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LAMPIRAN

Lampiran 1. Program MATLAB Hubungan k dan β Terhadap R_0 Serta Hubungan θ dan β Terhadap R_0 Pada Gambar 4.2 dan 4.3

```
% hubungan k dengan beta
clear all
close all
clc
k=0;
BETA=[];
K=[];
for i=1:100
    beta=(2.105263158*(10^-
10)*(1.364428125*(10^12)*k+8.527675781*(10^9)))/(128*k+5);
    BETA(end+1)=beta;
    K(end+1)=k;
    k=k+0.01;
end
plot(K,BETA,'-r','linewidth',3)
grid on
title('Hubungan Laju Vaksinasi dan Laju Infeksi Terhadap Angka
Reprduksi Dasar');
% ylim([2.168 2.17])
xlabel('Laju Vaksinasi');
ylabel('Laju Infeksi');
legend('R0=1')


%hubungan theta dengan beta

clear all
close all
clc
theta=0;
BETA=[];
THETA=[];
for i=1:100
    beta=1.149647960*theta+0.1761835498;
    BETA(end+1)=beta;
    THETA(end+1)=theta;
    theta=theta+0.01;
end
plot(THETA,BETA,'-b','linewidth',3)
grid on
title('Hubungan Laju Vaksinasi dan Laju Infeksi Terhadap Angka
Reprduksi Dasar');
% ylim([2.168 2.17])
xlabel('Laju Treatment');
ylabel('Laju Infeksi');
legend('R0=1')
```

Lampiran 2. Program MATLAB Simulasi Numerik Pada Dinamika Populasi $R_0 < 1$ Pada Gambar 4.4

```
clear all
close all
clc
% Parameter
t=0;
s=0.75;
v=0.05;
e=0.05;
i=0.05;
h=0.05;
r=0.05;
beta=0.2;
k=0.001;
mu=0.00625;
delta=0.001;
psi=0.0001;
gamma=0.146;
theta=0.2;
alpha=0.38;
eta=0.16;
xi=0.292;
st=0.05;
T=[t];
S=[s];
V=[v];
E=[e];
I=[i];
H=[h];
R=[r];

%%Skema Numerik
for p =1:50000

    k1s=st*(mu-(k+beta*i+mu)*s);
    k2s=st*(mu-(k+beta*(i+k1s/2)+mu)*(s+k1s/2));
    k3s=st*(mu-(k+beta*(i+k2s/2)+mu)*(s+k2s/2));
    k4s=st*(mu-(k+beta*(i+k3s/2)+mu)*(s+k3s/2));

    k1v=st*((k*s)-(eta*beta*i+mu)*v);
    k2v=st*((k*(s+k1v/2))-(eta*beta*(i+k1v/2)+mu)*(v+k1v/2));
    k3v=st*((k*(s+k2v/2))-(eta*beta*(i+k2v/2)+mu)*(v+k2v/2));
    k4v=st*((k*(s+k3v/2))-(eta*beta*(i+k3v/2)+mu)*(v+k3v/2));

    k1e=st*(beta*s*i+eta*beta*v*i-(alpha+mu)*e);
    k2e=st*(beta*(s+k1e/2)*(i+k1e/2)+eta*beta*(v+k1e/2)*(i+k1e/2)-
(alpha+mu)*(e+k1e/2));
    k3e=st*(beta*(s+k2e/2)*(i+k2e/2)+eta*beta*(v+k2e/2)*(i+k2e/2)-
(alpha+mu)*(e+k2e/2));
    k4e=st*(beta*(s+k3e/2)*(i+k3e/2)+eta*beta*(v+k3e/2)*(i+k3e/2)-
(alpha+mu)*(e+k3e/2));

    k1i=st*(alpha*e-(gamma+theta+delta+mu)*i);
```

```
    k2i=st*(alpha*(e+k1i/2)-(gamma+theta+delta+mu)*(i+k1i/2));
    k3i=st*(alpha*(e+k2i/2)-(gamma+theta+delta+mu)*(i+k2i/2));
    k4i=st*(alpha*(e+k3i/2)-(gamma+theta+delta+mu)*(i+k3i/2));

    k1h=st*(theta*i-(psi+xi+mu)*h);
    k2h=st*(theta*(i+k1h/2)-(psi+xi+mu)*(h+k1h/2));
    k3h=st*(theta*(i+k2h/2)-(psi+xi+mu)*(h+k2h/2));
    k4h=st*(theta*(i+k3h/2)-(psi+xi+mu)*(h+k3h/2));

    k1r=st*(gamma*i+xi*h-mu*r);
    k2r=st*(gamma*(i+k1r/2)+xi*(h+k1r/2)-mu*(r+k1r/2));
    k3r=st*(gamma*(i+k2r/2)+xi*(h+k1r/2)-mu*(r+k2r/2));
    k4r=st*(gamma*(i+k3r/2)+xi*(h+k3r/2)-mu*(r+k3r/2));

    s=s+(k1s+2*k2s+2*k3s+k4s)/6;
    v=v+(k1v+2*k2v+2*k3v+k4v)/6;
    e=e+(k1e+2*k2e+2*k3e+k4e)/6;
    i=i+(k1i+2*k2i+2*k3i+k4i)/6;
    h=h+(k1h+2*k2h+2*k3h+k4h)/6;
    r=r+(k1r+2*k2r+2*k3r+k4r)/6;
    t=t+st;
    T(end+1)=t;
    S(end+1)=s;
    V(end+1)=v;
    E(end+1)=e;
    I(end+1)=i;
    H(end+1)=h;
    R(end+1)=r;

end
%plotting

plot(T,S,'-g','linewidth',3);
grid on;
xlabel('Hari');ylabel('s(t)');
legend('s(t)')
xlim([0 1500])
axes('position',[.65 .175 .25 .25])
box on
plot(T,S,'-g','linewidth',3);
grid on
xlim([0 50])
ylim([0.7 0.75])

plot(T,V,'-c','linewidth',3);
grid on;
xlabel('Hari');ylabel('v(t)');
legend('v(t)')
xlim([0 1500])

plot(T,E,'-y','linewidth',3);
grid on;
xlabel('Hari');ylabel('e(t)');
legend('e(t)')
xlim([0 1500])
```

```
axes('position',[.65 .175 .25 .25])
box on
plot(T,E,'-y','linewidth',3);
grid on
xlim([0 50])
ylim([0 0.05])

plot(T,I,'-r','linewidth',3);
grid on;
xlabel('Hari');ylabel('i(t)');
legend('i(t)')
xlim([0 1500])
axes('position',[.65 .175 .25 .25])
box on
plot(T,I,'-r','linewidth',3);
grid on
xlim([0 50])
ylim([0 0.05])

plot(T,H,'-m','linewidth',3);
grid on;
xlabel('Hari');ylabel('h(t)');
legend('h(t)')
xlim([0 1500])
axes('position',[.65 .175 .25 .25])
box on
plot(T,H,'-m','linewidth',3);
grid on
xlim([0 50])
ylim([0 0.05])

plot(T,R,'-b','linewidth',3);
grid on;
xlabel('Hari');ylabel('r(t)');
legend('r(t)')
xlim([0 1500])
axes('position',[.65 .175 .25 .25])
box on
plot(T,R,'-b','linewidth',3);
grid on
xlim([0 100])
ylim([0.05 0.25])
```

Lampiran 3. Program MATLAB Simulasi Numerik Pada Dinamika Populasi $R_0 > 1$ Pada Gambar 4.5

```
clear all
close all
clc
% Parameter
t=0;
s=0.55;
v=0.05;
e=0.004;
i=0.004;
h=0.002;
r=0.39;
beta=0.6;
k=0.001;
mu=0.00625;
delta=0.001;
psi=0.0001;
gamma=0.146;
theta=0.2;
alpha=0.38;
eta=0.16;
xi=0.292;
st=0.05;
T=[t];
S=[s];
V=[v];
E=[e];
I=[i];
H=[h];
R=[r];

%%Skema Numerik
for p =1:50000

    k1s=st*(mu-(k+beta*i+mu)*s);
    k2s=st*(mu-(k+beta*(i+k1s/2)+mu)*(s+k1s/2));
    k3s=st*(mu-(k+beta*(i+k2s/2)+mu)*(s+k2s/2));
    k4s=st*(mu-(k+beta*(i+k3s/2)+mu)*(s+k3s/2));

    k1v=st*((k*s)-(eta*beta*i+mu)*v);
    k2v=st*((k*(s+k1v/2))-(eta*beta*(i+k1v/2)+mu)*(v+k1v/2));
    k3v=st*((k*(s+k2v/2))-(eta*beta*(i+k2v/2)+mu)*(v+k2v/2));
    k4v=st*((k*(s+k3v/2))-(eta*beta*(i+k3v/2)+mu)*(v+k3v/2));

    k1e=st*(beta*s*i+eta*beta*v*i-(alpha+mu)*e);
    k2e=st*(beta*(s+k1e/2)*(i+k1e/2)+eta*beta*(v+k1e/2)*(i+k1e/2)-
(alpha+mu)*(e+k1e/2));
    k3e=st*(beta*(s+k2e/2)*(i+k2e/2)+eta*beta*(v+k2e/2)*(i+k2e/2)-
(alpha+mu)*(e+k2e/2));
    k4e=st*(beta*(s+k3e/2)*(i+k3e/2)+eta*beta*(v+k3e/2)*(i+k3e/2)-
(alpha+mu)*(e+k3e/2));
```

```
    k1i=st*(alpha*e-(gamma+theta+delta+mu)*i);
    k2i=st*(alpha*(e+k1i/2)-(gamma+theta+delta+mu)*(i+k1i/2));
    k3i=st*(alpha*(e+k2i/2)-(gamma+theta+delta+mu)*(i+k2i/2));
    k4i=st*(alpha*(e+k3i/2)-(gamma+theta+delta+mu)*(i+k3i/2));

    k1h=st*(theta*i-(psi+xi+mu)*h);
    k2h=st*(theta*(i+k1h/2)-(psi+xi+mu)*(h+k1h/2));
    k3h=st*(theta*(i+k2h/2)-(psi+xi+mu)*(h+k2h/2));
    k4h=st*(theta*(i+k3h/2)-(psi+xi+mu)*(h+k3h/2));

    k1r=st*(gamma*i+xi*h-mu*r);
    k2r=st*(gamma*(i+k1r/2)+xi*(h+k1r/2)-mu*(r+k1r/2));
    k3r=st*(gamma*(i+k2r/2)+xi*(h+k1r/2)-mu*(r+k2r/2));
    k4r=st*(gamma*(i+k3r/2)+xi*(h+k3r/2)-mu*(r+k3r/2));

    s=s+(k1s+2*k2s+2*k3s+k4s)/6;
    v=v+(k1v+2*k2v+2*k3v+k4v)/6;
    e=e+(k1e+2*k2e+2*k3e+k4e)/6;
    i=i+(k1i+2*k2i+2*k3i+k4i)/6;
    h=h+(k1h+2*k2h+2*k3h+k4h)/6;
    r=r+(k1r+2*k2r+2*k3r+k4r)/6;
    t=t+st;
    T(end+1)=t;
    S(end+1)=s;
    V(end+1)=v;
    E(end+1)=e;
    I(end+1)=i;
    H(end+1)=h;
    R(end+1)=r;
end
%plotting

plot(T,S,'-g','linewidth',3);
grid on;
xlabel('Hari');ylabel('s(t)');
legend('s(t)')
xlim([0 2000])

plot(T,V,'-c','linewidth',3);
grid on;
xlabel('Hari');ylabel('v(t)');
legend('v(t)')
xlim([0 2000])

plot(T,E,'-y','linewidth',3);
grid on;
xlabel('Hari');ylabel('e(t)');
legend('e(t)')
xlim([0 2000])

plot(T,I,'-r','linewidth',3);
grid on;
xlabel('Hari');ylabel('i(t)');
legend('i(t)')
```

```
xlim([0 2000])

plot(T,H,'-m','linewidth',3);
grid on;
xlabel('Hari');ylabel('h(t)');
legend('h(t)')
xlim([0 2000])

plot(T,R,'-b','linewidth',3);
grid on;
xlabel('Hari');ylabel('r(t)');
legend('r(t)')
xlim([0 2000])
```