (1 - u_2(j-1)))) - (1 - \rho) * \beta * \text{pelu} * (P(j) + P(j-1)) * 0.5 * ((1 - u_1(j)) + (1 - u_1(j-1))) + \eta_2) - (\lambda_C(j) - h_2 * m_{2C}) * ((1 - \rho) * \beta * \text{pelu} * (P(j) + P(j-1)) * 0.5 * ((1 - u_1(j)) + (1 - u_1(j-1)))) - (\lambda_R(j) - h_2 * m_{2R}) * (\rho * \beta * \text{pelu} * (P(j) + P(j-1)) * 0.5 * ((1 - u_2(j)) + (1 - u_2(j-1)))) - \eta_2 - \gamma - \mu) - (\lambda_{RR}(j) - h_2 * m_{2RR}) * \gamma;$
 $m_{3RR} = (- (\lambda_P(j) - h_2 * m_{2P}) * \eta_3 - (\lambda_{RR}(j) - h_2 * m_{2RR}) * (-\eta_3 - \mu));$

$m_{4P} = (- ((\lambda_P(j)) - h * m_{3P})) * (- \rho * \beta * \text{pelu} * (C(j-1) + R(j-1)) * (1 - u_2(j-1)) - (1 - \rho) * \beta * \text{pelu} * (C(j-1) + R(j-1)) * (1 - u_1(j-1)) - \mu) - (\lambda_C(j) - h * m_{3C}) * ((1 - \rho) * \beta * \text{pelu} * (C(j-1) + R(j-1)) * (1 - u_1(j-1))) - (\lambda_R(j) - h * m_{3R}) * (\rho * \beta * \text{pelu} * (C(j-1) + R(j-1)) * (1 - u_2(j-1))));$

$m_{4C} = (- (\lambda_P(j) - h * m_{3P})) * (- \rho * \beta * \text{pelu} * (P(j-1)) * (1 - u_2(j-1)) - (1 - \rho) * \beta * \text{pelu} * (P(j-1)) * (1 - u_1(j-1)) + \eta_1) - (\lambda_C(j) - h * m_{3C}) * ((1 - \rho) * \beta * \text{pelu} * (P(j-1)) * (1 - u_1(j-1))) - \eta_1 - \delta - \mu) - (\lambda_R(j) - h * m_{3R}) * (\rho * \beta * \text{pelu} * (P(j-1)) * (1 - u_2(j-1))) + \delta);$

$m_{4R} = -A - (\lambda_P(j) - h * m_{3P}) * (- \rho * \beta * \text{pelu} * (P(j-1)) * (1 - u_2(j-1)) - (1 - \rho) * \beta * \text{pelu} * (P(j-1)) * (1 - u_1(j-1)) + \eta_2) -$

```
(lambdaC(j)-h*m3C)*( (1-rho)*beta*pelu*(P(j-1))*(1-u1(j-1)) - (lambdaR(j)-h*m3R)*(rho*beta*pelu*(P(j-1))*(1-u2(j-1)) - eta2-gamma-miu) - (lambdaRR(j)-h*m3RR)*gamma;
m4RR= (- (lambdaP(j)-h*m3P))*eta3- (lambdaRR(j)-h*m3RR)* (- eta3-miu);
```

```
lambdaP(j-1) = lambdaP(j) - (h/6)*(m1P + 2*m2P + 2*m3P + m4P );
```

```
lambdaC(j-1) = lambdaC(j) - (h/6)*(m1C + 2*m2C + 2*m3C +m4C );
```

```
lambdaR(j-1) = lambdaR(j) - (h/6)*(m1R + 2*m2R + 2*m3R +m4R);
```

```
lambdaRR(j-1)= lambdaRR(j) - (h/6)*(m1RR + 2*m2RR + 2*m3RR +m4RR);
```

```
%u2(j)= min(1,max(0,(lambdaC(j)-lambdaR(j))*sigma.*(C(i)/D)));
```

```
%u3(j)= min(1,max(0,(lambdaC(j)-lambdaR(j))*eta.*(C(i)/E)));
```

```
u1(j)= min(1, max(0,(lambdaC(j)-lambdaP(j))*(1-rho)*pelu*beta*(C(i)+R(i)).*(P(i)/B)));
```

```
u2(j)= min(1,max(0,(lambdaR(j)-lambdaP(j))*rho*beta*pelu*(C(i)+R(i)).*(P(i)/D)));
```

```
end
```

```
for i = 1:M
```

```
m1P1 = lamda+eta1*C1(i)+eta2*R1(i)+eta3*RR1(i) - (C1(i)+R1(i))*(1-u22)*rho*beta*pelu*P1(i) - beta*pelu*P1(i)*(1-rho)*(C1(i)+R1(i))*(1-u11) -miu*P1(i);
```

```
m1C1 = (1-rho)*beta*pelu*P1(i)*(C1(i)+R1(i))*(1-u11) - eta1*C1(i) -delta*C1(i) -miu*C1(i);
```

```
m1R1 = rho*beta*pelu*P1(i)*(C1(i)+R1(i))*(1-u22) +delta*C1(i) -eta2*R1(i) -gamma*R1(i) -miu*R1(i);
```

```
m1RR1 = gamma*R1(i) -eta3*RR1(i) -miu*RR1(i);
```

```
m2P1 =
```

```
lamda+eta1*(C1(i)+h2*m1C1)+eta2*(R1(i)+h2*m1R1)+eta3*(RR1(i)+h2*m1RR1) - ((C1(i)+h2*m1C1)+(R1(i)+h2*m1R1))*(1-u22)*rho*beta*pelu*(P1(i)+h2*m1P1) - beta*pelu*(P1(i)+h2*m1P1)*(1-rho)*((C1(i)+h2*m1C1)+(R1(i)+h2*m1R1))*(1-u11) - miu*(P1(i)+h2*m1P1);
```

```
m2C1 = (1-rho)*beta*pelu*(P1(i)+h2*m1P1)*((C1(i)+h2*m1C1)+(R1(i)+h
```


$$2*m1R1) * (1-u11) - eta1 * (C1(i) + h2*m1C1) - delta * (C1(i) + h2*m1C1) - miu * (C1(i) + h2*m1C1);$$

$$m2R1 = rho * beta * pelu * (P1(i) + h2*m1P1) * ((C1(i) + h2*m1C1) + (R1(i) + h2*m1R1)) * (1-u22) + delta * (C1(i) + h2*m1C1) - eta2 * (R1(i) + h2*m1R1) - gamma * (R1(i) + h2*m1R1) - miu * (R1(i) + h2*m1R1);$$

$$m2RR1 = gamma * (R1(i) + h2*m1R1) - eta3 * (RR1(i) + h2*m1RR1) - miu * (RR1(i) + h2*m1RR1);$$

$$m3P1 = lamda + eta1 * (C1(i) + h2*m2C1) + eta2 * (R1(i) + h2*m2R1) + eta3 * (RR1(i) + h2*m2RR1) - ((C1(i) + h2*m2C1) + (R1(i) + h2*m2R1)) * (1-u22) * rho * beta * pelu * (P1(i) + h2*m2P1) - beta * pelu * (P1(i) + h2*m2P1) * (1-rho) * ((C1(i) + h2*m2C1) + (R1(i) + h2*m2R1)) * (1-u11) - miu * (P1(i) + h2*m2P1);$$

$$m3C1 = (1-rho) * beta * pelu * (P1(i) + h2*m2P1) * ((C1(i) + h2*m2C1) + (R1(i) + h2*m2R1)) * (1-u11) - eta1 * (C1(i) + h2*m2C1) - delta * (C1(i) + h2*m2C1) - miu * (C1(i) + h2*m2C1);$$

$$m3R1 = rho * beta * pelu * (P1(i) + h2*m2P1) * ((C1(i) + h2*m2C1) + (R1(i) + h2*m2R1)) * (1-u22) + delta * (C1(i) + h2*m2C1) - eta2 * (R1(i) + h2*m2R1) - gamma * (R1(i) + h2*m2R1) - miu * (R1(i) + h2*m2R1);$$

$$m3RR1 = gamma * (R1(i) + h2*m2R1) - eta3 * (RR1(i) + h2*m2RR1) - miu * (RR1(i) + h2*m2RR1);$$

$$m4P1 = lamda + eta1 * (C1(i) + h*m3C1) + eta2 * (R1(i) + h*m3R1) + eta3 * (RR1(i) + h*m3RR1) - ((C1(i) + h*m3C1) + (R1(i) + h*m3R1)) * (1-u22) * rho * beta * pelu * (P1(i) + h*m3P1) - beta * pelu * (P1(i) + h*m3P1) * (1-rho) * ((C1(i) + h*m3C1) + (R1(i) + h*m3R1)) * (1-u11) - miu * (P1(i) + h*m3P1);$$

$$m4C1 = (1-rho) * beta * pelu * (P1(i) + h*m3P1) * ((C1(i) + h*m3C1) + (R1(i) + h*m3R1)) * (1-u11) - eta1 * (C1(i) + h*m3C1) - delta * (C1(i) + h*m3C1) - miu * (C1(i) + h*m3C1);$$

$$m4R1 = rho * beta * pelu * (P1(i) + h*m3P1) * ((C1(i) + h*m3C1) + (R1(i) + h*m3R1)) * (1-u22) + delta * (C1(i) + h*m3C1) - eta2 * (R1(i) + h*m3R1) - gamma * (R1(i) + h*m3R1) - miu * (R1(i) + h*m3R1);$$

```

R1)) * (1-u22)+delta*(C1(i)+h*m3C1)-eta2*(R1(i)+h*m3R1)-
gamma*(R1(i)+h*m3R1)-miu*(R1(i)+h*m3R1);

m4RR1 = gamma*(R1(i)+h*m3R1)-eta3*(RR1(i)+h*m3RR1)-
miu*(RR1(i)+h*m3RR1);

P1(i+1) = P1(i) + (h/6)*(m1P1 + 2*m2P1 + 2*m3P1 + m4P1);
C1(i+1) = C1(i) + (h/6)*(m1C1 + 2*m2C1 + 2*m3C1 + m4C1
);
R1(i+1) = R1(i) + (h/6)*(m1R1 + 2*m2R1 + 2*m3R1 + m4R1
);
RR1(i+1) = RR1(i) + (h/6)*(m1RR1 + 2*m2RR1 + 2*m3RR1 +
m4RR1);

TP1(i+1)= P1(i+1)+ C1(i+1)+ R1(i+1)+ RR1(i+1);

end
%%%%%
temp1 = ((lambdaC(j)-lambdaP(j)) .* (1-
rho)*pelu.*P.*beta.*(C+R))/B;

temp2= ((lambdaR(j)-
lambdaP(j)) .* (rho*beta*pelu.*P.*(C+R)))/D;

ua = min(1,max(0,temp1));
ub = min(1,max(0,temp2));

u1 = 0.5*(ua + oldu1);
u2 = 0.5*(ub + oldu2);

tempu1 = deta*sum(abs(u1)) - sum(abs(oldu1 - u1));
tempu2 = deta*sum(abs(u2)) - sum(abs(oldu2 - u2));

tempP = deta*sum(abs(P)) - sum(abs(oldP - P));
tempC = deta*sum(abs(C)) - sum(abs(oldC - C));
tempR = deta*sum(abs(R)) - sum(abs(oldR - R));
tempRR = deta*sum(abs(RR)) - sum(abs(oldRR - RR));

templP = deta*sum(abs(lambdaP)) - sum(abs(olddlambdAP
- lambdaP));
templC = deta*sum(abs(lambdaC)) - sum(abs(olddlambdAC
- lambdaC));
templR = deta*sum(abs(lambdaR)) - sum(abs(olddlambdAR
- lambdaR));
templRR = deta*sum(abs(lambdaRR)) -
sum(abs(olddlambdARR - lambdaRR));

test1= min(min(tempP,tempC),tempR);

```

```

test = min (test1,tempRR);

disp(['it: ', num2str(kk), ', Test: ', num2str(test)]);

end
end
fprintf('jumlah iterasi = %i ',kk)
Kontrol(1,:) = t;
Kontrol(2,:) = P;
Kontrol(3,:) = C;
Kontrol(4,:) = R;
Kontrol(5,:) = RR;

Kontrol(6,:) = u1;
Kontrol(7,:) = u2;

Kontrol(8,:) = P1;
Kontrol(9,:) = C1;
Kontrol(10,:) = R1;
Kontrol(11,:) = RR1;

Kontrol(12,)= TP;
Kontrol(13,)= TP1;

fprintf('Hasil Akhir = Ko(:,end) ')

```

LAMPIRAN 2. Simulasi_thesis.m

```

close
clear
clc
pilih1=0;
pilih2=0;

lamda = 130;
eta1 = 0.15;
eta2 = 0.25;
eta3 = 0.21;
beta = 0.01;
pelu = 0.021;
rho=0.03;
miu = 0.02;
delta = 0.3;
gamma = 0.008;
u11=0;
u22=0;

%N =TP0= 2000;
A=50;
B=25;
D=25;

P0 = 4000;
C0 = 1000;
R0 = 600;
RR0= 400 ;
Ta = 50;

TP0 = 6000;
%du22=0.001;

Koo =
simulasi(lamda,miu,u11,u22,beta,pelu,gamma,delta,eta1,et
a2,eta3,rho,P0,C0,R0,RR0,A,B,D,Ta,TP0);

disp(' ')
clc
while(pilih1==0)
disp('=====')
====')
disp(' PILIH GRAFIK HASIL SIMULASI YANG INGIN
DITAMPILKAN ')
disp(' ATAU MENGAKHIRI SIMULASI
')

disp('=====')
====')
disp(' ')

```

```

disp(' 1. INDIVIDU BERSTATUS MENIKAH')
disp(' 2. INDIVIDU BERSTATUS PINDAH RANJANG')
disp(' 3. INDIVIDU BERSTATUS CERAI ')
disp(' 4. INDIVIDU BERSTATUS CERAI DAN DEPRESI/STRES ')
disp(' 5. TINGKAT KONTROL U1 DAN U2 ')
disp(' 6. SELESAI ')
disp('')
disp('')
pilih2=input('SILAHKAN PILIH 1, 2, 3, 4, 5, 6, 7 : ');
disp('')
disp('')
if pilih2==1

plot(Koo(1,:),Koo(2,:), '--
blue',Koo(1,:),Koo(8,:), 'green', 'linewidth',2)

xlabel('Waktu (dalam tahun)')
ylabel('M(t) (Populasi Yang Menikah)')
legend('M dengan Kontrol Optimal','M tanpa Kontrol')
grid on;

pilih1=0;
elseif(pilih2==2)
plot(Koo(1,:),Koo(3,:), '--
blue',Koo(1,:),Koo(9,:), 'green', 'linewidth',2)

xlabel('Waktu (dalam tahun)')
ylabel('S(t) ' (Populasi Yang Pisah Ranjang)')
legend('S dengan Kontrol Optimal','S tanpa Kontrol')
grid on;

pilih1=0;
elseif(pilih2==3)
%figure 1
plot(Koo(1,:),Koo(4,:), '--
blue',Koo(1,:),Koo(10,:), 'green', 'linewidth',2)

xlabel('Waktu (dalam tahun)')
ylabel('D(t) ' (Populasi Yang Cerai)')
legend('D dengan Kontrol Optimal','D tanpa Kontrol')
grid on;

pilih1=0;
elseif(pilih2==4)
%figure 1

plot(Koo(1,:),Koo(5,:), '--
blue',Koo(1,:),Koo(11,:), 'green', 'linewidth',2)

```

```

xlabel('Waktu (dalam tahun)')
ylabel('H(t) '(Populasi yang cerai dan depresi)')
legend('H dengan Kontrol Optimal','H tanpa Kontrol')
grid on;

pilih1=0;
elseif(pilih2==5)
%figure 1
plot(Koo(1,:),Koo(6,:), 'blue',Koo(1,:),Koo(7,:), 'green
','linewidth',2)
xlabel('waktu (dalam tahun),')
ylabel('u1* dan u2*')
legend('u1* campur tangan keluarga','u2* Pihak
eksternal(hakim)')
grid on;

pilih1=0;
elseif(pilih2==6)
pilih1=1;
end
end

clc

disp('')
disp('')
disp('')
disp('')
disp('HASIL AKHIR SIMULASI')
Koo(:,end)
pilih1=1;
disp('SELESAI')

```