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LAMPIRAN

Lampiran 1. Titik kesetimbangan bebas penyakit dan titik kesetimbangan endemik model penyebaran penyakit HIV/AIDS

```
> with(plots) : with(linalg) : with(VectorCalculus) :
> P1 := μ − (1 − p)·β·X1·(X3 + X4) − μ·X1
> P2 := (1 − p)·β·X1·(X3 + X4) - (γ + μ)·X2
> P3 := γ·X2 + δ·X4 − (k1 + k2 + μ)·X3
> P4 := k1·X3 − (δ + ω + μ)·X4
> P5 := k2·X3 + ω·X4 − ((1 − q)·σ + μ + d)·X5
> P6 := q·σ·X5 − (μ + d)·X6
> fixedpoint := solve({P1, P2, P3, P4, P5, P6}, {X1, X2, X3, X4, X5, X6})
```

Lampiran 2. Penentuan bilangan reproduksi dasar

```
> restart :
> with(linalg) :
>
c1 := matrix(5, 5, [A, 0, 0, 0, 0, -γ, B, -δ, 0, 0, 0, -k1, C, 0, 0, 0, -k2, -ω, D1, 0, 0, 0, 0, -(1 − q)
    · σ, E])
```

$$c1 := \begin{bmatrix} A & 0 & 0 & 0 & 0 \\ -\gamma & B & -\delta & 0 & 0 \\ 0 & -k_1 & C & 0 & 0 \\ 0 & -k_2 & -\omega & D1 & 0 \\ 0 & 0 & 0 & -(1-q)\,\sigma & E \end{bmatrix}$$

```
> X1 := 1
```

$$X_1 := 1$$

```
> c2 := matrix(5, 5, [0, (1 − p)·β·X1, (1 − p)·β·X1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
    0, 0, 0, 0])
```

$$c2 := \begin{bmatrix} 0 & (1-p)\,\beta & (1-p)\,\beta & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

> $c3 := inverse(c1)$

$$c3 := \left[\left[\frac{1}{A}, 0, 0, 0, 0\right],\right.$$
$$\left[\frac{\gamma C}{A\left(B C - \delta k_1\right)}, \frac{C}{B C - \delta k_1}, \frac{\delta}{B C - \delta k_1}, 0, 0\right],$$
$$\left[\frac{\gamma k_1}{A\left(B C - \delta k_1\right)}, \frac{k_1}{B C - \delta k_1}, \frac{B}{B C - \delta k_1}, 0, 0\right],$$
$$\left[\frac{\gamma\left(C k_2 + k_1 \omega\right)}{A D1\left(B C - \delta k_1\right)}, \frac{C k_2 + k_1 \omega}{D1\left(B C - \delta k_1\right)}, \frac{B \omega + \delta k_2}{D1\left(B C - \delta k_1\right)}, \frac{1}{D1}, 0\right],$$
$$\left[-\frac{\gamma \sigma\left(C k_2 q + k_1 \omega q - C k_2 - k_1 \omega\right)}{A D1 E\left(B C - \delta k_1\right)}, -\frac{\sigma\left(C k_2 q + k_1 \omega q - C k_2 - k_1 \omega\right)}{D1 E\left(B C - \delta k_1\right)},\right.$$
$$\left.\left.-\frac{\sigma\left(B \omega q + \delta k_2 q - B \omega - \delta k_2\right)}{D1 E\left(B C - \delta k_1\right)}, -\frac{(q-1)\,\sigma}{D1 E}, \frac{1}{E}\right]\right]$$

> $evalm(c2.c3)$

$$\left[\left[\frac{(1-p)\,\beta\gamma C}{A\left(B C - \delta k_1\right)} + \frac{(1-p)\,\beta\gamma k_1}{A\left(B C - \delta k_1\right)}, \frac{(1-p)\,\beta C}{B C - \delta k_1} + \frac{(1-p)\,\beta k_1}{B C - \delta k_1}, \frac{(1-p)\,\beta\delta}{B C - \delta k_1}\right.\right.$$
$$\left.+ \frac{(1-p)\,\beta B}{B C - \delta k_1}, 0, 0\right],$$
$$\left[0, 0, 0, 0, 0\right],$$
$$\left[0, 0, 0, 0, 0\right],$$
$$\left[0, 0, 0, 0, 0\right],$$
$$\left.\left[0, 0, 0, 0, 0\right]\right]$$

> $f0 := \text{lambda}$

$$f0 := \lambda$$

> $E := matrix(5, 5, [f0, 0, 0, 0, 0, 0, f0, 0, 0, 0, 0, 0, f0, 0, 0, 0, 0, 0, f0, 0, 0, 0, 0, 0, f0])$

$$E := \begin{bmatrix} \lambda & 0 & 0 & 0 & 0 \\ 0 & \lambda & 0 & 0 & 0 \\ 0 & 0 & \lambda & 0 & 0 \\ 0 & 0 & 0 & \lambda & 0 \\ 0 & 0 & 0 & 0 & \lambda \end{bmatrix}$$

> $G := evalm(c2.c3)$

$$G := \left[\left[\frac{(1-p)\,\beta\,\gamma\,C}{A\left(B\,C-\delta\,k_1\right)}+\frac{(1-p)\,\beta\,\gamma\,k_1}{A\left(B\,C-\delta\,k_1\right)}, \frac{(1-p)\,\beta\,C}{B\,C-\delta\,k_1}+\frac{(1-p)\,\beta\,k_1}{B\,C-\delta\,k_1}, \frac{(1-p)\,\beta\,\delta}{B\,C-\delta\,k_1}+\frac{(1-p)\,\beta\,B}{B\,C-\delta\,k_1}, 0, 0\right], \left[0, 0, 0, 0, 0\right], \left[0, 0, 0, 0, 0\right], \left[0, 0, 0, 0, 0\right], \left[0, 0, 0, 0, 0\right]\right]$$

> $J := evalm(E - G)$

$$J := \left[\left[\lambda-\frac{(1-p)\,\beta\,\gamma\,C}{A\left(B\,C-\delta\,k_1\right)}-\frac{(1-p)\,\beta\,\gamma\,k_1}{A\left(B\,C-\delta\,k_1\right)}, -\frac{(1-p)\,\beta\,C}{B\,C-\delta\,k_1}-\frac{(1-p)\,\beta\,k_1}{B\,C-\delta\,k_1}, -\frac{(1-p)\,\beta\,\delta}{B\,C-\delta\,k_1}-\frac{(1-p)\,\beta\,B}{B\,C-\delta\,k_1}, 0, 0\right], \left[0, \lambda, 0, 0, 0\right], \left[0, 0, \lambda, 0, 0\right], \left[0, 0, 0, \lambda, 0\right], \left[0, 0, 0, 0, \lambda\right]\right]$$

> $J1 := det(J)$

$$J1 := \left(\lambda-\frac{(1-p)\,\beta\,\gamma\,C}{A\left(B\,C-\delta\,k_1\right)}-\frac{(1-p)\,\beta\,\gamma\,k_1}{A\left(B\,C-\delta\,k_1\right)}\right)\lambda^4$$

> $R0 := \frac{(1-p)\,\beta\,\gamma\,C}{A\left(B\,C-\delta\,k_1\right)}+\frac{(1-p)\,\beta\,\gamma\,k_1}{A\left(B\,C-\delta\,k_1\right)}$

$$R0 := \frac{(1-p)\,\beta\,\gamma\,C}{A\left(B\,C-\delta\,k_1\right)}+\frac{(1-p)\,\beta\,\gamma\,k_1}{A\left(B\,C-\delta\,k_1\right)}$$

> $simplify(R0)$

$$-\frac{(-1+p)\,\beta\,\gamma\left(C+k_1\right)}{A\left(B\,C-\delta\,k_1\right)}$$

> $A := \gamma+\mu;\ B := k_1+k_2+\mu;\ C := \delta+\omega+\mu;\ D1 := (1-q)\cdot\sigma+\mu+d;\ E := \mu+d$

$$A := \gamma+\mu$$

$$B := k_1+k_2+\mu$$

$$C := \delta+\omega+\mu$$

$$D1 := (1-q)\,\sigma+\mu+d$$

$$E := \mu+d$$

> $R0$

$$\frac{(1-p)\,\beta\,\gamma\left(\delta+\omega+\mu\right)}{(\gamma+\mu)\left(\left(k_1+k_2+\mu\right)\left(\delta+\omega+\mu\right)-\delta\,k_1\right)}+\frac{(1-p)\,\beta\,\gamma\,k_1}{(\gamma+\mu)\left(\left(k_1+k_2+\mu\right)\left(\delta+\omega+\mu\right)-\delta\,k_1\right)}$$

> $simplify(R0)$

$$-\frac{(-1+p)\,\beta\,\gamma\left(\delta+\omega+\mu+k_1\right)}{(\gamma+\mu)\left(\delta\,k_2+\delta\,\mu+k_1\,\mu+k_1\,\omega+k_2\,\mu+k_2\,\omega+\mu^2+\mu\,\omega\right)}$$

Lampiran 3. Analisis sensitivitas bilangan repropduksi dasar

> $restart:$
> $with(linalg):$
>

$\#\beta := 0.06; \mu := 0.02; \delta := 0.01;\ k_1 := 0.01;\ k_2 := 0.02;\ \gamma I := 0.17;\ \omega := 0.05;\ p := 0.08;\ q := 0.9;\ \sigma := 0.03;\ d := 0.5$

> $R0 := -\frac{(-1+p)\,\beta\,\gamma I\left(\delta+\omega+\mu+k_1\right)}{(\gamma I+\mu)\left(\delta\,k_2+\delta\,\mu+k_1\,\mu+k_1\,\omega+k_2\,\mu+k_2\,\omega+\mu^2+\mu\,\omega\right)}$

$$R0 := -\frac{(-1+p)\,\beta\,\gamma I\left(\delta+\omega+\mu+k_1\right)}{(\gamma I+\mu)\left(\delta\,k_2+\delta\,\mu+k_1\,\mu+k_1\,\omega+k_2\,\mu+k_2\,\omega+\mu^2+\mu\,\omega\right)}$$

> 7

7

>

> $diff(R0, p)$

$$-\frac{\beta\,\gamma I\left(\delta+\omega+\mu+k_1\right)}{\left(\gamma I+\mu\right)\left(\delta k_2+\delta\mu+k_1\mu+k_1\omega+k_2\mu+k_2\omega+\mu^2+\mu\omega\right)}$$

> $$-\frac{\beta\,\gamma I\left(\delta+\omega+\mu+k_1\right)}{\left(\gamma I+\mu\right)\left(\delta k_2+\delta\mu+k_1\mu+k_1\omega+k_2\mu+k_2\omega+\mu^2+\mu\omega\right)}\cdot\frac{p}{R0}$$

$$\frac{p}{-1+p}$$

> $diff(R0, q)$

$$0$$

>

$$-\left(\left(-1+p\right)\beta D(\varepsilon)\left(\eta q-q\sigma+d+\mu+\sigma\right)\left(\eta-\sigma\right)\left(\delta+\omega+\mu+k_1\right)\right)\Big/\left(\left(\varepsilon+\mu\right)\left(\delta\eta\mu q-\delta k_2 q\sigma-\delta\mu q\sigma+\eta k_1\mu q+\eta\mu^2 q+\eta\mu\omega q-k_1\mu q\sigma-k_1\omega q\sigma-k_2\mu q\sigma-k_2\omega q\sigma-\mu^2 q\sigma-\mu\omega q\sigma+d\delta k_2+d\delta\mu+dk_1\mu+dk_1\omega+dk_2\mu+dk_2\omega+d\mu^2+d\mu\omega+\delta k_2\mu+\delta k_2\sigma+\delta\mu^2+\delta\mu\sigma+k_1\mu^2+k_1\mu\omega+k_1\mu\sigma+k_1\omega\sigma+k_2\mu^2+k_2\mu\omega+k_2\mu\sigma+k_2\omega\sigma+\mu^3+\mu^2\omega+\mu^2\sigma+\mu\omega\sigma\right)\right)+\left(\left(-1+p\right)\beta\varepsilon(\eta q-q\sigma+d+\mu+\sigma)\left(\delta+\omega+\mu+k_1\right)\left(\delta\eta\mu-\delta k_2\sigma-\delta\mu\sigma+\eta k_1\mu+\eta\mu^2+\eta\mu\omega-k_1\mu\sigma-k_1\omega\sigma-k_2\mu\sigma-k_2\omega\sigma-\mu^2\sigma-\mu\omega\sigma\right)\right)\Big/\left(\left(\varepsilon+\mu\right)\left(\delta\eta\mu q-\delta k_2 q\sigma-\delta\mu q\sigma+\eta k_1\mu q+\eta\mu^2 q+\eta\mu\omega q-k_1\mu q\sigma-k_1\omega q\sigma-k_2\mu q\sigma-k_2\omega q\sigma-\mu^2 q\sigma-\mu\omega q\sigma+d\delta k_2+d\delta\mu+dk_1\mu+dk_1\omega+dk_2\mu+dk_2\omega+d\mu^2+d\mu\omega+\delta k_2\mu+\delta k_2\sigma+\delta\mu^2+\delta\mu\sigma+k_1\mu^2+k_1\mu\omega+k_1\mu\sigma+k_1\omega\sigma+k_2\mu^2+k_2\mu\omega+k_2\mu\sigma+k_2\omega\sigma+\mu^3+\mu^2\omega+\mu^2\sigma+\mu\omega\sigma\right)^2\right)\cdot\frac{q}{R0}$$

$$-\Big(\big(-1+p\big)\,\beta\,D(\varepsilon)\big(\eta\,q-q\,\sigma+d+\mu+\sigma\big)\,\big(\eta-\sigma\big)\,\big(\delta+\omega+\mu+k_1\big)\Big)\Big/\Big(\big(\varepsilon+\mu\big)\,\big(\delta\,\eta\,\mu\,q-\delta\,k_2\,q\,\sigma-\delta\,\mu\,q\,\sigma+\eta\,k_1\,\mu\,q+\eta\,\mu^2\,q+\eta\,\mu\,\omega\,q-k_1\,\mu\,q\,\sigma-k_1\,\omega\,q\,\sigma-k_2\,\mu\,q\,\sigma-k_2\,\omega\,q\,\sigma-\mu^2\,q\,\sigma-\mu\,\omega\,q\,\sigma+d\,\delta\,k_2+d\,\delta\,\mu+d\,k_1\,\mu+d\,k_1\,\omega+d\,k_2\,\mu+d\,k_2\,\omega+d\,\mu^2+d\,\mu\,\omega+\delta\,k_2\,\mu+\delta\,k_2\,\sigma+\delta\,\mu^2+\delta\,\mu\,\sigma+k_1\,\mu^2+k_1\,\mu\,\omega+k_1\,\mu\,\sigma+k_1\,\omega\,\sigma+k_2\,\mu^2+k_2\,\mu\,\omega+k_2\,\mu\,\sigma+k_2\,\omega\,\sigma+\mu^3+\mu^2\,\omega+\mu^2\,\sigma+\mu\,\omega\,\sigma\big)\Big)-\Big(\Big(\big(-1+p\big)\,\beta\,\varepsilon\big(\eta\,q-q\,\sigma+d+\mu+\sigma\big)\,\big(\delta+\omega+\mu+k_1\big)\,\big(\delta\,\eta\,\mu-\delta\,k_2\,\sigma-\delta\,\mu\,\sigma+\eta\,k_1\,\mu+\eta\,\mu^2+\eta\,\mu\,\omega-k_1\,\mu\,\sigma-k_1\,\omega\,\sigma-k_2\,\mu\,\sigma-k_2\,\omega\,\sigma-\mu^2\,\sigma-\mu\,\omega\,\sigma\big)\Big)\Big/\Big(\big(\varepsilon+\mu\big)\,\big(\delta\,\eta\,\mu\,q-\delta\,k_2\,q\,\sigma-\delta\,\mu\,q\,\sigma+\eta\,k_1\,\mu\,q+\eta\,\mu^2\,q+\eta\,\mu\,\omega\,q-k_1\,\mu\,q\,\sigma-k_1\,\omega\,q\,\sigma-k_2\,\mu\,q\,\sigma-k_2\,\omega\,q\,\sigma-\mu^2\,q\,\sigma-\mu\,\omega\,q\,\sigma+d\,\delta\,k_2+d\,\delta\,\mu+d\,k_1\,\mu+d\,k_1\,\omega+d\,k_2\,\mu+d\,k_2\,\omega+d\,\mu^2+d\,\mu\,\omega+\delta\,k_2\,\mu+\delta\,k_2\,\sigma+\delta\,\mu^2+\delta\,\mu\,\sigma+k_1\,\mu^2+k_1\,\mu\,\omega+k_1\,\mu\,\sigma+k_1\,\omega\,\sigma+k_2\,\mu^2+k_2\,\mu\,\omega+k_2\,\mu\,\sigma+k_2\,\omega\,\sigma+\mu^3+\mu^2\,\omega+\mu^2\,\sigma+\mu\,\omega\,\sigma\big)^2\Big)\Big)\cdot\Big(\Big(q\,\big(\varepsilon+\mu\big)\,\big(\delta\,\eta\,\mu\,q-\delta\,k_2\,q\,\sigma-\delta\,\mu\,q\,\sigma+\eta\,k_1\,\mu\,q+\eta\,\mu^2\,q+\eta\,\mu\,\omega\,q-k_1\,\mu\,q\,\sigma-k_1\,\omega\,q\,\sigma-k_2\,\mu\,q\,\sigma-k_2\,\omega\,q\,\sigma-\mu^2\,q\,\sigma-\mu\,\omega\,q\,\sigma+d\,\delta\,k_2+d\,\delta\,\mu+d\,k_1\,\mu+d\,k_1\,\omega+d\,k_2\,\mu+d\,k_2\,\omega+d\,\mu^2+d\,\mu\,\omega+\delta\,k_2\,\mu+\delta\,k_2\,\sigma+\delta\,\mu^2+\delta\,\mu\,\sigma+k_1\,\mu^2+k_1\,\mu\,\omega+k_1\,\mu\,\sigma+k_1\,\omega\,\sigma+k_2\,\mu^2+k_2\,\mu\,\omega+k_2\,\mu\,\sigma+k_2\,\omega\,\sigma+\mu^3+\mu^2\,\omega+\mu^2\,\sigma+\mu\,\omega\,\sigma\big)\Big)\Big/\Big(\big(-1+p\big)\,\beta\,\varepsilon\big(\eta\,q-q\,\sigma+d+\mu+\sigma\big)\,\big(\delta+\omega+\mu+k_1\big)\Big)\Big)$$

> $s := diff(\mathrm{R0}, \beta)$

$$s := -\frac{\big(-1+p\big)\,\gamma\!\mathit{I}\,\big(\delta+\omega+\mu+k_1\big)}{\big(\gamma\!\mathit{I}+\mu\big)\,\big(\delta\,k_2+\delta\,\mu+k_1\,\mu+k_1\,\omega+k_2\,\mu+k_2\,\omega+\mu^2+\mu\,\omega\big)}$$

> $$-\frac{\big(-1+p\big)\,\gamma\!\mathit{I}\,\big(\delta+\omega+\mu+k_1\big)}{\big(\gamma\!\mathit{I}+\mu\big)\,\big(\delta\,k_2+\delta\,\mu+k_1\,\mu+k_1\,\omega+k_2\,\mu+k_2\,\omega+\mu^2+\mu\,\omega\big)}\cdot\frac{\beta}{R0}$$

$$1$$

>

> $t := diff(\mathrm{R0}, \gamma\mathrm{I})$

$$t := -\frac{\big(-1+p\big)\,\beta\,\big(\delta+\omega+\mu+k_1\big)}{\big(\gamma\!\mathit{I}+\mu\big)\,\big(\delta\,k_2+\delta\,\mu+k_1\,\mu+k_1\,\omega+k_2\,\mu+k_2\,\omega+\mu^2+\mu\,\omega\big)}+\frac{\big(-1+p\big)\,\beta\,\gamma\!\mathit{I}\,\big(\delta+\omega+\mu+k_1\big)}{\big(\gamma\!\mathit{I}+\mu\big)^2\,\big(\delta\,k_2+\delta\,\mu+k_1\,\mu+k_1\,\omega+k_2\,\mu+k_2\,\omega+\mu^2+\mu\,\omega\big)}$$

> $$\mathrm{t}\cdot\frac{\gamma\!\mathit{I}}{R0}$$

$$-\frac{1}{(-1+p)\,\beta\,(\delta+\omega+\mu+k_1)}\left(\left(-\frac{(-1+p)\,\beta\,(\delta+\omega+\mu+k_1)}{(\gamma I+\mu)\,(\delta k_2+\delta\mu+k_1\mu+k_1\omega+k_2\mu+k_2\omega+\mu^2+\mu\omega)}+\frac{(-1+p)\,\beta\,\gamma I\,(\delta+\omega+\mu+k_1)}{(\gamma I+\mu)^2\,(\delta k_2+\delta\mu+k_1\mu+k_1\omega+k_2\mu+k_2\omega+\mu^2+\mu\omega)}\right)(\gamma I+\mu)\,(\delta k_2+\delta\mu+k_1\mu+k_1\omega+k_2\mu+k_2\omega+\mu^2+\mu\omega)\right)$$

```
> w := diff(R0, δ)
```

$$w := -\frac{(-1+p)\,\beta\,\gamma I}{(\gamma I+\mu)\,(\delta k_2+\delta\mu+k_1\mu+k_1\omega+k_2\mu+k_2\omega+\mu^2+\mu\omega)}+\frac{(-1+p)\,\beta\,\gamma I\,(\delta+\omega+\mu+k_1)\,(k_2+\mu)}{(\gamma I+\mu)\,(\delta k_2+\delta\mu+k_1\mu+k_1\omega+k_2\mu+k_2\omega+\mu^2+\mu\omega)^2}$$

```
> w·δ/R0
```

$$-\frac{1}{(-1+p)\,\beta\,\gamma I\,(\delta+\omega+\mu+k_1)}\left(\left(-\frac{(-1+p)\,\beta\,\gamma I}{(\gamma I+\mu)\,(\delta k_2+\delta\mu+k_1\mu+k_1\omega+k_2\mu+k_2\omega+\mu^2+\mu\omega)}+\frac{(-1+p)\,\beta\,\gamma I\,(\delta+\omega+\mu+k_1)\,(k_2+\mu)}{(\gamma I+\mu)\,(\delta k_2+\delta\mu+k_1\mu+k_1\omega+k_2\mu+k_2\omega+\mu^2+\mu\omega)^2}\right)\delta\,(\gamma I+\mu)\,(\delta k_2+\delta\mu+k_1\mu+k_1\omega+k_2\mu+k_2\omega+\mu^2+\mu\omega)\right)$$

Lampiran 4. Sintax simulasi untu grafik pembentukan komisi penanggulangan HIV/AIDS

1. Sintax untuk pemberian nilai parameter sebesar 0.008

```
> restart :
> with(linalg) : with(plots) : with(DEtools) :
```

> $\beta := 0.065; \mu := 0.02; \delta := 0.01; k_1 := 0.01; k_2 := 0.02; \gamma I := 0.17; \omega := 0.05; p := 0.008; q := 0.9; \sigma := 0.03; d := 0.5$

$$\beta := 0.065$$
$$\mu := 0.02$$
$$\delta := 0.01$$
$$k_1 := 0.01$$
$$k_2 := 0.02$$
$$\gamma I := 0.17$$
$$\omega := 0.05$$
$$p := 0.008$$
$$q := 0.9$$
$$\sigma := 0.03$$
$$d := 0.5$$

> $R0 := \dfrac{(1-p)\,\beta\,\gamma I\left(\delta+\omega+\mu+k_1\right)}{\left(\gamma I+\mu\right)\left(\delta k_2+\delta\mu+k_1\mu+k_1\omega+k_2\mu+k_2\omega+\mu^2+\mu\omega\right)}$

$$R0 := 1.331368421$$

> $P1 := \mu-(1-p)\cdot\beta\cdot X_1\cdot\left(X_3+X_4\right)-\mu\cdot X_1$

$$P1 := 0.02 - 0.064480\,X_1\left(X_3+X_4\right) - 0.02\,X_1$$

> $P2 := (1-p)\cdot\beta\cdot X_1\cdot\left(X_3+X_4\right)-\left(\gamma I+\mu\right)\cdot X_2$

$$P2 := 0.064480\,X_1\left(X_3+X_4\right) - 0.19\,X_2$$

> $P3 := \gamma I\cdot X_2+\delta\cdot X_4-\left(k_1+k_2+\mu\right)\cdot X_3$

$$P3 := 0.17\,X_2 + 0.01\,X_4 - 0.05\,X_3$$

> $P4 := k_1\cdot X_3-\left(\delta+\omega+\mu\right)\cdot X_4$

$$P4 := 0.01\,X_3 - 0.08\,X_4$$

> $P5 := k_2\cdot X_3+\omega\cdot X_4-\left((1-q)\cdot\sigma+\mu+d\right)\cdot X_5$

$$P5 := 0.02\,X_3 + 0.05\,X_4 - 0.523\,X_5$$

> $P6 := q\cdot\sigma\cdot X_5-\left(\mu+d\right)\cdot X_6$

$$P6 := 0.027\,X_5 - 0.52\,X_6$$

> $fixpoint := solve\left(\{P1,P2,P3,P4,P5,P6\},\{X_1,X_2,X_3,X_4,X_5,X_6\}\right)$

$$fixpoint := \{X_1 = 1., X_2 = 0., X_3 = 0., X_4 = 0., X_5 = 0., X_6 = 0.\}, \{X_1 = 0.7511068944, X_2 = 0.02619927428, X_3 = 0.09136157184, X_4 = 0.01142019648, X_5 = 0.004585547344, X_6 = 0.0002380957275\}$$

> $with(plots):with(linalg):with(VectorCalculus):$

> $fix1 := fixpoint[1];$

$$fix1 := \{X_1 = 1., X_2 = 0., X_3 = 0., X_4 = 0., X_5 = 0., X_6 = 0.\}$$

> $jac := Jacobian\left(\left[P1,P2,P3,P4,P5,P6\right],\left[X_1,X_2,X_3,X_4,X_5,X_6\right]\right);$

$$jac := \left[\left[-0.064480\,X_3 - 0.064480\,X_4 - 0.02,\ 0,\ -0.064480\,X_1,\ -0.064480\,X_1,\ 0,\ 0\right],\ \left[0.064480\,X_3 + 0.064480\,X_4,\ -0.19,\ 0.064480\,X_1,\ 0.064480\,X_1,\ 0,\ 0\right],\ \left[0,\ 0.17,\ -0.05,\ 0.01,\ 0,\ 0\right],\ \left[0,\ 0,\ 0.01,\ -0.08,\ 0,\ 0\right],\ \left[0,\ 0,\ 0.02,\ 0.05,\ -0.523,\ 0\right],\ \left[0,\ 0,\ 0,\ 0,\ 0.027,\ -0.52\right]\right]$$

> $jac1 := subs(fix1, evalm(jac)); eigenvalues(jac1);$

$$jac1 := \begin{bmatrix} -0.02 & 0 & -0.064480 & -0.064480 & 0 & 0 \\ 0. & -0.19 & 0.064480 & 0.064480 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

$$-0.0200000000000000,\ -0.520000000000000,\ -0.523000000000000,\ -0.0880721642466997,\ 0.0114551415028191,\ -0.243382977256119$$

> $fix2 := fixpoint[2];$

$$fix2 := \{X_1 = 0.7511068944,\ X_2 = 0.02619927428,\ X_3 = 0.09136157184,\ X_4 = 0.01142019648,\ X_5 = 0.004585547344,\ X_6 = 0.0002380957275\}$$

> $jac2 := subs(fix2, evalm(jac)); eigenvalues(jac2);$

$$jac2 := \begin{bmatrix} -0.02662736842 & 0 & -0.04843137255 & -0.04843137255 & 0 & 0 \\ 0.006627368421 & -0.19 & 0.04843137255 & 0.04843137255 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

$$-0.520000000000000,\ -0.523000000000000,\ -0.233453712445815,\ -0.0878119692638653,\ -0.0126808433551600 + 0.00887417492370092\,I,\ -0.0126808433551600 - 0.00887417492370092\,I$$

> $eval(-0.0126808433551600 - 0.00887417492370092)$

$$-0.02155501828$$

> $-0.0126808433551600 + 0.00887417492370092$

$$-0.003806668436$$

> $T1 := \frac{d}{dt}X_1(t) = \mu - (1-p)\cdot\beta\cdot X_1(t)\cdot\left(X_3(t) + X_4(t)\right) - \mu\cdot X_1(t)$

$$T1 := \frac{d}{dt}X_1(t) = 0.02 - 0.064480\,X_1(t)\left(X_3(t) + X_4(t)\right) - 0.02\,X_1(t)$$

> $T2 := \frac{d}{dt}X_2(t) = (1-p)\cdot\beta\cdot X_1(t)\cdot\left(X_3(t)+X_4(t)\right) - (\gamma I+\mu)\cdot X_2(t)$

$$T2 := \frac{d}{dt}X_2(t) = 0.064480\,X_1(t)\left(X_3(t)+X_4(t)\right) - 0.19\,X_2(t)$$

> $T3 := \frac{d}{dt}X_3(t) = \gamma I\cdot X_2(t) + \delta\cdot X_4(t) - \left(k_1+k_2+\mu\right)\cdot X_3(t)$

$$T3 := \frac{d}{dt}X_3(t) = 0.17\,X_2(t) + 0.01\,X_4(t) - 0.05\,X_3(t)$$

> $T4 := \frac{d}{dt}X_4(t) = k_1\cdot X_3(t) - (\delta+\omega+\mu)\cdot X_4(t)$

$$T4 := \frac{d}{dt}X_4(t) = 0.01\,X_3(t) - 0.08\,X_4(t)$$

> $T5 := \frac{d}{dt}X_5(t) = k_2\cdot X_3(t) + \omega\cdot X_4(t) - ((1-q)\cdot\sigma+\mu+d)\cdot X_5(t)$

$$T5 := \frac{d}{dt}X_5(t) = 0.02\,X_3(t) + 0.05\,X_4(t) - 0.523\,X_5(t)$$

> $T6 := \frac{d}{dt}X_6(t) = q\cdot\sigma\cdot X_5(t) - (\mu+d)\cdot X_6(t)$

$$T6 := \frac{d}{dt}X_6(t) = 0.027\,X_5(t) - 0.52\,X_6(t)$$

> $\#X_1 = 0.7511068944, X_2 = 0.02619927428, X_3 = 0.09136157184, X_4 = 0.01142019648, X_5 = 0.004585547344, X_6 = 0.0002380957275$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..600, [[X_1(0) = 0.7, X_2(0) = 0.02, X_3(0) = 0.09, X_4(0) = 0.01, X_5(0) = 0.004, X_6(0) = 0.0002]], linecolor = [green], arrows = medium, scene = [t, X_1(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..600, [[X_1(0) = 0.7, X_2(0) = 0.02, X_3(0) = 0.09, X_4(0) = 0.01, X_5(0) = 0.004, X_6(0) = 0.0002]], linecolor = [green], arrows = medium, scene = [t, X_2(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..600, [[X_1(0) = 0.7, X_2(0) = 0.02, X_3(0) = 0.09, X_4(0) = 0.01, X_5(0) = 0.004, X_6(0) = 0.0002]], linecolor = [green], arrows = medium, scene = [t, X_3(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..600, [[X_1(0) = 0.7, X_2(0) = 0.02, X_3(0) = 0.09, X_4(0) = 0.01, X_5(0) = 0.004, X_6(0) = 0.0002]], linecolor = [green], arrows = medium, scene = [t, X_4(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..600, [[X_1(0) = 0.7, X_2(0) = 0.02, X_3(0) = 0.09, X_4(0) = 0.01, X_5(0) = 0.004, X_6(0) = 0.0002]], linecolor = [green], arrows = medium, scene = [t, X_5(t)], stepsize = 0.1);$

> $DEplot\left(\left[T1, T2, T3, T4, T5, T6\right], \left[X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)\right], t = 0..600, \left[\left[X_1(0) = 0.7, X_2(0) = 0.02, X_3(0) = 0.09, X_4(0) = 0.01, X_5(0) = 0.004, X_6(0) = 0.0002\right]\right], linecolor = \left[green\right], arrows = medium, scene = \left[t, X_6(t)\right], stepsize = 0.1\right);$

2. Sintax pemberian niali parameter sebesar 0.08

> $restart:$
> $with(linalg): with(plots): with(DEtools):$
> $\beta := 0.065; \mu := 0.02; \delta := 0.01; k_1 := 0.01; k_2 := 0.02; \gamma\prime := 0.17; \omega := 0.05; p := 0.08; q := 0.9; \sigma := 0.03; d := 0.5$

$$\beta := 0.065$$
$$\mu := 0.02$$
$$\delta := 0.01$$
$$k_1 := 0.01$$
$$k_2 := 0.02$$
$$\gamma\prime := 0.17$$
$$\omega := 0.05$$
$$p := 0.08$$
$$q := 0.9$$
$$\sigma := 0.03$$
$$d := 0.5$$

> $R0 := \frac{(1-p)\,\beta\,\gamma\prime\left(\delta+\omega+\mu+k_1\right)}{\left(\gamma\prime+\mu\right)\left(\delta k_2+\delta\mu+k_1\mu+k_1\omega+k_2\mu+k_2\omega+\mu^2+\mu\omega\right)}$

$$R0 := 1.234736842$$

> $P1 := \mu-(1-p)\cdot\beta\cdot X_1\cdot\left(X_3+X_4\right)-\mu\cdot X_1$

$$P1 := 0.02 - 0.05980\,X_1\left(X_3+X_4\right) - 0.02\,X_1$$

> $P2 := (1-p)\cdot\beta\cdot X_1\cdot\left(X_3+X_4\right)-\left(\gamma\prime+\mu\right)\cdot X_2$

$$P2 := 0.05980\,X_1\left(X_3+X_4\right) - 0.19\,X_2$$

> $P3 := \gamma\prime\cdot X_2+\delta\cdot X_4-\left(k_1+k_2+\mu\right)\cdot X_3$

$$P3 := 0.17\,X_2 + 0.01\,X_4 - 0.05\,X_3$$

> $P4 := k_1\cdot X_3-\left(\delta+\omega+\mu\right)\cdot X_4$

$$P4 := 0.01\,X_3 - 0.08\,X_4$$

> $P5 := k_2\cdot X_3+\omega\cdot X_4-\left((1-q)\cdot\sigma+\mu+d\right)\cdot X_5$

$$P5 := 0.02\,X_3 + 0.05\,X_4 - 0.523\,X_5$$

> $P6 := q\cdot\sigma\cdot X_5-\left(\mu+d\right)\cdot X_6$

$$P6 := 0.027\,X_5 - 0.52\,X_6$$

> $fixpoint := solve\left(\left\{P1, P2, P3, P4, P5, P6\right\}, \left\{X_1, X_2, X_3, X_4, X_5, X_6\right\}\right)$

$$fixpoint := \{X_1 = 1., X_2 = 0., X_3 = 0., X_4 = 0., X_5 = 0., X_6 = 0.\}, \{X_1 = 0.8098891731, X_2 = 0.02001166599, X_3 = 0.06978427116, X_4 = 0.008723033895, X_5 = 0.003502556631, X_6 = 0.0001818635174\}$$

```
> with(plots) : with(linalg) : with(VectorCalculus) :
> fix1 := fixpoint[1];
```

$$fix1 := \{X_1 = 1., X_2 = 0., X_3 = 0., X_4 = 0., X_5 = 0., X_6 = 0.\}$$

```
> jac := Jacobian([P1, P2, P3, P4, P5, P6], [X1, X2, X3, X4, X5, X6]);
```

$$jac := \begin{bmatrix} -0.05980X_3 - 0.05980X_4 - 0.02 & 0 & -0.05980X_1 & -0.05980X_1 & 0 & 0 \\ 0.05980X_3 + 0.05980X_4 & -0.19 & 0.05980X_1 & 0.05980X_1 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

```
> jac1 := subs(fix1, evalm(jac)); eigenvalues(jac1);
```

$$jac1 := \begin{bmatrix} -0.02 & 0 & -0.05980 & -0.05980 & 0 & 0 \\ 0. & -0.19 & 0.05980 & 0.05980 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

$$-0.0200000000000000,\ -0.520000000000000,\ -0.523000000000000,\ -0.0879675133659312,\ 0.00822984146115907,\ -0.240262328095228$$

```
> fix2 := fixpoint[2];
```

$$fix2 := \{X_1 = 0.8098891731, X_2 = 0.02001166599, X_3 = 0.06978427116, X_4 = 0.008723033895, X_5 = 0.003502556631, X_6 = 0.0001818635174\}$$

```
> jac2 := subs(fix2, evalm(jac)); eigenvalues(jac2);
```

$$jac2 := \begin{bmatrix} -0.02469473684 & 0 & -0.04843137255 & -0.04843137255 & 0 & 0 \\ 0.004694736842 & -0.19 & 0.04843137255 & 0.04843137255 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

$$-0.520000000000000,\ -0.523000000000000,\ -0.233124473656492,\ -0.0119020756893909 + 0.00532600768734223\,I,\ -0.0119020756893909 - 0.00532600768734223\,I,\ -0.0877661118047263$$

```
> -0.0119020756893909-0.00532600768734223
```

$$-0.01722808338$$

> $-0.0119020756893909 + 0.00532600768734223$

$$-0.006576068003$$

> $T1 := \frac{d}{dt}X_1(t) = \mu - (1-p)\cdot\beta\cdot X_1(t)\cdot\left(X_3(t) + X_4(t)\right) - \mu\cdot X_1(t)$

$$T1 := \frac{d}{dt}X_1(t) = 0.02 - 0.05980\,X_1(t)\left(X_3(t) + X_4(t)\right) - 0.02\,X_1(t)$$

> $T2 := \frac{d}{dt}X_2(t) = (1-p)\cdot\beta\cdot X_1(t)\cdot\left(X_3(t) + X_4(t)\right) - (\gamma I + \mu)\cdot X_2(t)$

$$T2 := \frac{d}{dt}X_2(t) = 0.05980\,X_1(t)\left(X_3(t) + X_4(t)\right) - 0.19\,X_2(t)$$

> $T3 := \frac{d}{dt}X_3(t) = \gamma I\cdot X_2(t) + \delta\cdot X_4(t) - (k_1 + k_2 + \mu)\cdot X_3(t)$

$$T3 := \frac{d}{dt}X_3(t) = 0.17\,X_2(t) + 0.01\,X_4(t) - 0.05\,X_3(t)$$

> $T4 := \frac{d}{dt}X_4(t) = k_1\cdot X_3(t) - (\delta + \omega + \mu)\cdot X_4(t)$

$$T4 := \frac{d}{dt}X_4(t) = 0.01\,X_3(t) - 0.08\,X_4(t)$$

> $T5 := \frac{d}{dt}X_5(t) = k_2\cdot X_3(t) + \omega\cdot X_4(t) - ((1-q)\cdot\sigma + \mu + d)\cdot X_5(t)$

$$T5 := \frac{d}{dt}X_5(t) = 0.02\,X_3(t) + 0.05\,X_4(t) - 0.523\,X_5(t)$$

> $T6 := \frac{d}{dt}X_6(t) = q\cdot\sigma\cdot X_5(t) - (\mu + d)\cdot X_6(t)$

$$T6 := \frac{d}{dt}X_6(t) = 0.027\,X_5(t) - 0.52\,X_6(t)$$

> $\#X_1 = 0.8098891731, X_2 = 0.02001166599, X_3 = 0.06978427116, X_4 = 0.008723033895, X_5 = 0.003502556631, X_6 = 0.0001818635174$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..700, [[X_1(0) = 0.8, X_2(0) = 0.02, X_3(0) = 0.06, X_4(0) = 0.008, X_5(0) = 0.003, X_6(0) = 0.0001]], linecolor = [green], arrows = medium, scene = [t, X_1(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..600, [[X_1(0) = 0.8, X_2(0) = 0.02, X_3(0) = 0.06, X_4(0) = 0.008, X_5(0) = 0.003, X_6(0) = 0.0001]], linecolor = [green], arrows = medium, scene = [t, X_2(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..600, [[X_1(0) = 0.8, X_2(0) = 0.02, X_3(0) = 0.06, X_4(0) = 0.008, X_5(0) = 0.003, X_6(0) = 0.0001]], linecolor = [green], arrows = medium, scene = [t, X_3(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..600, [[X_1(0) = 0.8, X_2(0) = 0.02, X_3(0) = 0.06, X_4(0) = 0.008, X_5(0) = 0.003, X_6(0) = 0.0001]], linecolor = [green], arrows = medium, scene = [t, X_4(t)], stepsize = 0.1);$

```
> DEplot([T1, T2, T3, T4, T5, T6], [X1(t), X2(t), X3(t), X4(t), X5(t), X6(t)], t = 0..600, [[X1(0) = 0.8, X2(0) = 0.02, X3(0) = 0.06, X4(0) = 0.008, X5(0) = 0.003, X6(0) = 0.0001]], linecolor = [green], arrows = medium, scene = [t, X5(t)], stepsize = 0.1);
```

```
> DEplot([T1, T2, T3, T4, T5, T6], [X1(t), X2(t), X3(t), X4(t), X5(t), X6(t)], t = 0..600, [[X1(0) = 0.8, X2(0) = 0.02, X3(0) = 0.06, X4(0) = 0.008, X5(0) = 0.003, X6(0) = 0.0001]], linecolor = [green], arrows = medium, scene = [t, X6(t)], stepsize = 0.1);
```

3. Sintax pemeberian nilai parameter sebesar 0.2

```
> restart :
> with(linalg) : with(plots) : with(DEtools) :
> β := 0.065; μ := 0.02; δ := 0.01; k1 := 0.01; k2 := 0.02; γI := 0.17; ω := 0.05; p := 0.2; q := 0.9; σ := 0.03; d := 0.5
```

$$\beta := 0.065$$

$$\mu := 0.02$$

$$\delta := 0.01$$

$$k_1 := 0.01$$

$$k_2 := 0.02$$

$$\gamma I := 0.17$$

$$\omega := 0.05$$

$$p := 0.2$$

$$q := 0.9$$

$$\sigma := 0.03$$

$$d := 0.5$$

```
> R0 := (1 - p) β γI (δ + ω + μ + k1) / ((γI + μ) (δ k2 + δ μ + k1 μ + k1 ω + k2 μ + k2 ω + μ^2 + μ ω))
```

$$R0 := 1.073684211$$

```
> P1 := μ - (1 - p)·β·X1·(X3 + X4) - μ·X1
```

$$P1 := 0.02 - 0.0520\,X_1\,(X_3 + X_4) - 0.02\,X_1$$

```
> P2 := (1 - p)·β·X1·(X3 + X4) - (γI + μ)·X2
```

$$P2 := 0.0520\,X_1\,(X_3 + X_4) - 0.19\,X_2$$

```
> P3 := γI·X2 + δ·X4 - (k1 + k2 + μ)·X3
```

$$P3 := 0.17\,X_2 + 0.01\,X_4 - 0.05\,X_3$$

```
> P4 := k1·X3 - (δ + ω + μ)·X4
```

$$P4 := 0.01\,X_3 - 0.08\,X_4$$

```
> P5 := k2·X3 + ω·X4 - ((1 - q)·σ + μ + d)·X5
```

$$P5 := 0.02\,X_3 + 0.05\,X_4 - 0.523\,X_5$$

> $P6 := q \cdot \sigma \cdot X_5 - (\mu + d) \cdot X_6$

$$P6 := 0.027\,X_5 - 0.52\,X_6$$

> $fixpoint := solve(\{P1, P2, P3, P4, P5, P6\}, \{X_1, X_2, X_3, X_4, X_5, X_6\})$

$$fixpoint := \{X_1 = 1., X_2 = 0., X_3 = 0., X_4 = 0., X_5 = 0., X_6 = 0.\}, \{X_1 = 0.9313725490, X_2 = 0.007223942208, X_3 = 0.02519118309, X_4 = 0.003148897886, X_5 = 0.001264375824, X_6 = 0.00006565028317\}$$

> $with(plots) : with(linalg) : with(VectorCalculus) :$

> $fix1 := fixpoint[1];$

$$fix1 := \{X_1 = 1., X_2 = 0., X_3 = 0., X_4 = 0., X_5 = 0., X_6 = 0.\}$$

> $jac := Jacobian([P1, P2, P3, P4, P5, P6], [X_1, X_2, X_3, X_4, X_5, X_6]);$

$$jac := \begin{bmatrix} -0.0520\,X_3 - 0.0520\,X_4 - 0.02 & 0 & -0.0520\,X_1 & -0.0520\,X_1 & 0 & 0 \\ 0.0520\,X_3 + 0.0520\,X_4 & -0.19 & 0.0520\,X_1 & 0.0520\,X_1 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

> $jac1 := subs(fix1, evalm(jac)); eigenvalues(jac1);$

$$jac1 := \begin{bmatrix} -0.02 & 0 & -0.0520 & -0.0520 & 0 & 0 \\ 0. & -0.19 & 0.0520 & 0.0520 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

$$-0.0200000000000000, -0.520000000000000, -0.523000000000000, -0.0877650732564576, 0.00264861199594352, -0.234883538739486$$

> $fix2 := fixpoint[2];$

$$fix2 := \{X_1 = 0.9313725490, X_2 = 0.007223942208, X_3 = 0.02519118309, X_4 = 0.003148897886, X_5 = 0.001264375824, X_6 = 0.00006565028317\}$$

> $jac2 := subs(fix2, evalm(jac)); eigenvalues(jac2);$

$$jac2 := \begin{bmatrix} -0.02147368421 & 0 & -0.04843137255 & -0.04843137255 & 0 & 0 \\ 0.001473684211 & -0.19 & 0.04843137255 & 0.04843137255 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

$$-0.520000000000000, -0.523000000000000, -0.232584896801984, -0.00293115068009426, -0.0876915647647327, -0.0182660719631888$$

> $T1 := \frac{d}{dt}X_1(t) = \mu - (1-p)\cdot\beta\cdot X_1(t)\cdot\left(X_3(t) + X_4(t)\right) - \mu\cdot X_1(t)$

$$T1 := \frac{d}{dt}X_1(t) = 0.02 - 0.0520\,X_1(t)\left(X_3(t) + X_4(t)\right) - 0.02\,X_1(t)$$

> $T2 := \frac{d}{dt}X_2(t) = (1-p)\cdot\beta\cdot X_1(t)\cdot\left(X_3(t) + X_4(t)\right) - (\gamma I + \mu)\cdot X_2(t)$

$$T2 := \frac{d}{dt}X_2(t) = 0.0520\,X_1(t)\left(X_3(t) + X_4(t)\right) - 0.19\,X_2(t)$$

> $T3 := \frac{d}{dt}X_3(t) = \gamma I\cdot X_2(t) + \delta\cdot X_4(t) - (k_1 + k_2 + \mu)\cdot X_3(t)$

$$T3 := \frac{d}{dt}X_3(t) = 0.17\,X_2(t) + 0.01\,X_4(t) - 0.05\,X_3(t)$$

> $T4 := \frac{d}{dt}X_4(t) = k_1\cdot X_3(t) - (\delta + \omega + \mu)\cdot X_4(t)$

$$T4 := \frac{d}{dt}X_4(t) = 0.01\,X_3(t) - 0.08\,X_4(t)$$

> $T5 := \frac{d}{dt}X_5(t) = k_2\cdot X_3(t) + \omega\cdot X_4(t) - ((1-q)\cdot\sigma + \mu + d)\cdot X_5(t)$

$$T5 := \frac{d}{dt}X_5(t) = 0.02\,X_3(t) + 0.05\,X_4(t) - 0.523\,X_5(t)$$

> $T6 := \frac{d}{dt}X_6(t) = q\cdot\sigma\cdot X_5(t) - (\mu + d)\cdot X_6(t)$

$$T6 := \frac{d}{dt}X_6(t) = 0.027\,X_5(t) - 0.52\,X_6(t)$$

> $\#X_1 = 0.9313725490, X_2 = 0.007223942208, X_3 = 0.02519118309, X_4 = 0.003148897886, X_5 = 0.001264375824, X_6 = 0.00006565028317$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..400, [[X_1(0) = 0.9, X_2(0) = 0.007, X_3(0) = 0.02, X_4(0) = 0.003, X_5(0) = 0.001, X_6(0) = 0.00006]], linecolor = [green], arrows = medium, scene = [t, X_1(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..2000, [[X_1(0) = 0.9, X_2(0) = 0.007, X_3(0) = 0.02, X_4(0) = 0.003, X_5(0) = 0.001, X_6(0) = 0.00006]], linecolor = [green], arrows = medium, scene = [t, X_2(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..2000, [[X_1(0) = 0.9, X_2(0) = 0.007, X_3(0) = 0.02, X_4(0) = 0.003, X_5(0) = 0.001, X_6(0) = 0.00006]], linecolor = [green], arrows = medium, scene = [t, X_3(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..2000, [[X_1(0) = 0.9, X_2(0) = 0.007, X_3(0) = 0.02, X_4(0) = 0.003, X_5(0) = 0.001, X_6(0) = 0.00006]], linecolor = [green], arrows = medium, scene = [t, X_4(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..2000, [[X_1(0) = 0.9, X_2(0) = 0.007, X_3(0) = 0.02, X_4(0) = 0.003, X_5(0) = 0.001, X_6(0) = 0.00006]], linecolor = [green], arrows = medium, scene = [t, X_5(t)], stepsize = 0.1);$

```
> DEplot([T1, T2, T3, T4, T5, T6], [X1(t), X2(t), X3(t), X4(t), X5(t), X6(t)], t = 0..2000, [[X1(0) = 0.9, X2(0) = 0.007, X3(0) = 0.02, X4(0) = 0.003, X5(0) = 0.001, X6(0) = 0.00006]], linecolor = [green], arrows = medium, scene = [t, X6(t)], stepsize = 0.1);
```

4. Sintax pemberian nilai parameter sebesar 0.3

```
> restart :
> with(linalg) : with(plots) : with(DEtools) :
>
β := 0.065; μ := 0.02; δ := 0.01; k1 := 0.01; k2 := 0.02; γI := 0.17; ω := 0.05; η := 0.02; p := 0.3; q := 0.9; σ := 0.03; d := 0.5
```

$$\beta := 0.065$$
$$\mu := 0.02$$
$$\delta := 0.01$$
$$k_1 := 0.01$$
$$k_2 := 0.02$$
$$\gamma I := 0.17$$
$$\omega := 0.05$$
$$\eta := 0.02$$
$$p := 0.3$$
$$q := 0.9$$
$$\sigma := 0.03$$
$$d := 0.5$$

```
> R0 := (1 − p) β γI (δ + ω + μ + k1) / ((γI + μ) (δ k2 + δ μ + k1 μ + k1 ω + k2 μ + k2 ω + μ^2 + μ ω))
```

$$R0 := 0.9394736841$$

```
> P1 := μ − (1 − p)·β·X1·(X3 + X4) − μ·X1
```

$$P1 := 0.02 - 0.0455\,X_1\,(X_3 + X_4) - 0.02\,X_1$$

```
> P2 := (1 − p)·β·X1·(X3 + X4) - (γI + μ)·X2
```

$$P2 := 0.0455\,X_1\,(X_3 + X_4) - 0.19\,X_2$$

```
> P3 := γI·X2 + δ·X4 − (k1 + k2 + μ)·X3
```

$$P3 := 0.17\,X_2 + 0.01\,X_4 - 0.05\,X_3$$

```
> P4 := k1·X3 − (δ + ω + μ)·X4
```

$$P4 := 0.01\,X_3 - 0.08\,X_4$$

```
> P5 := k2·X3 + ω·X4 − ((1 − q)·σ + μ + d)·X5
```

$$P5 := 0.02\,X_3 + 0.05\,X_4 - 0.523\,X_5$$

```
> P6 := q·σ·X5 − (μ + d)·X6
```

$$P6 := 0.027\,X_5 - 0.52\,X_6$$

> $fixpoint := solve(\{P1, P2, P3, P4, P5, P6\}, \{X_1, X_2, X_3, X_4, X_5, X_6\})$

$$fixpoint := \{X_1 = 1., X_2 = 0., X_3 = 0., X_4 = 0., X_5 = 0., X_6 = 0.\}, \{X_1 = 1.064425770, X_2 = -0.006781660032, X_3 = -0.02364886575, X_4 = -0.002956108219, X_5 = -0.001186965059, X_6 = -0.00006163087808\}$$

> $with(plots) : with(linalg) : with(VectorCalculus) :$

> $fix1 := fixpoint[1];$

$$fix1 := \{X_1 = 1., X_2 = 0., X_3 = 0., X_4 = 0., X_5 = 0., X_6 = 0.\}$$

> $jac := Jacobian([P1, P2, P3, P4, P5, P6], [X_1, X_2, X_3, X_4, X_5, X_6]);$

$$jac := \begin{bmatrix} -0.0455 X_3 - 0.0455 X_4 - 0.02 & 0 & -0.0455 X_1 & -0.0455 X_1 & 0 & 0 \\ 0.0455 X_3 + 0.0455 X_4 & -0.19 & 0.0455 X_1 & 0.0455 X_1 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

> $jac1 := subs(fix1, evalm(jac)); eigenvalues(jac1);$

$$jac1 := \begin{bmatrix} -0.02 & 0 & -0.0455 & -0.0455 & 0 & 0 \\ 0. & -0.19 & 0.0455 & 0.0455 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

$$-0.0200000000000000, -0.520000000000000, -0.523000000000000, -0.0875623981395335, -0.00222492597913895, -0.230212675881328$$

> $T1 := \frac{d}{dt} X_1(t) = \mu - (1 - p) \cdot \beta \cdot X_1(t) \cdot (X_3(t) + X_4(t)) - \mu \cdot X_1(t)$

$$T1 := \frac{d}{dt} X_1(t) = 0.02 - 0.0455 X_1(t) (X_3(t) + X_4(t)) - 0.02 X_1(t)$$

> $T2 := \frac{d}{dt} X_2(t) = (1 - p) \cdot \beta \cdot X_1(t) \cdot (X_3(t) + X_4(t)) - (\gamma 1 + \mu) \cdot X_2(t)$

$$T2 := \frac{d}{dt} X_2(t) = 0.0455 X_1(t) (X_3(t) + X_4(t)) - 0.19 X_2(t)$$

> $T3 := \frac{d}{dt} X_3(t) = \gamma 1 \cdot X_2(t) + \delta \cdot X_4(t) - (k_1 + k_2 + \mu) \cdot X_3(t)$

$$T3 := \frac{d}{dt} X_3(t) = 0.17 X_2(t) + 0.01 X_4(t) - 0.05 X_3(t)$$

> $T4 := \frac{d}{dt} X_4(t) = k_1 \cdot X_3(t) - (\delta + \omega + \mu) \cdot X_4(t)$

$$T4 := \frac{d}{dt} X_4(t) = 0.01 X_3(t) - 0.08 X_4(t)$$

> $T5 := \frac{d}{dt}X_5(t) = k_2 \cdot X_3(t) + \omega \cdot X_4(t) - ((1-q)\cdot\sigma + \mu + d)\cdot X_5(t)$

$$T5 := \frac{d}{dt}X_5(t) = 0.02\,X_3(t) + 0.05\,X_4(t) - 0.523\,X_5(t)$$

> $T6 := \frac{d}{dt}X_6(t) = q\cdot\sigma\cdot X_5(t) - (\mu + d)\cdot X_6(t)$

$$T6 := \frac{d}{dt}X_6(t) = 0.027\,X_5(t) - 0.52\,X_6(t)$$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..800, [[X_1(0) = 0.8, X_2(0) = 0.05, X_3(0) = 0.04, X_4(0) = 0.03, X_5(0) = 0.02, X_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, X_1(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..4000, [[X_1(0) = 0.8, X_2(0) = 0.05, X_3(0) = 0.04, X_4(0) = 0.03, X_5(0) = 0.02, X_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, X_2(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..4000, [[X_1(0) = 0.8, X_2(0) = 0.05, X_3(0) = 0.04, X_4(0) = 0.03, X_5(0) = 0.02, X_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, X_3(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..4000, [[X_1(0) = 0.8, X_2(0) = 0.05, X_3(0) = 0.04, X_4(0) = 0.03, X_5(0) = 0.02, X_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, X_4(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..3000, [[X_1(0) = 0.8, X_2(0) = 0.05, X_3(0) = 0.04, X_4(0) = 0.03, X_5(0) = 0.02, X_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, X_5(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..3000, [[X_1(0) = 0.8, X_2(0) = 0.05, X_3(0) = 0.04, X_4(0) = 0.03, X_5(0) = 0.02, X_6(0) = 0.001]], linecolor = [green], arrows = medium, scene = [t, X_6(t)], stepsize = 0.1);$

2. Sintax untuk pemberian nilai parameter sebesar 0.5

> $restart:$
> $with(linalg): with(plots): with(DEtools):$
> $\beta := 0.065; \mu := 0.02; \delta := 0.01; k_1 := 0.01; k_2 := 0.02; \gamma I := 0.17; \omega := 0.05; \eta := 0.02; p := 0.5; q := 0.9; \sigma := 0.03; d := 0.5$
> $R0 := \frac{(1-p)\,\beta\,\gamma I\,(\delta + \omega + \mu + k_1)}{(\gamma I + \mu)\,(\delta k_2 + \delta\mu + k_1\mu + k_1\omega + k_2\mu + k_2\omega + \mu^2 + \mu\omega)}$

> $P1 := \mu - (1-p)\cdot\beta\cdot x_1\cdot(x_3 + x_4) - \mu\cdot x_1$
> $P2 := (1-p)\cdot\beta\cdot x_1\cdot(x_3 + x_4) - (\gamma I + \mu)\cdot x_2$
> $P3 := \gamma I\cdot x_2 + \delta\cdot x_4 - (k_1 + k_2 + \mu)\cdot x_3$

> $P4 := k_1 \cdot x_3 - (\delta + \omega + \mu) \cdot x_4$

> $P5 := k_2 \cdot x_3 + \omega \cdot x_4 - ((1 - q) \cdot \sigma + \mu + d) \cdot x_5$

> $P6 := q \cdot \sigma \cdot x_5 - (\mu + d) \cdot x_6$

> $fixpoint := solve(\{P1, P2, P3, P4, P5, P6\}, \{x_1, x_2, x_3, x_4, x_5, x_6\})$

> $with(plots) : with(linalg) : with(VectorCalculus) :$

> $fix1 := fixpoint[1];$

> $jac := Jacobian([P1, P2, P3, P4, P5, P6], [x_1, x_2, x_3, x_4, x_5, x_6]);$

> $jac1 := subs(fix1, evalm(jac)); eigenvalues(jac1);$

> $T1 := \frac{d}{dt} x_1(t) = \mu - (1 - p) \cdot \beta \cdot x_1(t) \cdot (x_3(t) + x_4(t)) - \mu \cdot x_1(t)$

> $T2 := \frac{d}{dt} x_2(t) = (1 - p) \cdot \beta \cdot x_1(t) \cdot (x_3(t) + x_4(t)) - (\gamma I + \mu) \cdot x_2(t)$

> $T3 := \frac{d}{dt} x_3(t) = \gamma I \cdot x_2(t) + \delta \cdot x_4(t) - (k_1 + k_2 + \mu) \cdot x_3(t)$

> $T4 := \frac{d}{dt} x_4(t) = k_1 \cdot x_3(t) - (\delta + \omega + \mu) \cdot x_4(t)$

> $T5 := \frac{d}{dt} x_5(t) = k_2 \cdot x_3(t) + \omega \cdot x_4(t) - ((1 - q) \cdot \sigma + \mu + d) \cdot x_5(t)$

> $T6 := \frac{d}{dt} x_6(t) = q \cdot \sigma \cdot x_5(t) - (\mu + d) \cdot x_6(t)$

> $DEplot([T1, T2, T3, T4, T5, T6], [x_1(t), x_2(t), x_3(t), x_4(t), x_5(t), x_6(t)], t = 0..1000, [[x_1(0) = 0.8, x_2(0) = 0.05, x_3(0) = 0.04, x_4(0) = 0.03, x_5(0) = 0.02, x_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, x_1(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [x_1(t), x_2(t), x_3(t), x_4(t), x_5(t), x_6(t)], t = 0..700, [[x_1(0) = 0.8, x_2(0) = 0.05, x_3(0) = 0.04, x_4(0) = 0.03, x_5(0) = 0.02, x_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, x_2(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [x_1(t), x_2(t), x_3(t), x_4(t), x_5(t), x_6(t)], t = 0..800, [[x_1(0) = 0.8, x_2(0) = 0.05, x_3(0) = 0.04, x_4(0) = 0.03, x_5(0) = 0.02, x_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, x_3(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [x_1(t), x_2(t), x_3(t), x_4(t), x_5(t), x_6(t)], t = 0..700, [[x_1(0) = 0.8, x_2(0) = 0.05, x_3(0) = 0.04, x_4(0) = 0.03, x_5(0) = 0.02, x_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, x_4(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [x_1(t), x_2(t), x_3(t), x_4(t), x_5(t), x_6(t)], t = 0..600, [[x_1(0) = 0.8, x_2(0) = 0.05, x_3(0) = 0.04, x_4(0) = 0.03, x_5(0) = 0.02, x_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, x_5(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [x_1(t), x_2(t), x_3(t), x_4(t), x_5(t), x_6(t)], t = 0..600, [[x_1(0) = 0.8, x_2(0) = 0.05, x_3(0) = 0.04, x_4(0) = 0.03, x_5(0) = 0.02, x_6(0) = 0.001]], linecolor = [green], arrows = medium, scene = [t, x_6(t)], stepsize = 0.1);$

Lampiran 5. Sintax simulasi untuk grafik interaksi antar individu terinfeksi HIV dengan individu sehat

1. Sintax untuk pemberian nilai parameter sebesar 0.065

```
> restart :
> with(linalg) : with(plots) : with(DEtools) :
> β := 0.03; μ := 0.02; δ := 0.01; k1 := 0.01; k2 := 0.02; γI := 0.17; ω := 0.05; p := 0.08; q
      := 0.9; σ := 0.03; d := 0.5
> R0 := (1 − p) β γI (δ + ω + μ + k1) / ((γI + μ) (δ k2 + δ μ + k1 μ + k1 ω + k2 μ + k2 ω + μ^2 + μ ω))
> P1 := μ − (1 − p)·β·x1·(x3 + x4) − μ·x1
> P2 := (1 − p)·β·x1·(x3 + x4) - (γI + μ)·x2
> P3 := γI·x2 + δ·x4 − (k1 + k2 + μ)·x3
> P4 := k1·x3 − (δ + ω + μ)·x4
> P5 := k2·x3 + ω·x4 − ((1 − q)·σ + μ + d)·x5
> P6 := q·σ·x5 − (μ + d)·x6
> fixpoint := solve({P1, P2, P3, P4, P5, P6}, {x1, x2, x3, x4, x5, x6})
> with(plots) : with(linalg) : with(VectorCalculus) :
> fix1 := fixpoint[1];
> jac := Jacobian([P1, P2, P3, P4, P5, P6], [X1, X2, X3, X4, X5, X6]);
> jac1 := subs(fix1, evalm(jac)); eigenvalues(jac1);
> T1 := d/dt x1(t) = μ − (1 − p)·β·x1(t)·(x3(t) + x4(t)) − μ·x1(t)
> T2 := d/dt x2(t) = (1 − p)·β·x1(t)·(x3(t) + x4(t)) - (γI + μ)·x2(t)
> T3 := d/dt x3(t) = γI·x2(t) + δ·x4(t) - (k1 + k2 + μ)·x3(t)
> T4 := d/dt x4(t) = k1·x3(t) - (δ + ω + μ)·x4(t)
> T5 := d/dt x5(t) = k2·x3(t) + ω·x4(t) - ((1 − q)·σ + μ + d)·x5(t)
> T6 := d/dt x6(t) = q·σ·x5(t) - (μ + d)·x6(t)

> DEplot([T1, T2, T3, T4, T5, T6], [x1(t), x2(t), x3(t), x4(t), x5(t), x6(t)], t = 0..700, [[x1(0) = 0.8,
      x2(0) = 0.05, x3(0) = 0.04, x4(0) = 0.03, x5(0) = 0.02, x6(0) = 0.01]], linecolor = [green],
      arrows = medium, scene = [t, x1(t)], stepsize = 0.1);

> DEplot([T1, T2, T3, T4, T5, T6], [x1(t), x2(t), x3(t), x4(t), x5(t), x6(t)], t = 0..500, [[x1(0) = 0.8,
      x2(0) = 0.05, x3(0) = 0.04, x4(0) = 0.03, x5(0) = 0.02, x6(0) = 0.01]], linecolor = [green],
      arrows = medium, scene = [t, x2(t)], stepsize = 0.1)
```

```
> DEplot([T1, T2, T3, T4, T5, T6], [x1(t), x2(t), x3(t), x4(t), x5(t), x6(t)], t = 0..600, [[x1(0) = 0.8,
    x2(0) = 0.05, x3(0) = 0.04, x4(0) = 0.03, x5(0) = 0.02, x6(0) = 0.01]], linecolor = [green],
    arrows = medium, scene = [t, x3(t)], stepsize = 0.1)

> DEplot([T1, T2, T3, T4, T5, T6], [x1(t), x2(t), x3(t), x4(t), x5(t), x6(t)], t = 0..500, [[x1(0) = 0.8,
    x2(0) = 0.05, x3(0) = 0.04, x4(0) = 0.03, x5(0) = 0.02, x6(0) = 0.01]], linecolor = [green],
    arrows = medium, scene = [t, x4(t)], stepsize = 0.1)

> DEplot([T1, T2, T3, T4, T5, T6], [x1(t), x2(t), x3(t), x4(t), x5(t), x6(t)], t = 0..500, [[x1(0) = 0.8,
    x2(0) = 0.05, x3(0) = 0.04, x4(0) = 0.03, x5(0) = 0.02, x6(0) = 0.01]], linecolor = [green],
    arrows = medium, scene = [t, x5(t)], stepsize = 0.1);

> DEplot([T1, T2, T3, T4, T5, T6], [x1(t), x2(t), x3(t), x4(t), x5(t), x6(t)], t = 0..500, [[x1(0) = 0.8,
    x2(0) = 0.05, x3(0) = 0.04, x4(0) = 0.03, x5(0) = 0.02, x6(0) = 0.001]], linecolor = [green],
    arrows = medium, scene = [t, x6(t)], stepsize = 0.1);
```

2. Sintax pemberian nilai parameter sebesar 0.055

```
> restart :
> with(linalg) : with(plots) : with(DEtools) :
> β := 0.055; μ := 0.02; δ := 0.01; k1 := 0.01; k2 := 0.02; γI := 0.17; ω := 0.05; p := 0.08; q
    := 0.9; σ := 0.03; d := 0.5
```

$$\beta := 0.055$$
$$\mu := 0.02$$
$$\delta := 0.01$$
$$k_1 := 0.01$$
$$k_2 := 0.02$$
$$\gamma I := 0.17$$
$$\omega := 0.05$$
$$p := 0.08$$
$$q := 0.9$$
$$\sigma := 0.03$$
$$d := 0.5$$

```
> R0 := (1 − p) β γI (δ + ω + μ + k1) / ((γI + μ) (δ k2 + δ μ + k1 μ + k1 ω + k2 μ + k2 ω + μ^2 + μ ω))
```

$$R0 := 1.044777328$$

```
> P1 := μ − (1 − p)·β·X1·(X3 + X4) − μ·X1
```

$$P1 := 0.02 - 0.05060\,X_1\,(X_3 + X_4) - 0.02\,X_1$$

```
> P2 := (1 − p)·β·X1·(X3 + X4) - (γI + μ)·X2
```

$$P2 := 0.05060\,X_1\,(X_3 + X_4) - 0.19\,X_2$$

```
> P3 := γI·X2 + δ·X4 − (k1 + k2 + μ)·X3
```

$$P3 := 0.17\,X_2 + 0.01\,X_4 - 0.05\,X_3$$

> $P4 := k_1 \cdot X_3 - (\delta + \omega + \mu) \cdot X_4$

$$P4 := 0.01\,X_3 - 0.08\,X_4$$

> $P5 := k_2 \cdot X_3 + \omega \cdot X_4 - ((1-q) \cdot \sigma + \mu + d) \cdot X_5$

$$P5 := 0.02\,X_3 + 0.05\,X_4 - 0.523\,X_5$$

> $P6 := q \cdot \sigma \cdot X_5 - (\mu + d) \cdot X_6$

$$P6 := 0.027\,X_5 - 0.52\,X_6$$

> $fixpoint := solve(\{P1, P2, P3, P4, P5, P6\}, \{X_1, X_2, X_3, X_4, X_5, X_6\})$

$$fixpoint := \{X_1 = 1., X_2 = 0., X_3 = 0., X_4 = 0., X_5 = 0., X_6 = 0.\}, \{X_1 = 0.9571417500, X_2 = 0.004511394739, X_3 = 0.01573204319, X_4 = 0.001966505399, X_5 = 0.0007896101985, X_6 = 0.00004099899107\}$$

> $with(plots) : with(linalg) : with(VectorCalculus) :$

> $fix1 := fixpoint[1];$

$$fix1 := \{X_1 = 1., X_2 = 0., X_3 = 0., X_4 = 0., X_5 = 0., X_6 = 0.\}$$

> $jac := Jacobian([P1, P2, P3, P4, P5, P6], [X_1, X_2, X_3, X_4, X_5, X_6]);$

$$jac := \begin{bmatrix} -0.05060\,X_3 - 0.05060\,X_4 - 0.02 & 0 & -0.05060\,X_1 & -0.05060\,X_1 & 0 & 0 \\ 0.05060\,X_3 + 0.05060\,X_4 & -0.19 & 0.05060\,X_1 & 0.05060\,X_1 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

> $jac1 := subs(fix1, evalm(jac)); eigenvalues(jac1);$

$$jac1 := \begin{bmatrix} -0.02 & 0 & -0.05060 & -0.05060 & 0 & 0 \\ 0. & -0.19 & 0.05060 & 0.05060 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

$$-0.02000000000000000,\ -0.520000000000000,\ -0.523000000000000,\ -0.0877243486608096,\ 0.00161710957626643,\ -0.233892760915457$$

> $fix2 := fixpoint[2];$

$$fix2 := \{X_1 = 0.9571417500, X_2 = 0.004511394739, X_3 = 0.01573204319, X_4 = 0.001966505399, X_5 = 0.0007896101985, X_6 = 0.00004099899107\}$$

> $jac2 := subs(fix2, evalm(jac)); eigenvalues(jac2);$

$$jac2 := \begin{bmatrix} -0.02089554656 & 0 & -0.04843137255 & -0.04843137255 & 0 & 0 \\ 0.0008955465586 & -0.19 & 0.04843137255 & 0.04843137255 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

$$-0.520000000000000,\ -0.523000000000000,\ -0.232489242918323,\ -0.00171195950010024,\ -0.0876784269202372,\ -0.0190159172213398$$

> $$T1 := \frac{d}{dt}X_1(t) = \mu - (1-p)\cdot\beta\cdot X_1(t)\cdot\left(X_3(t) + X_4(t)\right) - \mu\cdot X_1(t)$$

$$T1 := \frac{d}{dt}X_1(t) = 0.02 - 0.05060\,X_1(t)\left(X_3(t) + X_4(t)\right) - 0.02\,X_1(t)$$

> $$T2 := \frac{d}{dt}X_2(t) = (1-p)\cdot\beta\cdot X_1(t)\cdot\left(X_3(t) + X_4(t)\right) - (\gamma I + \mu)\cdot X_2(t)$$

$$T2 := \frac{d}{dt}X_2(t) = 0.05060\,X_1(t)\left(X_3(t) + X_4(t)\right) - 0.19\,X_2(t)$$

> $$T3 := \frac{d}{dt}X_3(t) = \gamma I\cdot X_2(t) + \delta\cdot X_4(t) - \left(k_1 + k_2 + \mu\right)\cdot X_3(t)$$

$$T3 := \frac{d}{dt}X_3(t) = 0.17\,X_2(t) + 0.01\,X_4(t) - 0.05\,X_3(t)$$

> $$T4 := \frac{d}{dt}X_4(t) = k_1\cdot X_3(t) - (\delta + \omega + \mu)\cdot X_4(t)$$

$$T4 := \frac{d}{dt}X_4(t) = 0.01\,X_3(t) - 0.08\,X_4(t)$$

> $$T5 := \frac{d}{dt}X_5(t) = k_2\cdot X_3(t) + \omega\cdot X_4(t) - ((1-q)\cdot\sigma + \mu + d)\cdot X_5(t)$$

$$T5 := \frac{d}{dt}X_5(t) = 0.02\,X_3(t) + 0.05\,X_4(t) - 0.523\,X_5(t)$$

> $$T6 := \frac{d}{dt}X_6(t) = q\cdot\sigma\cdot X_5(t) - (\mu + d)\cdot X_6(t)$$

$$T6 := \frac{d}{dt}X_6(t) = 0.027\,X_5(t) - 0.52\,X_6(t)$$

> $$\#X_1 = 0.9571417500,\ X_2 = 0.004511394739,\ X_3 = 0.01573204319,\ X_4 = 0.001966505399,\ X_5 = 0.0007896101985,\ X_6 = 0.00004099899107$$

> $$DEplot\left([T1, T2, T3, T4, T5, T6], \left[X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)\right], t = 0..2000, \left[\left[X_1(0) = 0.94, X_2(0) = 0.004, X_3(0) = 0.01, X_4(0) = 0.001, X_5(0) = 0.0007, X_6(0) = 0.00004\right]\right], linecolor = [green], arrows = medium, scene = \left[t, X_1(t)\right], stepsize = 0.1\right);$$

> $$DEplot\left([T1, T2, T3, T4, T5, T6], \left[X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)\right], t = 0..3000, \left[\left[X_1(0) = 0.94, X_2(0) = 0.0042, X_3(0) = 0.01, X_4(0) = 0.001, X_5(0) = 0.0007, X_6(0) = 0.00004\right]\right], linecolor = [green], arrows = medium, scene = \left[t, X_2(t)\right], stepsize = 0.1\right);$$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..2000, [[X_1(0) = 0.94, X_2(0) = 0.0042, X_3(0) = 0.014, X_4(0) = 0.001, X_5(0) = 0.0007, X_6(0) = 0.00004]], linecolor = [green], arrows = medium, scene = [t, X_3(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..2000, [[X_1(0) = 0.94, X_2(0) = 0.0045, X_3(0) = 0.015, X_4(0) = 0.0016, X_5(0) = 0.0007, X_6(0) = 0.00004]], linecolor = [green], arrows = medium, scene = [t, X_4(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..2000, [[X_1(0) = 0.94, X_2(0) = 0.0045, X_3(0) = 0.015, X_4(0) = 0.0016, X_5(0) = 0.0007, X_6(0) = 0.00004]], linecolor = [green], arrows = medium, scene = [t, X_5(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..2000, [[X_1(0) = 0.94, X_2(0) = 0.0045, X_3(0) = 0.015, X_4(0) = 0.0016, X_5(0) = 0.0007, X_6(0) = 0.00004]], linecolor = [green], arrows = medium, scene = [t, X_6(t)], stepsize = 0.1);$

3. Sintax pemberian nilai parameter sebesar 0.6

> $restart :$
> $with(linalg) : with(plots) : with(DEtools) :$
> $\beta := 0.06; \mu := 0.02; \delta := 0.01; k_1 := 0.01; k_2 := 0.02; \gamma I := 0.17; \omega := 0.05; p := 0.008; q := 0.9; \sigma := 0.03; d := 0.5$

$$\beta := 0.06$$
$$\mu := 0.02$$
$$\delta := 0.01$$
$$k_1 := 0.01$$
$$k_2 := 0.02$$
$$\gamma I := 0.17$$
$$\omega := 0.05$$
$$p := 0.008$$
$$q := 0.9$$
$$\sigma := 0.03$$
$$d := 0.5$$

> $R0 := \frac{(1-p)\,\beta\,\gamma I\left(\delta + \omega + \mu + k_1\right)}{\left(\gamma I + \mu\right)\left(\delta k_2 + \delta\mu + k_1\mu + k_1\omega + k_2\mu + k_2\omega + \mu^2 + \mu\omega\right)}$

$$R0 := 1.228955466$$

> $P1 := \mu - (1-p)\cdot\beta\cdot X_1\cdot\left(X_3 + X_4\right) - \mu\cdot X_1$

$$P1 := 0.02 - 0.05952\,X_1\left(X_3 + X_4\right) - 0.02\,X_1$$

> $P2 := (1-p)\cdot\beta\cdot X_1\cdot\left(X_3 + X_4\right) - \left(\gamma I + \mu\right)\cdot X_2$

$$P2 := 0.05952\,X_1\left(X_3 + X_4\right) - 0.19\,X_2$$

> $P3 := \gamma I \cdot X_2 + \delta \cdot X_4 - (k_1 + k_2 + \mu) \cdot X_3$

$$P3 := 0.17\,X_2 + 0.01\,X_4 - 0.05\,X_3$$

> $P4 := k_1 \cdot X_3 - (\delta + \omega + \mu) \cdot X_4$

$$P4 := 0.01\,X_3 - 0.08\,X_4$$

> $P5 := k_2 \cdot X_3 + \omega \cdot X_4 - ((1-q) \cdot \sigma + \mu + d) \cdot X_5$

$$P5 := 0.02\,X_3 + 0.05\,X_4 - 0.523\,X_5$$

> $P6 := q \cdot \sigma \cdot X_5 - (\mu + d) \cdot X_6$

$$P6 := 0.027\,X_5 - 0.52\,X_6$$

> $fixpoint := solve(\{P1, P2, P3, P4, P5, P6\}, \{X_1, X_2, X_3, X_4, X_5, X_6\})$

$$fixpoint := \{X_1 = 1., X_2 = 0., X_3 = 0., X_4 = 0., X_5 = 0., X_6 = 0.\}, \{X_1 = 0.8136991356, X_2 = 0.01961061731, X_3 = 0.06838574241, X_4 = 0.008548217801, X_5 = 0.003432362788, X_6 = 0.0001782188371\}$$

> $with(plots) : with(linalg) : with(VectorCalculus) :$

> $fix1 := fixpoint[1];$

$$fix1 := \{X_1 = 1., X_2 = 0., X_3 = 0., X_4 = 0., X_5 = 0., X_6 = 0.\}$$

> $jac := Jacobian([P1, P2, P3, P4, P5, P6], [X_1, X_2, X_3, X_4, X_5, X_6]);$

$$jac := \begin{bmatrix} -0.05952\,X_3 - 0.05952\,X_4 - 0.02 & 0 & -0.05952\,X_1 & -0.05952\,X_1 & 0 & 0 \\ 0.05952\,X_3 + 0.05952\,X_4 & -0.19 & 0.05952\,X_1 & 0.05952\,X_1 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

> $jac1 := subs(fix1, evalm(jac)); eigenvalues(jac1);$

$$jac1 := \begin{bmatrix} -0.02 & 0 & -0.05952 & -0.05952 & 0 & 0 \\ 0. & -0.19 & 0.05952 & 0.05952 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

$$-0.0200000000000000,\ -0.520000000000000,\ -0.523000000000000,\ -0.0879608879856904,\ 0.00803407641159817,\ -0.240073188425908$$

> $fix2 := fixpoint[2];$

$$fix2 := \{X_1 = 0.8136991356, X_2 = 0.01961061731, X_3 = 0.06838574241, X_4 = 0.008548217801, X_5 = 0.003432362788, X_6 = 0.0001782188371\}$$

> $jac2 := subs(fix2, evalm(jac)); eigenvalues(jac2);$

$$jac2 := \begin{bmatrix} -0.02457910931 & 0 & -0.04843137255 & -0.04843137255 & 0 & 0 \\ 0.004579109312 & -0.19 & 0.04843137255 & 0.04843137255 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

$$-0.520000000000000, -0.523000000000000, -0.233104907275160, -0.0118554032968719 + 0.00503056996279736\,I, -0.0118554032968719 - 0.00503056996279736\,I, -0.0877633954410963$$

> $-0.0118554032968719 + 0.00503056996279736$

$$-0.006824833337$$

> $-0.0118554032968719 - 0.00503056996279736$

$$-0.01688597326$$

> $T1 := \frac{d}{dt}X_1(t) = \mu - (1-p)\cdot\beta\cdot X_1(t)\cdot\left(X_3(t) + X_4(t)\right) - \mu\cdot X_1(t)$

$$T1 := \frac{d}{dt}X_1(t) = 0.02 - 0.05952\,X_1(t)\left(X_3(t) + X_4(t)\right) - 0.02\,X_1(t)$$

> $T2 := \frac{d}{dt}X_2(t) = (1-p)\cdot\beta\cdot X_1(t)\cdot\left(X_3(t) + X_4(t)\right) - (\gamma I + \mu)\cdot X_2(t)$

$$T2 := \frac{d}{dt}X_2(t) = 0.05952\,X_1(t)\left(X_3(t) + X_4(t)\right) - 0.19\,X_2(t)$$

> $T3 := \frac{d}{dt}X_3(t) = \gamma I\cdot X_2(t) + \delta\cdot X_4(t) - \left(k_1 + k_2 + \mu\right)\cdot X_3(t)$

$$T3 := \frac{d}{dt}X_3(t) = 0.17\,X_2(t) + 0.01\,X_4(t) - 0.05\,X_3(t)$$

> $T4 := \frac{d}{dt}X_4(t) = k_1\cdot X_3(t) - (\delta + \omega + \mu)\cdot X_4(t)$

$$T4 := \frac{d}{dt}X_4(t) = 0.01\,X_3(t) - 0.08\,X_4(t)$$

> $T5 := \frac{d}{dt}X_5(t) = k_2\cdot X_3(t) + \omega\cdot X_4(t) - ((1-q)\cdot\sigma + \mu + d)\cdot X_5(t)$

$$T5 := \frac{d}{dt}X_5(t) = 0.02\,X_3(t) + 0.05\,X_4(t) - 0.523\,X_5(t)$$

> $T6 := \frac{d}{dt}X_6(t) = q\cdot\sigma\cdot X_5(t) - (\mu + d)\cdot X_6(t)$

$$T6 := \frac{d}{dt}X_6(t) = 0.027\,X_5(t) - 0.52\,X_6(t)$$

> $\#X_1 = 0.8136991356, X_2 = 0.01961061731, X_3 = 0.06838574241, X_4 = 0.008548217801, X_5 = 0.003432362788, X_6 = 0.0001782188371$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..800, [[X_1(0) = 0.8, X_2(0) = 0.01, X_3(0) = 0.06, X_4(0) = 0.008, X_5(0) = 0.003, X_6(0) = 0.0001]], linecolor = [green], arrows = medium, scene = [t, X_1(t)], stepsize = 0.1);$

```
> DEplot([T1, T2, T3, T4, T5, T6], [X1(t), X2(t), X3(t), X4(t), X5(t), X6(t)], t = 0..600, [[X1(0) = 0.8, X2(0) = 0.01, X3(0) = 0.06, X4(0) = 0.008, X5(0) = 0.003, X6(0) = 0.0001]], linecolor = [green], arrows = medium, scene = [t, X2(t)], stepsize = 0.1);

> DEplot([T1, T2, T3, T4, T5, T6], [X1(t), X2(t), X3(t), X4(t), X5(t), X6(t)], t = 0..600, [[X1(0) = 0.8, X2(0) = 0.01, X3(0) = 0.06, X4(0) = 0.008, X5(0) = 0.003, X6(0) = 0.0001]], linecolor = [green], arrows = medium, scene = [t, X3(t)], stepsize = 0.1);

> DEplot([T1, T2, T3, T4, T5, T6], [X1(t), X2(t), X3(t), X4(t), X5(t), X6(t)], t = 0..600, [[X1(0) = 0.8, X2(0) = 0.01, X3(0) = 0.06, X4(0) = 0.008, X5(0) = 0.003, X6(0) = 0.0001]], linecolor = [green], arrows = medium, scene = [t, X4(t)], stepsize = 0.1);

> DEplot([T1, T2, T3, T4, T5, T6], [X1(t), X2(t), X3(t), X4(t), X5(t), X6(t)], t = 0..600, [[X1(0) = 0.8, X2(0) = 0.01, X3(0) = 0.06, X4(0) = 0.008, X5(0) = 0.003, X6(0) = 0.0001]], linecolor = [green], arrows = medium, scene = [t, X5(t)], stepsize = 0.1);

> DEplot([T1, T2, T3, T4, T5, T6], [X1(t), X2(t), X3(t), X4(t), X5(t), X6(t)], t = 0..600, [[X1(0) = 0.8, X2(0) = 0.01, X3(0) = 0.06, X4(0) = 0.008, X5(0) = 0.003, X6(0) = 0.0001]], linecolor = [green], arrows = medium, scene = [t, X6(t)], stepsize = 0.1);
```

4. Sintax pemberian nilai parameter sebesar 0.05

```
> restart :
> with(linalg) : with(plots) : with(DEtools) :
>
β := 0.05; μ := 0.02; δ := 0.01; k1 := 0.01; k2 := 0.02; γI := 0.17; ω := 0.05; η := 0.02; p := 0.08; q := 0.9; σ := 0.03; d := 0.5
```

$$\beta := 0.05$$
$$\mu := 0.02$$
$$\delta := 0.01$$
$$k_1 := 0.01$$
$$k_2 := 0.02$$
$$\gamma I := 0.17$$
$$\omega := 0.05$$
$$\eta := 0.02$$
$$p := 0.08$$
$$q := 0.9$$
$$\sigma := 0.03$$
$$d := 0.5$$

```
> R0 := (1 − p) β γI (δ + ω + μ + k1) / ((γI + μ) (δ k2 + δ μ + k1 μ + k1 ω + k2 μ + k2 ω + μ^2 + μ ω))
```

$$R0 := 0.9497975708$$

> $P1 := \mu - (1-p)\cdot\beta\cdot X_1\cdot(X_3+X_4) - \mu\cdot X_1$

$$P1 := 0.02 - 0.0460\,X_1\,(X_3+X_4) - 0.02\,X_1$$

> $P2 := (1-p)\cdot\beta\cdot X_1\cdot(X_3+X_4) - (\gamma I+\mu)\cdot X_2$

$$P2 := 0.0460\,X_1\,(X_3+X_4) - 0.19\,X_2$$

> $P3 := \gamma I\cdot X_2 + \delta\cdot X_4 - (k_1+k_2+\mu)\cdot X_3$

$$P3 := 0.17\,X_2 + 0.01\,X_4 - 0.05\,X_3$$

> $P4 := k_1\cdot X_3 - (\delta+\omega+\mu)\cdot X_4$

$$P4 := 0.01\,X_3 - 0.08\,X_4$$

> $P5 := k_2\cdot X_3 + \omega\cdot X_4 - ((1-q)\cdot\sigma+\mu+d)\cdot X_5$

$$P5 := 0.02\,X_3 + 0.05\,X_4 - 0.523\,X_5$$

> $P6 := q\cdot\sigma\cdot X_5 - (\mu+d)\cdot X_6$

$$P6 := 0.027\,X_5 - 0.52\,X_6$$

> $fixpoint := solve(\{P1,P2,P3,P4,P5,P6\},\{X_1,X_2,X_3,X_4,X_5,X_6\})$

$$fixpoint := \{X_1 = 1.,\ X_2 = 0.,\ X_3 = 0.,\ X_4 = 0.,\ X_5 = 0.,\ X_6 = 0.\},\ \{X_1 = 1.052855925,\ X_2 = -0.005563781577,\ X_3 = -0.01940190499,\ X_4 = -0.002425238123,\ X_5 = -0.0009738049825,\ X_6 = -0.00005056295102\}$$

> $with(plots) : with(linalg) : with(VectorCalculus) :$

> $fix1 := fixpoint[1];$

$$fix1 := \{X_1 = 1.,\ X_2 = 0.,\ X_3 = 0.,\ X_4 = 0.,\ X_5 = 0.,\ X_6 = 0.\}$$

> $jac := Jacobian([P1,P2,P3,P4,P5,P6],[X_1,X_2,X_3,X_4,X_5,X_6]);$

$$jac := \begin{bmatrix} -0.0460\,X_3 - 0.0460\,X_4 - 0.02 & 0 & -0.0460\,X_1 & -0.0460\,X_1 & 0 & 0 \\ 0.0460\,X_3 + 0.0460\,X_4 & -0.19 & 0.0460\,X_1 & 0.0460\,X_1 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

> $jac1 := subs(fix1, evalm(jac)); eigenvalues(jac1);$

$$jac1 := \begin{bmatrix} -0.02 & 0 & -0.0460 & -0.0460 & 0 & 0 \\ 0. & -0.19 & 0.0460 & 0.0460 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

$$-0.0200000000000000,\ -0.520000000000000,\ -0.523000000000000,\ -0.0875792991668673,\ -0.00184213964635691,\ -0.230578561186776$$

> $T1 := \frac{d}{dt}X_1(t) = \mu - (1-p)\cdot\beta\cdot X_1(t)\cdot(X_3(t)+X_4(t)) - \mu\cdot X_1(t)$

$$T1 := \frac{d}{dt} X_1(t) = 0.02 - 0.0460\, X_1(t)\left(X_3(t) + X_4(t)\right) - 0.02\, X_1(t)$$

> $T2 := \frac{d}{dt} X_2(t) = (1-p)\cdot\beta\cdot X_1(t)\cdot\left(X_3(t) + X_4(t)\right) - (\gamma I + \mu)\cdot X_2(t)$

$$T2 := \frac{d}{dt} X_2(t) = 0.0460\, X_1(t)\left(X_3(t) + X_4(t)\right) - 0.19\, X_2(t)$$

> $T3 := \frac{d}{dt} X_3(t) = \gamma I\cdot X_2(t) + \delta\cdot X_4(t) - \left(k_1 + k_2 + \mu\right)\cdot X_3(t)$

$$T3 := \frac{d}{dt} X_3(t) = 0.17\, X_2(t) + 0.01\, X_4(t) - 0.05\, X_3(t)$$

> $T4 := \frac{d}{dt} X_4(t) = k_1\cdot X_3(t) - (\delta + \omega + \mu)\cdot X_4(t)$

$$T4 := \frac{d}{dt} X_4(t) = 0.01\, X_3(t) - 0.08\, X_4(t)$$

> $T5 := \frac{d}{dt} X_5(t) = k_2\cdot X_3(t) + \omega\cdot X_4(t) - ((1-q)\cdot\sigma + \mu + d)\cdot X_5(t)$

$$T5 := \frac{d}{dt} X_5(t) = 0.02\, X_3(t) + 0.05\, X_4(t) - 0.523\, X_5(t)$$

> $T6 := \frac{d}{dt} X_6(t) = q\cdot\sigma\cdot X_5(t) - (\mu + d)\cdot X_6(t)$

$$T6 := \frac{d}{dt} X_6(t) = 0.027\, X_5(t) - 0.52\, X_6(t)$$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..4000, [[X_1(0) = 0.9, X_2(0) = 0.05, X_3(0) = 0.04, X_4(0) = 0.03, X_5(0) = 0.02, X_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, X_1(t)], method = rosenbrock, stepsize = 0.5);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..5000, [[X_1(0) = 0.8, X_2(0) = 0.02, X_3(0) = 0.04, X_4(0) = 0.03, X_5(0) = 0.02, X_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, X_2(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..5000, [[X_1(0) = 0.8, X_2(0) = 0.05, X_3(0) = 0.04, X_4(0) = 0.03, X_5(0) = 0.02, X_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, X_3(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..4000, [[X_1(0) = 0.8, X_2(0) = 0.05, X_3(0) = 0.04, X_4(0) = 0.03, X_5(0) = 0.02, X_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, X_4(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..4000, [[X_1(0) = 0.8, X_2(0) = 0.05, X_3(0) = 0.04, X_4(0) = 0.03, X_5(0) = 0.02, X_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, X_5(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..4000, [[X_1(0) = 0.8, X_2(0) = 0.05, X_3(0) = 0.04, X_4(0) = 0.03, X_5(0) = 0.02, X_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, X_5(t)], stepsize = 0.1);$

```
> DEplot([T1, T2, T3, T4, T5, T6], [X1(t), X2(t), X3(t), X4(t), X5(t), X6(t)], t = 0..4000, [[X1(0) = 0.8, X2(0) = 0.05, X3(0) = 0.04, X4(0) = 0.03, X5(0) = 0.02, X6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, X6(t)], stepsize = 0.1);
```

5. Sintax pemberian nilai parameter sebesar 0.03

```
> restart :
> with(linalg) : with(plots) : with(DEtools) :
> β := 0.03; μ := 0.02; δ := 0.01; k1 := 0.01; k2 := 0.02; γI := 0.17; ω := 0.05; p := 0.08; q := 0.9; σ := 0.03; d := 0.5
```

$$\beta := 0.03$$
$$\mu := 0.02$$
$$\delta := 0.01$$
$$k_1 := 0.01$$
$$k_2 := 0.02$$
$$\gamma I := 0.17$$
$$\omega := 0.05$$
$$p := 0.08$$
$$q := 0.9$$
$$\sigma := 0.03$$
$$d := 0.5$$

```
> R0 := (1 - p) β γI (δ + ω + μ + k1) / ((γI + μ) (δ k2 + δ μ + k1 μ + k1 ω + k2 μ + k2 ω + μ^2 + μ ω))
```

$$R0 := 0.5698785426$$

```
> P1 := μ - (1 - p)·β·X1·(X3 + X4) - μ·X1
```

$$P1 := 0.02 - 0.0276\,X_1\,(X_3 + X_4) - 0.02\,X_1$$

```
> P2 := (1 - p)·β·X1·(X3 + X4) - (γI + μ)·X2
```

$$P2 := 0.0276\,X_1\,(X_3 + X_4) - 0.19\,X_2$$

```
> P3 := γI·X2 + δ·X4 - (k1 + k2 + μ)·X3
```

$$P3 := 0.17\,X_2 + 0.01\,X_4 - 0.05\,X_3$$

```
> P4 := k1·X3 - (δ + ω + μ)·X4
```

$$P4 := 0.01\,X_3 - 0.08\,X_4$$

```
> P5 := k2·X3 + ω·X4 - ((1 - q)·σ + μ + d)·X5
```

$$P5 := 0.02\,X_3 + 0.05\,X_4 - 0.523\,X_5$$

```
> P6 := q·σ·X5 - (μ + d)·X6
```

$$P6 := 0.027\,X_5 - 0.52\,X_6$$

```
> fixpoint := solve({P1, P2, P3, P4, P5, P6}, {X1, X2, X3, X4, X5, X6})
```

$$fixpoint := \{X_1 = 1., X_2 = 0., X_3 = 0., X_4 = 0., X_5 = 0., X_6 = 0.\}, \{X_1 = 1.754759875, X_2 = -0.07944840789, X_3 = -0.2770508583, X_4 = -0.03463135729, X_5 = -0.01390551631, X_6 = -0.0007220171930\}$$

```
> with(plots) : with(linalg) : with(VectorCalculus) :
> fix1 := fixpoint[1];
```

$$fix1 := \{X_1 = 1., X_2 = 0., X_3 = 0., X_4 = 0., X_5 = 0., X_6 = 0.\}$$

```
> fix1 := fixpoint[1];
```

$$fix1 := \{X_1 = 1., X_2 = 0., X_3 = 0., X_4 = 0., X_5 = 0., X_6 = 0.\}$$

```
> jac := Jacobian([P1, P2, P3, P4, P5, P6], [X1, X2, X3, X4, X5, X6]);
```

$$jac := \begin{bmatrix} -0.0276 X_3 - 0.0276 X_4 - 0.02 & 0 & -0.0276 X_1 & -0.0276 X_1 & 0 & 0 \\ 0.0276 X_3 + 0.0276 X_4 & -0.19 & 0.0276 X_1 & 0.0276 X_1 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

```
> jac1 := subs(fix1, evalm(jac)); eigenvalues(jac1);
```

$$jac1 := \begin{bmatrix} -0.02 & 0 & -0.0276 & -0.0276 & 0 & 0 \\ 0. & -0.19 & 0.0276 & 0.0276 & 0 & 0 \\ 0 & 0.17 & -0.05 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & -0.08 & 0 & 0 \\ 0 & 0 & 0.02 & 0.05 & -0.523 & 0 \\ 0 & 0 & 0 & 0 & 0.027 & -0.52 \end{bmatrix}$$

$$-0.0200000000000000,\ -0.520000000000000,\ -0.523000000000000,\ -0.0867457440091467,\ -0.0169892789435319,\ -0.216264977047321$$

```
> T1 := d/dt X1(t) = μ - (1 - p)·β·X1(t)·(X3(t) + X4(t)) - μ·X1(t)
```

$$T1 := \frac{d}{dt} X_1(t) = 0.02 - 0.0276 X_1(t) \left(X_3(t) + X_4(t)\right) - 0.02 X_1(t)$$

```
> T2 := d/dt X2(t) = (1 - p)·β·X1(t)·(X3(t) + X4(t)) - (γI + μ)·X2(t)
```

$$T2 := \frac{d}{dt} X_2(t) = 0.0276 X_1(t) \left(X_3(t) + X_4(t)\right) - 0.19 X_2(t)$$

```
> T3 := d/dt X3(t) = γI·X2(t) + δ·X4(t) - (k1 + k2 + μ)·X3(t)
```

$$T3 := \frac{d}{dt} X_3(t) = 0.17 X_2(t) + 0.01 X_4(t) - 0.05 X_3(t)$$

```
> T4 := d/dt X4(t) = k1·X3(t) - (δ + ω + μ)·X4(t)
```

$$T4 := \frac{d}{dt} X_4(t) = 0.01 X_3(t) - 0.08 X_4(t)$$

> $T5 := \frac{d}{dt}X_5(t) = k_2 \cdot X_3(t) + \omega \cdot X_4(t) - ((1-q)\cdot\sigma + \mu + d)\cdot X_5(t)$

$$T5 := \frac{d}{dt}X_5(t) = 0.02\,X_3(t) + 0.05\,X_4(t) - 0.523\,X_5(t)$$

> $T6 := \frac{d}{dt}X_6(t) = q\cdot\sigma\cdot X_5(t) - (\mu + d)\cdot X_6(t)$

$$T6 := \frac{d}{dt}X_6(t) = 0.027\,X_5(t) - 0.52\,X_6(t)$$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..400, [[X_1(0) = 0.8, X_2(0) = 0.05, X_3(0) = 0.04, X_4(0) = 0.03, X_5(0) = 0.02, X_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, X_1(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..500, [[X_1(0) = 0.8, X_2(0) = 0.05, X_3(0) = 0.04, X_4(0) = 0.03, X_5(0) = 0.02, X_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, X_2(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..700, [[X_1(0) = 0.8, X_2(0) = 0.05, X_3(0) = 0.04, X_4(0) = 0.03, X_5(0) = 0.02, X_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, X_3(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..500, [[X_1(0) = 0.8, X_2(0) = 0.05, X_3(0) = 0.04, X_4(0) = 0.03, X_5(0) = 0.02, X_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, X_4(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..500, [[X_1(0) = 0.8, X_2(0) = 0.05, X_3(0) = 0.04, X_4(0) = 0.03, X_5(0) = 0.02, X_6(0) = 0.01]], linecolor = [green], arrows = medium, scene = [t, X_5(t)], stepsize = 0.1);$

> $DEplot([T1, T2, T3, T4, T5, T6], [X_1(t), X_2(t), X_3(t), X_4(t), X_5(t), X_6(t)], t = 0..500, [[X_1(0) = 0.8, X_2(0) = 0.05, X_3(0) = 0.04, X_4(0) = 0.03, X_5(0) = 0.02, X_6(0) = 0.001]], linecolor = [green], arrows = medium, scene = [t, X_6(t)], stepsize = 0.1);$

Lampiran 6. Hubungan antara parameter proporsi pembentukan komisi penanggulangan HIV/AIDS dan parameter interaksi antar individu terinfeksi HIV/AIDS dengan individu sehat pada saat $R_0 = 1$

> *restart* :
> *with*(*linalg*) :
>

$\#\beta := 0.06; \mu := 0.02; \delta := 0.01; k_1 := 0.01;\ k_2 := 0.02;\ \gamma I := 0.17;\ \omega := 0.05;\ p := 0.08;\ q := 0.9;\ \sigma := 0.03;\ d := 0.5$

> $R0 := -\frac{(-1+p)\,\beta\,\gamma I\,(\delta + \omega + \mu + k_1)}{(\gamma I + \mu)\,(\delta k_2 + \delta\mu + k_1\mu + k_1\omega + k_2\mu + k_2\omega + \mu^2 + \mu\omega)}$

$$R0 := -\frac{(-1+p)\,\beta\,\gamma I\left(\delta+\omega+\mu+k_1\right)}{\left(\gamma I+\mu\right)\left(\delta k_2+\delta\mu+k_1\mu+k_1\omega+k_2\mu+k_2\omega+\mu^2+\mu\omega\right)}$$

> 7

$$7$$

> $diff(R0, p)$

$$-\frac{\beta\,\gamma I\left(\delta+\omega+\mu+k_1\right)}{\left(\gamma I+\mu\right)\left(\delta k_2+\delta\mu+k_1\mu+k_1\omega+k_2\mu+k_2\omega+\mu^2+\mu\omega\right)}$$

> $$-\frac{\beta\,\gamma I\left(\delta+\omega+\mu+k_1\right)}{\left(\gamma I+\mu\right)\left(\delta k_2+\delta\mu+k_1\mu+k_1\omega+k_2\mu+k_2\omega+\mu^2+\mu\omega\right)}\cdot\frac{p}{R0}$$

$$\frac{p}{-1+p}$$

> $diff(R0, q)$

$$0$$