LAMPIRAN

Lampiran 1 Perhitungan titik tetap bebas penyakit

Titik tetap bebas penyakit dapat diperoleh dengan menyelesaikan sistem persamaan (9) sehingga:

$$\frac{dS}{dt} = A - \frac{\beta SI}{\alpha + \eta I} - \mu S + (1-\theta)m = 0$$

$$\frac{dI}{dt} = \frac{(1-k)\beta SI}{\alpha + \eta I} - \mu I - \delta_1 I - \sigma I - \alpha_1 I + \theta m = 0$$

$$\frac{dQ}{dt} = \frac{k\beta SI}{\alpha + \eta I} + \sigma I - \delta_2 Q - \mu Q - \alpha_2 Q = 0$$

Titik tetap bebas penyakit terjadi ketika $I = Q = 0$ dan $m = 0$, sehingga:

$$A - \frac{\beta S(0)}{\alpha + \eta(0)} - \mu S + 0 = 0$$

$$A - \mu S = 0$$

$$A = \mu S$$

$$S = \frac{A}{\mu}$$

Sehingga diperoleh titik tetap bebas penyakit

$$E_0 = (S_0, I_0, Q_0) = \left(\frac{A}{\mu}, 0, 0\right)$$

Lampiran 2 Perhitungan titik tetap endemik

```
using SymPy

A, a, n, b, u, k, d1, d2, o, a1, a2, t, m, s, i, q, r0 =
symbols("A, a, n, b, u, k, d1, d2, o, a1, a2, t, m, s, i, q,
r0", real = true)

f1 = A-((b*s*i)/(a+n*i))-u*s
S=solve(f1,s)

S=collect(S[1],i)

f2 = (((1-k)*(b*s*i))/(a+n*i))-u*i-d1*i-o*i-a1*i
f2 = f2.subs(s,(A*(a+i*n))/(a*u+i*(b+n*u)))
I=solve(f2,i)

factor(I[2])

I=collect(collect(collect(I[2],A),a*u),b)

I=simplify(I.subs(A*b*(1-k),(r0*(u*a*(u+d1+o+a1)))))

f3 = ((k*b*s*i)/(a+n*i))+o*i-d2*q-u*q-a2*q
f3 = f3.subs(s,(A*(a+i*n))/(a*u+i*(b+n*u)))
Q=solve(f3,q)

Q=simplify(collect(factor(Q[1]),i))

f11 = A-((b*s*i)/(a+n*i))-u*s+(1-t)*m
S1=solve(f11,s)

S1=simplify(collect(collect(factor(S1[1]),i),m))

f33 = ((k*b*s*i)/(a+n*i))+o*i-d2*q-u*q-a2*q
f33 = f33.subs(s,((A-m*(t-1))*(a+i*n))/(a*u+i*(b+n*u)))
Q1=solve(f33,q)

Q1=simplify(collect(collect(collect(factor(Q1[1]),b*k),i),m))

f22 = (((1-k)*(b*s*i))/(a+n*i))-u*i-d1*i-o*i-a1*i+t*m
f22 = f22.subs(s,((A-m*(t-1))*(a+i*n))/(a*u+i*(b+n*u)))

f22=collect(expand(f22),(A*b*i)/(a*u+b*i+i*n*u))

f22=f22.subs(A*b*(1-k),(r0*(u*a*(u+d1+o+a1))))

I1=collect(collect(collect(collect(collect(collect(collect(col
lect(collect(collect(collect((collect(cancel(f22),i)),m),b),n*
u),a),u),a1),d1),o),k),r0-1),a1+d1+o+u)
```

Lampiran 3 Pembuktian proposisi 1

Pelinearan pada titik tetap bebas penyakit E_0 akan menghasilkan matriks jacobi sebagai berikut:

$$J_{E_0} = \begin{pmatrix} a_{11} & a_{12} & 0 \\ 0 & a_{22} & 0 \\ 0 & a_{32} & a_{33} \end{pmatrix}$$

$$a_{11} = -\mu$$
$$a_{12} = -\frac{\beta A}{\alpha\mu} \qquad a_{32} = \frac{\beta A}{\alpha\mu} + \sigma$$
$$a_{22} = \frac{(1-k)\beta A}{\alpha\mu} - \mu - \delta_1 - \sigma - \alpha_1 \qquad a_{33} = -\delta_2 - \mu - \alpha_2$$

Nilai eigen untuk titik tetap bebas penyakit E_0 diperoleh sebagai berikut:

$$|J_{E_0} - \lambda I_3| = 0$$

atau

$$\begin{vmatrix} a_{11}-\lambda & a_{12} & 0 \\ 0 & a_{22}-\lambda & 0 \\ 0 & a_{32} & a_{33}-\lambda \end{vmatrix} = 0$$

Sehingga diperoleh persamaan karakteristik sebagai berikut:

$$(-\mu-\lambda)\left(\frac{(1-k)\beta A}{\alpha\mu} - \mu - \delta_1 - \sigma - \alpha_1 - \lambda\right)(-\delta_2 - \mu - \alpha_2 - \lambda) = 0$$

Sehingga diperoleh nilai eigen sebagai berikut:

$$\lambda_1 = -\mu \ \ (< 0)$$
$$\lambda_2 = -\delta_2 - \mu - \alpha_2 \ \ (< 0)$$
$$\begin{aligned} \lambda_3 &= \frac{(1-k)\beta A}{\alpha\mu} - \mu - \delta_1 - \sigma - \alpha_1 \\ &= \frac{(1-k)\beta A}{\alpha\mu} - (\mu + \delta_1 + \sigma + \alpha_1) \\ &= \frac{(1-k)\beta A(\mu + \delta_1 + \sigma + \alpha_1)}{\alpha\mu(\mu + \delta_1 + \sigma + \alpha_1)} - (\mu + \delta_1 + \sigma + \alpha_1) \\ &= \mathcal{R}_0(\mu + \delta_1 + \sigma + \alpha_1) - (\mu + \delta_1 + \sigma + \alpha_1) \\ &= (\mathcal{R}_0 - 1)(\mu + \delta_1 + \sigma + \alpha_1) \end{aligned}$$

λ_3 akan bernilai negatif jika $\mathcal{R}_0 < 1$, sehingga titik tetap E_0 akan bersifat stabil asimtotik local jika $\mathcal{R}_0 < 1$.

Lampiran 4 Pembuktian proposisi 2

Untuk mengetahui kestabilan global akan digunakan kriteria Bendixon-Dulac. Misalkan,

$$\frac{dI}{dt} = \frac{(1-k)\beta SI}{\alpha + \eta I} - (\mu + \delta_1 + \sigma + \alpha_1)I = f_1$$

$$\frac{dQ}{dt} = \frac{k\beta SI}{\alpha + \eta I} + \sigma I - (\delta_2 + \mu + \alpha_2)Q = f_2$$

Kemudian, ditentukan fungsi dulac sebagai berikut

$$g(I,Q) = \frac{1}{IQ}$$

Oleh karena itu

$$L(I,Q) = \frac{\partial(gf_1)}{\partial I} + \frac{\partial(gf_2)}{\partial Q}$$

$$= \frac{\partial}{\partial I}\left(\frac{1}{IQ}\left(\frac{(1-k)\beta SI}{\alpha + \eta I} - (\mu + \delta_1 + \sigma + \alpha_1)I\right)\right) + \frac{\partial}{\partial Q}\left(\frac{1}{IQ}\left(\frac{k\beta SI}{\alpha + \eta I} + \sigma I_1 - (\delta_2 + \mu + \alpha_2)Q\right)\right)$$

$$= \frac{\partial}{\partial I}\left(\frac{1}{Q}\left(\frac{(1-k)\beta S}{\alpha + \eta I} - \mu + \delta_1 + \sigma + \alpha_1\right)\right) + \frac{\partial}{\partial Q}\left(\frac{1}{Q}\left(\frac{k\beta S}{\alpha + \eta I} + \sigma\right) - \frac{1}{I}(\delta_2 + \mu + \alpha_2)\right)$$

$$= -\frac{1}{Q}\frac{(1-k)\beta\eta S}{(\alpha + \eta I)^2} - \frac{1}{Q^2}\frac{k\beta S}{\alpha + \eta I} - \frac{1}{Q^2}\sigma < 1$$

Untuk setiap $I, Q > 0$. Karena $L(I,Q)$ tidak berubah tanda dan tidak nol identik pada kuadran positif bidang $I - Q$, maka berdasarkan kriteria Bendixson-Dulac system tidak memiliki solusi periodic di daerah $\mathcal{R}_+^2$ bidang $I - Q$. Karena tidak ada solusi periodic di daerah $\mathcal{R}_+^2$ bidang $I - Q$ maka tidak ada yang membatasi daerah kestabilan asimtotik. Oleh karena itu titik tetap bebas penyakit akan selalu stabil asimtotik local ketika $\mathcal{R}_0 < 1$, dan stabil asimtotik global di daerah $\mathcal{R}_+^2$ bidang $I - Q$ jika $\mathcal{R}_0 < 1$

Lampiran 5 Pembuktian proposisi 3

Nilai eigen untuk titik tetap bebas penyakit E_0 diperoleh sebagai berikut:

$$\left|J_{E_1} - \lambda I_3\right| = 0$$

atau

$$\begin{vmatrix} b_{11} - \lambda & b_{12} & 0 \\ b_{21} & b_{22} - \lambda & 0 \\ b_{31} & b_{32} & b_{33} - \lambda \end{vmatrix} = 0$$

Sehingga diperoleh persamaan karakteristik sebagai berikut:

$$(b_{11} - \lambda)(b_{22} - \lambda)(b_{33} - \lambda) - (b_{33} - \lambda)b_{21}b_{12} = 0$$
$$(b_{33} - \lambda)((b_{11} - \lambda)(b_{22} - \lambda) - b_{21}b_{12}) = 0$$
$$(b_{33} - \lambda)(b_{11}b_{22} - \lambda b_{22} - \lambda b_{11} + \lambda^2 - b_{21}b_{12}) = 0$$
$$(b_{33} - \lambda)(\lambda^2 - (b_{22} + b_{11})\lambda + (b_{11}b_{22} - b_{21}b_{12})) = 0$$

Sehingga diperoleh nilai eigen sebagai berikut:

$$\begin{aligned} \lambda_1 &= b_{33} \\ &= -\delta_2 - \mu - \alpha_2 \\ &= -(\delta_2 + \mu + \alpha_2)\ (< 0) \end{aligned}$$

$$\lambda_{2,3} = \frac{(b_{22} + b_{11}) \pm \sqrt{(-b_{22} - b_{11})^2 - 4(b_{11}b_{22} - b_{21}b_{12})}}{2}$$

$$= \frac{(b_{22} + b_{11}) \pm \sqrt{{b_{22}}^2 + 2b_{11}b_{22} + {b_{11}}^2 - 4b_{11}b_{22} + 4b_{21}b_{12}}}{2}$$

$$= \frac{(b_{22} + b_{11}) \pm \sqrt{{b_{22}}^2 - 2b_{11}b_{22} + {b_{11}}^2 + 4b_{21}b_{12}}}{2}$$

$$= \frac{(b_{22} + b_{11}) \pm \sqrt{(b_{22} - b_{11})^2 + 4b_{21}b_{12}}}{2}$$

λ_2 dan λ_3 akan bernilai negatif jika $(b_{22} + b_{11}) < 0$ dan populasi terinfeksi bernilai positif jika $\mathcal{R}_0 > 1$, sehingga titik tetap E_1 akan bersifat stabil asimtotik lokal jika $(b_{22} + b_{11}) < 0$.

Lampiran 6 Perhitungan indeks sensitivitas

- Indeks sensitivitas k

$$\Upsilon_k^{\mathcal{R}_0} = \frac{k}{\mathcal{R}_0} \times \frac{\partial \mathcal{R}_0}{\partial k}$$

$$= \frac{k}{\frac{(1-k)\beta A}{\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)}} \times \frac{-\beta A}{\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)}$$

$$= \frac{k\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)}{(1-k)\beta A} \times \frac{-\beta A}{\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)}$$

$$= -\frac{k}{(1-k)}$$

$$= -\frac{0.5}{(1-0,5)} = -1$$

- Indeks sensitivitas α

$$\Upsilon_\alpha^{\mathcal{R}_0} = \frac{\alpha}{\mathcal{R}_0} \times \frac{\partial \mathcal{R}_0}{\partial \alpha}$$

$$= \frac{\alpha}{\frac{(1-k)\beta A}{\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)}} \times \frac{-\mu(\mu+\delta_1+\sigma+\alpha_1)(1-k)\beta A}{(\mu\alpha(\mu+\delta_1+\sigma+\alpha_1))^2}$$

$$= \frac{\mu\alpha^2(\mu+\delta_1+\sigma+\alpha_1)}{(1-k)\beta A} \times \frac{-\mu(\mu+\delta_1+\sigma+\alpha_1)(1-k)\beta A}{\left(\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)\right)^2} = -1$$

- Indeks sensitivitas δ_1

$$\Upsilon_{\delta_1}^{\mathcal{R}_0} = \frac{\delta_1}{\mathcal{R}_0} \times \frac{\partial \mathcal{R}_0}{\partial \delta_1}$$

$$= \frac{\delta_1}{\frac{(1-k)\beta A}{\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)}} \times \frac{-\mu\alpha(1-k)\beta A}{(\mu\alpha(\mu+\delta_1+\sigma+\alpha_1))^2}$$

$$= \frac{\delta_1\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)}{(1-k)\beta A} \times \frac{-\mu\alpha(1-k)\beta A}{\left(\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)\right)^2}$$

$$= -\frac{\delta_1}{\mu+\delta_1+\sigma+\alpha_1}$$

$$= -\frac{0.1}{3.57\times 10^{-5} + 0.1 + 0.59 + 0.06} = -0.13332$$

- Indeks sensitivitas σ

$$\Upsilon_{\sigma}^{\mathcal{R}_0} = \frac{\sigma}{\mathcal{R}_0}\times\frac{\partial\mathcal{R}_0}{\partial\sigma}$$

$$= \frac{\sigma}{\frac{(1-k)\beta A}{\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)}}\times\frac{-\mu\alpha(1-k)\beta A}{(\mu\alpha(\mu+\delta_1+\sigma+\alpha_1))^2}$$

$$= \frac{\sigma\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)}{(1-k)\beta A}\times\frac{-\mu\alpha(1-k)\beta A}{\left(\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)\right)^2}$$

$$= -\frac{\sigma}{\mu+\delta_1+\sigma+\alpha_1}$$

$$= -\frac{0.59}{3.57\times 10^{-5} + 0.1 + 0.59 + 0.06} = -0.7866$$

- Indeks sensitivitas α_1

$$\Upsilon_{\alpha_1}^{\mathcal{R}_0} = \frac{\alpha_1}{\mathcal{R}_0}\times\frac{\partial\mathcal{R}_0}{\partial\alpha_1}$$

$$= \frac{\alpha_1}{\frac{(1-k)\beta A}{\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)}}\times\frac{-\mu\alpha(1-k)\beta A}{(\mu\alpha(\mu+\delta_1+\sigma+\alpha_1))^2}$$

$$= \frac{\alpha_1\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)}{(1-k)\beta A}\times\frac{-\mu\alpha(1-k)\beta A}{\left(\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)\right)^2}$$

$$= -\frac{\alpha_1}{\mu+\delta_1+\sigma+\alpha_1}$$

$$= -\frac{0.06}{3.57\times 10^{-5} + 0.1 + 0.59 + 0.06} = -0.07999$$

- Indeks sensitivitas β

$$\Upsilon_{\beta}^{\mathcal{R}_0} = \frac{\beta}{\mathcal{R}_0}\times\frac{\partial\mathcal{R}_0}{\partial\beta}$$

$$= \frac{\beta}{\frac{(1-k)\beta A}{\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)}}\times\frac{-\mu\alpha(1-k)A}{(\mu\alpha(\mu+\delta_1+\sigma+\alpha_1))^2}$$

$$= \frac{\beta\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)}{(1-k)\beta A} \times \frac{(1-k)A}{\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)} = 1$$

- Indeks sensitivitas A

$$\Upsilon_A^{\mathcal{R}_0} = \frac{A}{\mathcal{R}_0} \times \frac{\partial \mathcal{R}_0}{\partial A}$$

$$= \frac{A}{\frac{(1-k)\beta A}{\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)}} \times \frac{-\mu\alpha(1-k)\beta}{(\mu\alpha(\mu+\delta_1+\sigma+\alpha_1))^2}$$

$$= \frac{A\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)}{(1-k)\beta A} \times \frac{(1-k)\beta}{\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)} = 1$$

- Indeks sensitivitas μ

$$\Upsilon_\mu^{\mathcal{R}_0} = \frac{\mu}{\mathcal{R}_0} \times \frac{\partial \mathcal{R}_0}{\partial \mu}$$

$$= \frac{\mu}{\frac{(1-k)\beta A}{\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)}} \times \frac{-(2\alpha\mu+\alpha\delta_1+\alpha\sigma+\alpha\alpha_1)(1-k)\beta A}{(\mu\alpha(\mu+\delta_1+\sigma+\alpha_1))^2}$$

$$= \frac{\mu^2\alpha(\mu+\delta_1+\sigma+\alpha_1)}{(1-k)\beta A} \times \frac{-\alpha(2\mu+\delta_1+\sigma+\alpha_1)(1-k)\beta A}{\left(\mu\alpha(\mu+\delta_1+\sigma+\alpha_1)\right)^2}$$

$$= \frac{-(2\mu+\delta_1+\sigma+\alpha_1)}{(\mu+\delta_1+\sigma+\alpha_1)}$$

$$= \frac{-(\mu+\mu+\delta_1+\sigma+\alpha_1)}{(\mu+\delta_1+\sigma+\alpha_1)}$$

$$= -\frac{\mu}{(\mu+\delta_1+\sigma+\alpha_1)} - \frac{(\mu+\delta_1+\sigma+\alpha_1)}{(\mu+\delta_1+\sigma+\alpha_1)}$$

$$= -\frac{\mu}{(\mu+\delta_1+\sigma+\alpha_1)} - 1$$

$$= -\frac{3.57\times10^{-5}}{3.57\times10^{-5}+0.1+0.59+0.06} - 1 = -1.0005$$

Lampiran 7 syntaks simulasi numerik

```
using DifferentialEquations
using Plots

function SIQ!(f, u, p, t)
    i = u[1]
    s = u[2]
    q = u[3]

    f[1] = (((1-k)*(b*s*i))/(a+n*i))-uu*i-d1*i-o*i-a1*i+tt*m
    f[2] = aa-((b*s*i)/(a+n*i))-uu*s+(1-tt)*m
    f[3] = ((k*b*s*i)/(a+n*i))+o*i-d2*q-uu*q-a2*q
end

u0 = [10; 10374231; 0] #nilai awal [I(0),S(0),Q(0)]

time_span = (0.0, 30000.0)
time_span1 = (0.0, 20.0)
time_span2 = (0.0, 60.0)
;

#parameter yang digunakan
aa = 391 #tingkat pertumbuhan
a = 5.0 #konstanta setengah saturasi
n = 1.0 #konstanta positif
uu = 3.57*10^-5 #tingkat kematian alami
k = 0.5 #tingkat pelacakan kontak
d1 = 0.1 #tingkat kesembuhan populasi terinfeksi
d2 = 0.1 #tingkat kesembuhan populasi dikarantina
o = 0.59 #tingkat transisi dari populasi terinfeksi ke populasi
     dikarantina
a1 = 0.06 #tingkat kematian akibat penyakit pada populasi
     terinfeksi
a2 = 0.06 #tingkat kematian akibat penyakit pada populasi
     dikarantina
tt= 0.9 #tingkat migran yang terinfeksi
;

#r0<1

b = 6*10^-7
k = 0.5
m = 0

prob_r1 = ODEProblem(SIQ!, u0, time_span)
prob_r11 = ODEProblem(SIQ!, u0, time_span2)
sol_r1 = solve(prob_r1, saveat=1);
sol_r11 = solve(prob_r11, saveat=0.0001);

plot(sol_r1, size=(950,450), layout=(1,2),xaxis="t",
     yaxis="Populasi", color=["red" "blue" "green"],labels = ["I"
     "S" "Q"], lw = 2, legends= :outertopright)

savefig("r1")

plot(sol_r11,size=(950,450), layout=(1,2),xaxis="t",
     yaxis="Populasi", color=["red" "blue" "green"],labels = ["I"
     "S" "Q"], lw = 2, legends= :outertopright)
```

```
savefig("r11")

#r0>1

b = 2.6*10^-6
k = 0.5
m = 0

prob_r2 = ODEProblem(SIQ!, u0, time_span)
prob_r22 = ODEProblem(SIQ!, u0, time_span2)
sol_r2 = solve(prob_r2, saveat=1);
sol_r22 = solve(prob_r22, saveat=0.0001);

plot(sol_r2, size=(950,450), layout=(1,2),xaxis="t",
     yaxis="Populasi", color=["red" "blue" "green"],labels = ["I"
     "S" "Q"], lw = 2, legends= :outertopright)

savefig("r2")

plot(sol_r22, size=(950,450), layout=(1,2),xaxis="t",
     yaxis="Populasi", color=["red" "blue" "green"],labels = ["I"
     "S" "Q"], lw = 2, legends= :outertopright)

savefig("r22")



#lockdown

b = 2.6*10^-6
k = 0.5
m = 0
prob_m1 = ODEProblem(SIQ!, u0, time_span1)
sol_m1 = solve(prob_m1, saveat=0.0001);

b = 2.6*10^-6
k = 0.5
m=100
prob_m2 = ODEProblem(SIQ!, u0, time_span1)
sol_m2 = solve(prob_m2, saveat=0.0001);

b = 2.6*10^-6
k = 0.5
m=250
prob_m3 = ODEProblem(SIQ!, u0, time_span1)
sol_m3 = solve(prob_m3, saveat=0.0001);

b = 2.6*10^-6
k = 0.5
m=500
prob_m4 = ODEProblem(SIQ!, u0, time_span1)
sol_m4 = solve(prob_m4, saveat=0.0001);

plot(sol_m1, size=(1800,1000), layout=(2,2),xaxis="t",
     yaxis="Populasi Terinfeksi", color=["orange"],labels = "m=0",
     lw = 2, legends= :outertopright)
plot!(sol_m2, color=["navy"],labels = "m=100", lw = 2)
plot!(sol_m3, color=["magenta"],labels = "m=250", lw = 2)
```

```
plot!(sol_m4, color=["dark green"],labels = "m=500", lw = 2)

savefig("lockdown")

#b

b = 6*10^-7
k = 0.5
m = 0
prob_b1 = ODEProblem(SIQ!, u0, time_span1)
sol_b1 = solve(prob_b1, saveat=0.0001);

b = 2*10^-6
k = 0.5
m = 0
prob_b2 = ODEProblem(SIQ!, u0, time_span1)
sol_b2 = solve(prob_b2, saveat=0.0001);

b = 2.6*10^-6
k = 0.5
m = 0
prob_b3 = ODEProblem(SIQ!, u0, time_span1)
sol_b3 = solve(prob_b3, saveat=0.0001);

b = 4*10^-6
k = 0.5
m = 0
prob_b4 = ODEProblem(SIQ!, u0, time_span1)
sol_b4 = solve(prob_b4, saveat=0.0001);

plot(sol_b1, size=(1800,1000), layout=(2,2),xaxis="t",
     yaxis="Populasi Terinfeksi", color=["orange"],labels = "b =
     0.0000006", lw = 2, legends= :outertopright)
plot!(sol_b2, color=["navy"],labels = "b = 0.000002", lw = 2)
plot!(sol_b3, color=["magenta"],labels = "b = 0.0000026", lw = 2)
plot!(sol_b4, color=["dark green"],labels = "b = 0.000004", lw =
     2)

savefig("b")

#k

b = 2.6*10^-6
k = 0.1
m = 0
prob_k1 = ODEProblem(SIQ!, u0, time_span1)
sol_k1 = solve(prob_k1, saveat=0.0001);

b = 2.6*10^-6
k = 0.5
m = 0
prob_k2 = ODEProblem(SIQ!, u0, time_span1)
sol_k2 = solve(prob_k2, saveat=0.0001);

b = 2.6*10^-6
k = 0.7
m = 0
prob_k3 = ODEProblem(SIQ!, u0, time_span1)
sol_k3 = solve(prob_k3, saveat=0.0001);
```

```
b = 2.6*10^-6
k = 0.9
m = 0
prob_k4 = ODEProblem(SIQ!, u0, time_span1)
sol_k4 = solve(prob_k4, saveat=0.0001);

plot(sol_k1, size=(1800,1000), layout=(2,2),xaxis="t",
     yaxis="Populasi Terinfeksi", color=["orange"],labels =
     "k=0.1", lw = 2, legends= :outertopright)
plot!(sol_k2, color=["navy"],labels = "k=0.5", lw = 2)
plot!(sol_k3, color=["magenta"],labels = "k=0.7", lw = 2)
plot!(sol_k4, color=["dark green"],labels = "k=0.9", lw = 2)

savefig("k")
```