

$$\begin{aligned}
dSdteqn[t_, a_] &= -\beta S[t, a] II[t, a] / (S[t, a] + EE[t, a] + II[t, a]) - \\
&\quad \mu S S[t, a] - D[S[t, a], t] - D[S[t, a], a] \\
dEEdteqn[t_, a_] &= (1 - \epsilon) \beta S[t, a] II[t, a] / (S[t, a] + EE[t, a] + II[t, a]) - \\
&\quad \delta EE[t, a] - \mu E EE[t, a] - D[EE[t, a], t] - D[EE[t, a], a] \\
dIIdteqn[t_, a_] &= \epsilon \beta S[t, a] II[t, a] / (S[t, a] + EE[t, a] + II[t, a]) + \\
&\quad \delta EE[t, a] - \mu I II[t, a] - D[II[t, a], t] - D[II[t, a], a] \\
&\quad - \mu S S[t, a] - \frac{\beta II[t, a] S[t, a]}{EE[t, a] + II[t, a] + S[t, a]} - S^{(0,1)}[t, a] - S^{(1,0)}[t, a] \\
&\quad - \delta EE[t, a] - \mu E EE[t, a] + \frac{\beta (1 - \epsilon) II[t, a] S[t, a]}{EE[t, a] + II[t, a] + S[t, a]} - EE^{(0,1)}[t, a] - EE^{(1,0)}[t, a] \\
&\quad \delta EE[t, a] - \mu I II[t, a] + \frac{\beta \epsilon II[t, a] S[t, a]}{EE[t, a] + II[t, a] + S[t, a]} - II^{(0,1)}[t, a] - II^{(1,0)}[t, a]
\end{aligned}$$

$$yEeqn[t_, a_] = kE EE[t, a] - yE[t, a]$$

$$yIeqn[t_, a_] = kI II[t, a] - yI[t, a]$$

$$kE EE[t, a] - yE[t, a]$$

$$kI II[t, a] - yI[t, a]$$

$$yEmap[t_, a_] = \text{Solve}[yEeqn[t, a] == 0, EE[t, a]][[1]]$$

$$yImap[t_, a_] = \text{Solve}[yIeqn[t, a] == 0, II[t, a]][[1]]$$

$$\left\{ EE[t, a] \rightarrow \frac{yE[t, a]}{kE} \right\}$$

$$\left\{ II[t, a] \rightarrow \frac{yI[t, a]}{kI} \right\}$$

$$\begin{aligned}
dSdteqn2[t_, a_] &= \\
&\quad dSdteqn[t, a] /. yEmap[t, a] /. D[yEmap[t, a], t] /. D[yEmap[t, a], a] /. yImap[t, a] /. \\
&\quad D[yImap[t, a], t] /. D[yImap[t, a], a] \\
dEEdteqn2[t_, a_] &= dEEdteqn[t, a] /. yEmap[t, a] /. D[yEmap[t, a], t] /. \\
&\quad D[yEmap[t, a], a] /. yImap[t, a] /. D[yImap[t, a], t] /. D[yImap[t, a], a] \\
dIIdteqn2[t_, a_] &= dIIdteqn[t, a] /. yEmap[t, a] /. D[yEmap[t, a], t] /. \\
&\quad D[yEmap[t, a], a] /. yImap[t, a] /. D[yImap[t, a], t] /. D[yImap[t, a], a]
\end{aligned}$$

$$\begin{aligned}
&\quad -\mu S S[t, a] - \frac{\beta S[t, a] yI[t, a]}{kI \left(S[t, a] + \frac{yE[t, a]}{kE} + \frac{yI[t, a]}{kI} \right)} - S^{(0,1)}[t, a] - S^{(1,0)}[t, a] \\
&\quad - \frac{\delta yE[t, a]}{kE} - \frac{\mu E yE[t, a]}{kE} + \frac{\beta (1 - \epsilon) S[t, a] yI[t, a]}{kI \left(S[t, a] + \frac{yE[t, a]}{kE} + \frac{yI[t, a]}{kI} \right)} - \frac{yE^{(0,1)}[t, a]}{kE} - \frac{yE^{(1,0)}[t, a]}{kE} \\
&\quad \frac{\delta yE[t, a]}{kE} - \frac{\mu I yI[t, a]}{kI} + \frac{\beta \epsilon S[t, a] yI[t, a]}{kI \left(S[t, a] + \frac{yE[t, a]}{kE} + \frac{yI[t, a]}{kI} \right)} - \frac{yI^{(0,1)}[t, a]}{kI} - \frac{yI^{(1,0)}[t, a]}{kI}
\end{aligned}$$

```
Smap[t_, a_] = Solve[dIIdteqn2[t, a] == 0, S[t, a]][[1]]
```

```
{S[t, a] → - ( ( (kI yE[t, a] + kE yI[t, a])  

    (kI δ yE[t, a] - kE μI yI[t, a] - kE yI(0,1)[t, a] - kE yI(1,0)[t, a]) ) ) /  

    (kE kI (kI δ yE[t, a] + kE β ∈ yI[t, a] - kE μI yI[t, a] -  

        kE yI(0,1)[t, a] - kE yI(1,0)[t, a]) ) ) ) }
```

```
dSdteqn3[t_, a_] = dSdteqn2[t, a] /. Smap[t, a] /. D[Smap[t, a], t] /. D[Smap[t, a], a]
```

```
dEEdteqn3[t_, a_] =
```

```
    dEEdteqn2[t, a] /. Smap[t, a] /. D[Smap[t, a], t] /. D[Smap[t, a], a]
```

$$\begin{aligned}
& (\mu S (k_I y_E[t, a] + k_E y_I[t, a]) \\
& \quad (k_I \delta y_E[t, a] - k_E \mu_I y_I[t, a] - k_E y_I^{(0,1)}[t, a] - k_E y_I^{(1,0)}[t, a])) / (k_E k_I \\
& \quad (k_I \delta y_E[t, a] + k_E \beta \in y_I[t, a] - k_E \mu_I y_I[t, a] - k_E y_I^{(0,1)}[t, a] - k_E y_I^{(1,0)}[t, a])) + \\
& \quad ((k_I y_E^{(0,1)}[t, a] + k_E y_I^{(0,1)}[t, a]) \\
& \quad (k_I \delta y_E[t, a] - k_E \mu_I y_I[t, a] - k_E y_I^{(0,1)}[t, a] - k_E y_I^{(1,0)}[t, a])) / (k_E k_I \\
& \quad (k_I \delta y_E[t, a] + k_E \beta \in y_I[t, a] - k_E \mu_I y_I[t, a] - k_E y_I^{(0,1)}[t, a] - k_E y_I^{(1,0)}[t, a])) + \\
& \quad ((k_I \delta y_E[t, a] - k_E \mu_I y_I[t, a] - k_E y_I^{(0,1)}[t, a] - k_E y_I^{(1,0)}[t, a]) \\
& \quad (k_I y_E^{(1,0)}[t, a] + k_E y_I^{(1,0)}[t, a])) / (k_E k_I \\
& \quad (k_I \delta y_E[t, a] + k_E \beta \in y_I[t, a] - k_E \mu_I y_I[t, a] - k_E y_I^{(0,1)}[t, a] - k_E y_I^{(1,0)}[t, a])) + \\
& \quad (\beta y_I[t, a] (k_I y_E[t, a] + k_E y_I[t, a]) \\
& \quad (k_I \delta y_E[t, a] - k_E \mu_I y_I[t, a] - k_E y_I^{(0,1)}[t, a] - k_E y_I^{(1,0)}[t, a])) / \\
& \quad \left(k_E k_I^2 (k_I \delta y_E[t, a] + k_E \beta \in y_I[t, a] - k_E \mu_I y_I[t, a] - k_E y_I^{(0,1)}[t, a] - k_E y_I^{(1,0)}[t, a]) \right. \\
& \quad \left(\frac{y_E[t, a]}{k_E} + \frac{y_I[t, a]}{k_I} - ((k_I y_E[t, a] + k_E y_I[t, a]) (k_I \delta y_E[t, a] - k_E \mu_I y_I[t, a] - \right. \\
& \quad \left. k_E y_I^{(0,1)}[t, a] - k_E y_I^{(1,0)}[t, a])) / (k_E k_I (k_I \delta y_E[t, a] + \right. \\
& \quad \left. k_E \beta \in y_I[t, a] - k_E \mu_I y_I[t, a] - k_E y_I^{(0,1)}[t, a] - k_E y_I^{(1,0)}[t, a])) \right) + \\
& \quad ((k_I y_E[t, a] + k_E y_I[t, a]) (k_I \delta y_E^{(0,1)}[t, a] - k_E \mu_I y_I^{(0,1)}[t, a] - \\
& \quad k_E y_I^{(0,2)}[t, a] - k_E y_I^{(1,1)}[t, a])) / (k_E k_I \\
& \quad (k_I \delta y_E[t, a] + k_E \beta \in y_I[t, a] - k_E \mu_I y_I[t, a] - k_E y_I^{(0,1)}[t, a] - k_E y_I^{(1,0)}[t, a])) - \\
& \quad ((k_I y_E[t, a] + k_E y_I[t, a]) (k_I \delta y_E[t, a] - k_E \mu_I y_I[t, a] - k_E y_I^{(0,1)}[t, a] - \\
& \quad k_E y_I^{(1,0)}[t, a]) (k_I \delta y_E^{(0,1)}[t, a] + k_E \beta \in y_I^{(0,1)}[t, a] - \\
& \quad k_E \mu_I y_I^{(0,1)}[t, a] - k_E y_I^{(0,2)}[t, a] - k_E y_I^{(1,1)}[t, a])) / (k_E k_I \\
& \quad (k_I \delta y_E[t, a] + k_E \beta \in y_I[t, a] - k_E \mu_I y_I[t, a] - k_E y_I^{(0,1)}[t, a] - k_E y_I^{(1,0)}[t, a]))^2 + \\
& \quad ((k_I y_E[t, a] + k_E y_I[t, a]) (k_I \delta y_E^{(1,0)}[t, a] - k_E \mu_I y_I^{(1,0)}[t, a] - \\
& \quad k_E y_I^{(1,1)}[t, a] - k_E y_I^{(2,0)}[t, a])) / (k_E k_I \\
& \quad (k_I \delta y_E[t, a] + k_E \beta \in y_I[t, a] - k_E \mu_I y_I[t, a] - k_E y_I^{(0,1)}[t, a] - k_E y_I^{(1,0)}[t, a])) - \\
& \quad ((k_I y_E[t, a] + k_E y_I[t, a]) (k_I \delta y_E[t, a] - k_E \mu_I y_I[t, a] - k_E y_I^{(0,1)}[t, a] - \\
& \quad k_E y_I^{(1,0)}[t, a]) (k_I \delta y_E^{(1,0)}[t, a] + k_E \beta \in y_I^{(1,0)}[t, a] - \\
& \quad k_E \mu_I y_I^{(1,0)}[t, a] - k_E y_I^{(1,1)}[t, a] - k_E y_I^{(2,0)}[t, a])) / (k_E k_I \\
& \quad (k_I \delta y_E[t, a] + k_E \beta \in y_I[t, a] - k_E \mu_I y_I[t, a] - k_E y_I^{(0,1)}[t, a] - k_E y_I^{(1,0)}[t, a]))^2)
\end{aligned}$$

$$\begin{aligned}
& - \frac{\delta yE[t, a]}{kE} - \frac{\mu E yE[t, a]}{kE} - \frac{yE^{(0,1)}[t, a]}{kE} - \\
& \frac{yE^{(1,0)}[t, a]}{kE} - \left(\beta (1 - \epsilon) yI[t, a] (kI yE[t, a] + kE yI[t, a]) \right. \\
& \left. (kI \delta yE[t, a] - kE \mu I yI[t, a] - kE yI^{(0,1)}[t, a] - kE yI^{(1,0)}[t, a]) \right) / \\
& \left(kE kI^2 (kI \delta yE[t, a] + kE \beta \epsilon yI[t, a] - kE \mu I yI[t, a] - kE yI^{(0,1)}[t, a] - kE yI^{(1,0)}[t, a]) \right. \\
& \left. \left(\frac{yE[t, a]}{kE} + \frac{yI[t, a]}{kI} - (kI yE[t, a] + kE yI[t, a]) (kI \delta yE[t, a] - kE \mu I yI[t, a] - \right. \right. \\
& \left. \left. kE yI^{(0,1)}[t, a] - kE yI^{(1,0)}[t, a]) \right) \right) / (kE kI (kI \delta yE[t, a] + \\
& kE \beta \epsilon yI[t, a] - kE \mu I yI[t, a] - kE yI^{(0,1)}[t, a] - kE yI^{(1,0)}[t, a])) \Big)
\end{aligned}$$

IPOpish1[t_, a_] = Denominator[Together[dSdteqn3[t, a]] Together[dSdteqn3[t, a]]
IPOpish2[t_, a_] = Denominator[Together[dEEdteqn3[t, a]] Together[dEEdteqn3[t, a]]

$$\begin{aligned}
& kI^3 \delta^3 yE[t, a]^3 + kI^3 \delta^2 \epsilon \mu S yE[t, a]^3 + 2 kE kI^2 \beta \delta^2 \epsilon yE[t, a]^2 yI[t, a] - \\
& 3 kE kI^2 \delta^2 \mu I yE[t, a]^2 yI[t, a] + kE kI^2 \delta^2 \epsilon \mu S yE[t, a]^2 yI[t, a] + \\
& kE kI^2 \beta \delta \epsilon^2 \mu S yE[t, a]^2 yI[t, a] - 2 kE kI^2 \delta \epsilon \mu I \mu S yE[t, a]^2 yI[t, a] + \\
& kE^2 kI \beta^2 \delta \epsilon^2 yE[t, a] yI[t, a]^2 - 4 kE^2 kI \beta \delta \epsilon \mu I yE[t, a] yI[t, a]^2 + \\
& 3 kE^2 kI \delta \mu I^2 yE[t, a] yI[t, a]^2 + kE^2 kI \beta \delta \epsilon^2 \mu S yE[t, a] yI[t, a]^2 - \\
& 2 kE^2 kI \delta \epsilon \mu I \mu S yE[t, a] yI[t, a]^2 - kE^2 kI \beta \epsilon^2 \mu I \mu S yE[t, a] yI[t, a]^2 + \\
& kE^2 kI \epsilon \mu I^2 \mu S yE[t, a] yI[t, a]^2 - kE^3 \beta^2 \epsilon^2 \mu I yI[t, a]^3 + 2 kE^3 \beta \epsilon \mu I^2 yI[t, a]^3 - \\
& kE^3 \mu I^3 yI[t, a]^3 - kE^3 \beta \epsilon^2 \mu I \mu S yI[t, a]^3 + kE^3 \epsilon \mu I^2 \mu S yI[t, a]^3 + \\
& kI^3 \delta^2 \epsilon yE[t, a]^2 yE^{(0,1)}[t, a] + 2 kE kI^2 \beta \delta \epsilon^2 yE[t, a] yI[t, a] yE^{(0,1)}[t, a] - \\
& 2 kE kI^2 \delta \epsilon \mu I yE[t, a] yI[t, a] yE^{(0,1)}[t, a] + kE^2 kI \beta \delta \epsilon^2 yI[t, a]^2 yE^{(0,1)}[t, a] - \\
& kE^2 kI \beta \epsilon^2 \mu I yI[t, a]^2 yE^{(0,1)}[t, a] + kE^2 kI \epsilon \mu I^2 yI[t, a]^2 yE^{(0,1)}[t, a] - \\
& 3 kE kI^2 \delta^2 yE[t, a]^2 yI^{(0,1)}[t, a] + kE kI^2 \delta^2 \epsilon yE[t, a]^2 yI^{(0,1)}[t, a] - \\
& kE kI^2 \beta \delta \epsilon^2 yE[t, a]^2 yI^{(0,1)}[t, a] - 2 kE kI^2 \delta \epsilon \mu S yE[t, a]^2 yI^{(0,1)}[t, a] - \\
& 4 kE^2 kI \beta \delta \epsilon yE[t, a] yI[t, a] yI^{(0,1)}[t, a] + 6 kE^2 kI \delta \mu I yE[t, a] yI[t, a] yI^{(0,1)}[t, a] - \\
& 2 kE^2 kI \delta \epsilon \mu I yE[t, a] yI[t, a] yI^{(0,1)}[t, a] - \\
& 2 kE^2 kI \delta \epsilon \mu S yE[t, a] yI[t, a] yI^{(0,1)}[t, a] - \\
& kE^2 kI \beta \epsilon^2 \mu S yE[t, a] yI[t, a] yI^{(0,1)}[t, a] + \\
& 2 kE^2 kI \epsilon \mu I \mu S yE[t, a] yI[t, a] yI^{(0,1)}[t, a] - kE^3 \beta^2 \epsilon^2 yI[t, a]^2 yI^{(0,1)}[t, a] + \\
& 4 kE^3 \beta \epsilon \mu I yI[t, a]^2 yI^{(0,1)}[t, a] - kE^3 \beta \epsilon^2 \mu I yI[t, a]^2 yI^{(0,1)}[t, a] - \\
& 3 kE^3 \mu I^2 yI[t, a]^2 yI^{(0,1)}[t, a] + kE^3 \epsilon \mu I^2 yI[t, a]^2 yI^{(0,1)}[t, a] - \\
& kE^3 \beta \epsilon^2 \mu S yI[t, a]^2 yI^{(0,1)}[t, a] + 2 kE^3 \epsilon \mu I \mu S yI[t, a]^2 yI^{(0,1)}[t, a] - \\
& 2 kE kI^2 \delta \epsilon yE[t, a] yE^{(0,1)}[t, a] yI^{(0,1)}[t, a] - \\
& kE^2 kI \beta \epsilon^2 yI[t, a] yE^{(0,1)}[t, a] yI^{(0,1)}[t, a] + \\
& 2 kE^2 kI \epsilon \mu I yI[t, a] yE^{(0,1)}[t, a] yI^{(0,1)}[t, a] + \\
& 3 kE^2 kI \delta yE[t, a] yI^{(0,1)}[t, a]^2 - 2 kE^2 kI \delta \epsilon yE[t, a] yI^{(0,1)}[t, a]^2 + \\
& kE^2 kI \beta \epsilon^2 yE[t, a] yI^{(0,1)}[t, a]^2 + kE^2 kI \epsilon \mu S yE[t, a] yI^{(0,1)}[t, a]^2 + \\
& 2 kE^3 \beta \epsilon yI[t, a] yI^{(0,1)}[t, a]^2 - 3 kE^3 \mu I yI[t, a] yI^{(0,1)}[t, a]^2 + \\
& 2 kE^3 \epsilon \mu I yI[t, a] yI^{(0,1)}[t, a]^2 + kE^3 \epsilon \mu S yI[t, a] yI^{(0,1)}[t, a]^2 + \\
& kE^2 kI \epsilon yE^{(0,1)}[t, a] yI^{(0,1)}[t, a]^2 - kE^3 yI^{(0,1)}[t, a]^3 + kE^3 \epsilon yI^{(0,1)}[t, a]^3 - \\
& kE^2 kI \beta \epsilon^2 yE[t, a] yI[t, a] yI^{(0,2)}[t, a] - kE^3 \beta \epsilon^2 yI[t, a]^2 yI^{(0,2)}[t, a] +
\end{aligned}$$

$$\begin{aligned}
& kI^3 \delta^2 \in yE[t, a]^2 yE^{(1,0)}[t, a] + 2 kE kI^2 \beta \delta \in^2 yE[t, a] yI[t, a] yE^{(1,0)}[t, a] - \\
& 2 kE kI^2 \delta \in \mu I yE[t, a] yI[t, a] yE^{(1,0)}[t, a] + kE^2 kI \beta \delta \in^2 yI[t, a]^2 yE^{(1,0)}[t, a] - \\
& kE^2 kI \beta \in^2 \mu I yI[t, a]^2 yE^{(1,0)}[t, a] + kE^2 kI \in \mu I^2 yI[t, a]^2 yE^{(1,0)}[t, a] - \\
& 2 kE kI^2 \delta \in yE[t, a] yI^{(0,1)}[t, a] yE^{(1,0)}[t, a] - \\
& kE^2 kI \beta \in^2 yI[t, a] yI^{(0,1)}[t, a] yE^{(1,0)}[t, a] + \\
& 2 kE^2 kI \in \mu I yI[t, a] yI^{(0,1)}[t, a] yE^{(1,0)}[t, a] + \\
& kE^2 kI \in yI^{(0,1)}[t, a]^2 yE^{(1,0)}[t, a] - 3 kE kI^2 \delta^2 yE[t, a]^2 yI^{(1,0)}[t, a] + \\
& kE kI^2 \delta^2 \in yE[t, a]^2 yI^{(1,0)}[t, a] - kE kI^2 \beta \delta \in^2 yE[t, a]^2 yI^{(1,0)}[t, a] - \\
& 2 kE kI^2 \delta \in \mu S yE[t, a]^2 yI^{(1,0)}[t, a] - 4 kE^2 kI \beta \delta \in yE[t, a] yI[t, a] yI^{(1,0)}[t, a] + \\
& 6 kE^2 kI \delta \mu I yE[t, a] yI[t, a] yI^{(1,0)}[t, a] - 2 kE^2 kI \delta \in \mu I yE[t, a] yI[t, a] yI^{(1,0)}[t, a] - \\
& 2 kE^2 kI \delta \in \mu S yE[t, a] yI[t, a] yI^{(1,0)}[t, a] - \\
& kE^2 kI \beta \in^2 \mu S yE[t, a] yI[t, a] yI^{(1,0)}[t, a] + \\
& 2 kE^2 kI \in \mu I \mu S yE[t, a] yI[t, a] yI^{(1,0)}[t, a] - kE^3 \beta^2 \in^2 yI[t, a]^2 yI^{(1,0)}[t, a] + \\
& 4 kE^3 \beta \in \mu I yI[t, a]^2 yI^{(1,0)}[t, a] - kE^3 \beta \in^2 \mu I yI[t, a]^2 yI^{(1,0)}[t, a] - \\
& 3 kE^3 \mu I^2 yI[t, a]^2 yI^{(1,0)}[t, a] + kE^3 \in \mu I^2 yI[t, a]^2 yI^{(1,0)}[t, a] - \\
& kE^3 \beta \in^2 \mu S yI[t, a]^2 yI^{(1,0)}[t, a] + 2 kE^3 \in \mu I \mu S yI[t, a]^2 yI^{(1,0)}[t, a] - \\
& 2 kE kI^2 \delta \in yE[t, a] yE^{(0,1)}[t, a] yI^{(1,0)}[t, a] - \\
& kE^2 kI \beta \in^2 yI[t, a] yE^{(0,1)}[t, a] yI^{(1,0)}[t, a] + \\
& 2 kE^2 kI \in \mu I yI[t, a] yE^{(0,1)}[t, a] yI^{(1,0)}[t, a] + \\
& 6 kE^2 kI \delta yE[t, a] yI^{(0,1)}[t, a] yI^{(1,0)}[t, a] - \\
& 4 kE^2 kI \delta \in yE[t, a] yI^{(0,1)}[t, a] yI^{(1,0)}[t, a] + \\
& 2 kE^2 kI \beta \in^2 yE[t, a] yI^{(0,1)}[t, a] yI^{(1,0)}[t, a] + \\
& 2 kE^2 kI \in \mu S yE[t, a] yI^{(0,1)}[t, a] yI^{(1,0)}[t, a] + \\
& 4 kE^3 \beta \in yI[t, a] yI^{(0,1)}[t, a] yI^{(1,0)}[t, a] - 6 kE^3 \mu I yI[t, a] yI^{(0,1)}[t, a] yI^{(1,0)}[t, a] + \\
& 4 kE^3 \in \mu I yI[t, a] yI^{(0,1)}[t, a] yI^{(1,0)}[t, a] + \\
& 2 kE^3 \in \mu S yI[t, a] yI^{(0,1)}[t, a] yI^{(1,0)}[t, a] + \\
& 2 kE^2 kI \in yE^{(0,1)}[t, a] yI^{(0,1)}[t, a] yI^{(1,0)}[t, a] - 3 kE^3 yI^{(0,1)}[t, a]^2 yI^{(1,0)}[t, a] + \\
& 3 kE^3 \in yI^{(0,1)}[t, a]^2 yI^{(1,0)}[t, a] - 2 kE kI^2 \delta \in yE[t, a] yE^{(1,0)}[t, a] yI^{(1,0)}[t, a] - \\
& kE^2 kI \beta \in^2 yI[t, a] yE^{(1,0)}[t, a] yI^{(1,0)}[t, a] + \\
& 2 kE^2 kI \in \mu I yI[t, a] yE^{(1,0)}[t, a] yI^{(1,0)}[t, a] + \\
& 2 kE^2 kI \in yI^{(0,1)}[t, a] yE^{(1,0)}[t, a] yI^{(1,0)}[t, a] + 3 kE^2 kI \delta yE[t, a] yI^{(1,0)}[t, a]^2 - \\
& 2 kE^2 kI \delta \in yE[t, a] yI^{(1,0)}[t, a]^2 + kE^2 kI \beta \in^2 yE[t, a] yI^{(1,0)}[t, a]^2 + \\
& kE^2 kI \in \mu S yE[t, a] yI^{(1,0)}[t, a]^2 + 2 kE^3 \beta \in yI[t, a] yI^{(1,0)}[t, a]^2 - \\
& 3 kE^3 \mu I yI[t, a] yI^{(1,0)}[t, a]^2 + 2 kE^3 \in \mu I yI[t, a] yI^{(1,0)}[t, a]^2 + \\
& kE^3 \in \mu S yI[t, a] yI^{(1,0)}[t, a]^2 + kE^2 kI \in yE^{(0,1)}[t, a] yI^{(1,0)}[t, a]^2 - \\
& 3 kE^3 yI^{(0,1)}[t, a] yI^{(1,0)}[t, a]^2 + 3 kE^3 \in yI^{(0,1)}[t, a] yI^{(1,0)}[t, a]^2 + \\
& kE^2 kI \in yE^{(1,0)}[t, a] yI^{(1,0)}[t, a]^2 - kE^3 yI^{(1,0)}[t, a]^3 + kE^3 \in yI^{(1,0)}[t, a]^3 - \\
& 2 kE^2 kI \beta \in^2 yE[t, a] yI[t, a] yI^{(1,1)}[t, a] - 2 kE^3 \beta \in^2 yI[t, a]^2 yI^{(1,1)}[t, a] - \\
& kE^2 kI \beta \in^2 yE[t, a] yI[t, a] yI^{(2,0)}[t, a] - kE^3 \beta \in^2 yI[t, a]^2 yI^{(2,0)}[t, a] \\
& - kI \delta yE[t, a] - kI \in \mu E yE[t, a] + kE \mu I yI[t, a] - kE \in \mu I yI[t, a] - kI \in yE^{(0,1)}[t, a] + \\
& kE yI^{(0,1)}[t, a] - kE \in yI^{(0,1)}[t, a] - kI \in yE^{(1,0)}[t, a] + kE yI^{(1,0)}[t, a] - kE \in yI^{(1,0)}[t, a]
\end{aligned}$$

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Monos1 = Sort[MonomialList[IPOPish1[t, a], {yI[t, a], D[yI[t, a], t], D[yI[t, a], a],
  D[yI[t, a], t, a], D[yI[t, a], {t, 2}], D[yI[t, a], {a, 2}], D[yE[t, a], t],
  D[yE[t, a], a], D[yE[t, a], t, a], D[yE[t, a], {t, 2}], D[yE[t, a], {a, 2}]]]
Monos2 = Sort[MonomialList[IPOPish2[t, a], {yI[t, a], D[yI[t, a], t], D[yI[t, a], a],
  D[yI[t, a], t, a], D[yI[t, a], {t, 2}], D[yI[t, a], {a, 2}], D[yE[t, a], t],
  D[yE[t, a], a], D[yE[t, a], t, a], D[yE[t, a], {t, 2}], D[yE[t, a], {a, 2}]]]

{kI3 δ3 yE[t, a]3 + kI3 δ2 ∈ μS yE[t, a]3,
(2 kE kI2 β δ2 ∈ yE[t, a]2 - 3 kE kI2 δ2 μI yE[t, a]2 + kE kI2 δ2 ∈ μS yE[t, a]2 +
kE kI2 β δ ∈ μS yE[t, a]2 - 2 kE kI2 δ ∈ μI μS yE[t, a]2) yI[t, a],
(kE2 kI β2 δ ∈ yE[t, a] - 4 kE2 kI β δ ∈ μI yE[t, a] + 3 kE2 kI δ μI2 yE[t, a] +
kE2 kI β δ ∈ μS yE[t, a] - 2 kE2 kI δ ∈ μI μS yE[t, a] -
kE2 kI β ∈ μI μS yE[t, a] + kE2 kI ∈ μI2 μS yE[t, a]) yI[t, a]2,
(-kE3 β2 ∈ μI + 2 kE3 β ∈ μI2 - kE3 μI3 - kE3 β ∈ μI μS + kE3 ∈ μI2 μS) yI[t, a]3,
kI3 δ2 ∈ yE[t, a]2 yE(0,1)[t, a],
(2 kE kI2 β δ ∈ yE[t, a] - 2 kE kI2 δ ∈ μI yE[t, a]) yI[t, a] yE(0,1)[t, a],
(kE2 kI β δ ∈ yE[t, a] - kE2 kI β ∈ μI + kE2 kI ∈ μI2) yI[t, a]2 yE(0,1)[t, a],
(-3 kE kI2 δ2 yE[t, a]2 + kE kI2 δ2 ∈ yE[t, a]2 -
kE kI2 β δ ∈ yE[t, a]2 - 2 kE kI2 δ ∈ μS yE[t, a]2) yI(0,1)[t, a],
(-4 kE2 kI β δ ∈ yE[t, a] + 6 kE2 kI δ μI yE[t, a] - 2 kE2 kI δ ∈ μI yE[t, a] - 2 kE2 kI δ ∈
μS yE[t, a] - kE2 kI β ∈ μS yE[t, a] + 2 kE2 kI ∈ μI μS yE[t, a]) yI[t, a] yI(0,1)[t, a],
(-kE3 β2 ∈ μI + 4 kE3 β ∈ μI - kE3 β ∈ μI2 - 3 kE3 μI2 + kE3 ∈ μI2 - kE3 β ∈ μS + 2 kE3 ∈ μI μS)
yI[t, a]2 yI(0,1)[t, a], -2 kE kI2 δ ∈ yE[t, a] yE(0,1)[t, a] yI(0,1)[t, a],
(-kE2 kI β ∈ μI + 2 kE2 kI ∈ μI) yI[t, a] yE(0,1)[t, a] yI(0,1)[t, a],
(3 kE2 kI δ yE[t, a] - 2 kE2 kI δ ∈ yE[t, a] + kE2 kI β ∈ yE[t, a] + kE2 kI ∈ μS yE[t, a])
yI(0,1)[t, a]2, (2 kE3 β ∈ -3 kE3 μI + 2 kE3 ∈ μI + kE3 ∈ μS) yI[t, a] yI(0,1)[t, a]2,
kE2 kI ∈ yE(0,1)[t, a] yI(0,1)[t, a]2, (-kE3 + kE3 ∈) yI(0,1)[t, a]3,
-kE2 kI β ∈ yE[t, a] yI[t, a] yI(0,2)[t, a],
-kE3 β ∈ yI[t, a]2 yI(0,2)[t, a], kI3 δ2 ∈ yE[t, a]2 yE(1,0)[t, a],
(2 kE kI2 β δ ∈ yE[t, a] - 2 kE kI2 δ ∈ μI yE[t, a]) yI[t, a] yE(1,0)[t, a],
(kE2 kI β δ ∈ yE[t, a] - kE2 kI β ∈ μI + kE2 kI ∈ μI2) yI[t, a]2 yE(1,0)[t, a],
-2 kE kI2 δ ∈ yE[t, a] yI(0,1)[t, a] yE(1,0)[t, a],
(-kE2 kI β ∈ μI + 2 kE2 kI ∈ μI) yI[t, a] yI(0,1)[t, a] yE(1,0)[t, a],
kE2 kI ∈ yI(0,1)[t, a]2 yE(1,0)[t, a], (-3 kE kI2 δ2 yE[t, a]2 + kE kI2 δ2 ∈ yE[t, a]2 -
kE kI2 β δ ∈ yE[t, a]2 - 2 kE kI2 δ ∈ μS yE[t, a]2) yI(1,0)[t, a],
(-4 kE2 kI β δ ∈ yE[t, a] + 6 kE2 kI δ μI yE[t, a] - 2 kE2 kI δ ∈ μI yE[t, a] - 2 kE2 kI δ ∈
μS yE[t, a] - kE2 kI β ∈ μS yE[t, a] + 2 kE2 kI ∈ μI μS yE[t, a]) yI[t, a] yI(1,0)[t, a],
(-kE3 β2 ∈ μI + 4 kE3 β ∈ μI - kE3 β ∈ μI2 - 3 kE3 μI2 + kE3 ∈ μI2 - kE3 β ∈ μS + 2 kE3 ∈ μI μS)
yI[t, a]2 yI(1,0)[t, a], -2 kE kI2 δ ∈ yE[t, a] yE(0,1)[t, a] yI(1,0)[t, a],
(-kE2 kI β ∈ μI + 2 kE2 kI ∈ μI) yI[t, a] yE(0,1)[t, a] yI(1,0)[t, a],
(6 kE2 kI δ yE[t, a] - 4 kE2 kI δ ∈ yE[t, a] + 2 kE2 kI β ∈ yE[t, a] + 2 kE2 kI ∈ μS yE[t, a])
yI(0,1)[t, a] yI(1,0)[t, a],
(4 kE3 β ∈ -6 kE3 μI + 4 kE3 ∈ μI + 2 kE3 ∈ μS) yI[t, a] yI(0,1)[t, a] yI(1,0)[t, a],
2 kE2 kI ∈ yE(0,1)[t, a] yI(0,1)[t, a] yI(1,0)[t, a],

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$$\begin{aligned}
& (-3 kE^3 + 3 kE^3 \epsilon) yI^{(0,1)}[t, a]^2 yI^{(1,0)}[t, a], \\
& -2 kE kI^2 \delta \in yE[t, a] yE^{(1,0)}[t, a] yI^{(1,0)}[t, a], \\
& (-kE^2 kI \beta \epsilon^2 + 2 kE^2 kI \epsilon \mu I) yI[t, a] yE^{(1,0)}[t, a] yI^{(1,0)}[t, a], \\
& 2 kE^2 kI \epsilon yI^{(0,1)}[t, a] yE^{(1,0)}[t, a] yI^{(1,0)}[t, a], \\
& (3 kE^2 kI \delta yE[t, a] - 2 kE^2 kI \delta \in yE[t, a] + kE^2 kI \beta \epsilon^2 yE[t, a] + kE^2 kI \epsilon \mu S yE[t, a]) \\
& yI^{(1,0)}[t, a]^2, (2 kE^3 \beta \epsilon - 3 kE^3 \mu I + 2 kE^3 \epsilon \mu I + kE^3 \epsilon \mu S) yI[t, a] yI^{(1,0)}[t, a]^2, \\
& kE^2 kI \epsilon yE^{(0,1)}[t, a] yI^{(1,0)}[t, a]^2, (-3 kE^3 + 3 kE^3 \epsilon) yI^{(0,1)}[t, a] yI^{(1,0)}[t, a]^2, \\
& kE^2 kI \epsilon yE^{(1,0)}[t, a] yI^{(1,0)}[t, a]^2, (-kE^3 + kE^3 \epsilon) yI^{(1,0)}[t, a]^3, \\
& -2 kE^2 kI \beta \epsilon^2 yE[t, a] yI[t, a] yI^{(1,1)}[t, a], -2 kE^3 \beta \epsilon^2 yI[t, a]^2 yI^{(1,1)}[t, a], \\
& -kE^2 kI \beta \epsilon^2 yE[t, a] yI[t, a] yI^{(2,0)}[t, a], -kE^3 \beta \epsilon^2 yI[t, a]^2 yI^{(2,0)}[t, a] \}
\end{aligned}$$

$$\begin{aligned}
\text{Out[42]} = & \{-kI \delta yE[t, a] - kI \epsilon \mu E yE[t, a], (kE \mu I - kE \epsilon \mu I) yI[t, a], -kI \epsilon yE^{(0,1)}[t, a], \\
& (kE - kE \epsilon) yI^{(0,1)}[t, a], -kI \epsilon yE^{(1,0)}[t, a], (kE - kE \epsilon) yI^{(1,0)}[t, a] \}
\end{aligned}$$

MonicMonos1 =

$$\begin{aligned}
& \text{Monos1} / (\text{Last}[\text{Monos1}] /. \{yI[t, a] \rightarrow 1, D[yI[t, a], t] \rightarrow 1, D[yI[t, a], a] \rightarrow 1, \\
& D[yI[t, a], t, a] \rightarrow 1, D[yI[t, a], \{t, 2\}] \rightarrow 1, D[yI[t, a], \{a, 2\}] \rightarrow 1, \\
& yE[t, a] \rightarrow 1, D[yE[t, a], t] \rightarrow 1, D[yE[t, a], a] \rightarrow 1, \\
& D[yE[t, a], t, a] \rightarrow 1, D[yE[t, a], \{t, 2\}] \rightarrow 1, D[yE[t, a], \{a, 2\}] \rightarrow 1\})
\end{aligned}$$

$$\begin{aligned}
& \text{MonicMonos2} = \text{Monos2} / (\text{Last}[\text{Monos2}] /. \{yI[t, a] \rightarrow 1, D[yI[t, a], t] \rightarrow 1, \\
& D[yI[t, a], a] \rightarrow 1, D[yI[t, a], t, a] \rightarrow 1, D[yI[t, a], \{t, 2\}] \rightarrow 1, \\
& D[yI[t, a], \{a, 2\}] \rightarrow 1, yE[t, a] \rightarrow 1, D[yE[t, a], t] \rightarrow 1, D[yE[t, a], a] \rightarrow 1, \\
& D[yE[t, a], t, a] \rightarrow 1, D[yE[t, a], \{t, 2\}] \rightarrow 1, D[yE[t, a], \{a, 2\}] \rightarrow 1\})
\end{aligned}$$

$$\begin{aligned}
& \left\{ -\frac{kI^3 \delta^3 yE[t, a]^3 + kI^3 \delta^2 \epsilon \mu S yE[t, a]^3}{kE^3 \beta \epsilon^2}, \right. \\
& -\frac{1}{kE^3 \beta \epsilon^2} (2 kE kI^2 \beta \delta^2 \in yE[t, a]^2 - 3 kE kI^2 \delta^2 \mu I yE[t, a]^2 + kE kI^2 \delta^2 \epsilon \mu S yE[t, a]^2 + \\
& kE kI^2 \beta \delta \epsilon^2 \mu S yE[t, a]^2 - 2 kE kI^2 \delta \epsilon \mu I \mu S yE[t, a]^2) yI[t, a], \\
& -\frac{1}{kE^3 \beta \epsilon^2} (kE^2 kI \beta^2 \delta \epsilon^2 yE[t, a] - 4 kE^2 kI \beta \delta \epsilon \mu I yE[t, a] + 3 kE^2 kI \delta \mu I^2 yE[t, a] + \\
& kE^2 kI \beta \delta \epsilon^2 \mu S yE[t, a] - 2 kE^2 kI \delta \epsilon \mu I \mu S yE[t, a] - \\
& kE^2 kI \beta \epsilon^2 \mu I \mu S yE[t, a] + kE^2 kI \epsilon \mu I^2 \mu S yE[t, a]) yI[t, a]^2, \\
& -\frac{1}{kE^3 \beta \epsilon^2} (-kE^3 \beta^2 \epsilon^2 \mu I + 2 kE^3 \beta \epsilon \mu I^2 - kE^3 \mu I^3 - kE^3 \beta \epsilon^2 \mu I \mu S + kE^3 \epsilon \mu I^2 \mu S) yI[t, a]^3, \\
& -\frac{kI^3 \delta^2 yE[t, a]^2 yE^{(0,1)}[t, a]}{kE^3 \beta \epsilon}, \\
& -\frac{1}{kE^3 \beta \epsilon^2} (2 kE kI^2 \beta \delta \epsilon^2 yE[t, a] - 2 kE kI^2 \delta \epsilon \mu I yE[t, a]) yI[t, a] yE^{(0,1)}[t, a], \\
& -\frac{1}{kE^3 \beta \epsilon^2} (kE^2 kI \beta \delta \epsilon^2 - kE^2 kI \beta \epsilon^2 \mu I + kE^2 kI \epsilon \mu I^2) yI[t, a]^2 yE^{(0,1)}[t, a], \\
& -\frac{1}{kE^3 \beta \epsilon^2} (-3 kE kI^2 \delta^2 yE[t, a]^2 + kE kI^2 \delta^2 \epsilon yE[t, a]^2 - \\
& kE kI^2 \beta \delta \epsilon^2 yE[t, a]^2 - 2 kE kI^2 \delta \epsilon \mu S yE[t, a]^2) yI^{(0,1)}[t, a],
\end{aligned}$$

$$\begin{aligned}
& - \frac{1}{kE^3 \beta \epsilon^2} \left(-4 kE^2 kI \beta \delta \in yE[t, a] + 6 kE^2 kI \delta \mu I yE[t, a] - 2 kE^2 kI \delta \in \mu I yE[t, a] - \right. \\
& \quad \left. 2 kE^2 kI \delta \in \mu S yE[t, a] - kE^2 kI \beta \epsilon^2 \mu S yE[t, a] + 2 kE^2 kI \in \mu I \mu S yE[t, a] \right) \\
& \quad yI[t, a] yI^{(0,1)}[t, a], - \frac{1}{kE^3 \beta \epsilon^2} \left(-kE^3 \beta^2 \epsilon^2 + 4 kE^3 \beta \in \mu I - kE^3 \beta \epsilon^2 \mu I - \right. \\
& \quad \left. 3 kE^3 \mu I^2 + kE^3 \in \mu I^2 - kE^3 \beta \epsilon^2 \mu S + 2 kE^3 \in \mu I \mu S \right) yI[t, a]^2 yI^{(0,1)}[t, a], \\
& \quad \frac{2 kI^2 \delta yE[t, a] yE^{(0,1)}[t, a] yI^{(0,1)}[t, a]}{kE^2 \beta \in}, - \frac{1}{kE^3 \beta \epsilon^2} \\
& \quad \left(-kE^2 kI \beta \epsilon^2 + 2 kE^2 kI \in \mu I \right) yI[t, a] yE^{(0,1)}[t, a] yI^{(0,1)}[t, a], - \frac{1}{kE^3 \beta \epsilon^2} \\
& \quad \left(3 kE^2 kI \delta yE[t, a] - 2 kE^2 kI \delta \in yE[t, a] + kE^2 kI \beta \epsilon^2 yE[t, a] + kE^2 kI \in \mu S yE[t, a] \right) \\
& \quad yI^{(0,1)}[t, a]^2, \\
& - \frac{1}{kE^3 \beta \epsilon^2} \left(2 kE^3 \beta \in - 3 kE^3 \mu I + 2 kE^3 \in \mu I + kE^3 \in \mu S \right) yI[t, a] yI^{(0,1)}[t, a]^2, \\
& - \frac{kI yE^{(0,1)}[t, a] yI^{(0,1)}[t, a]^2}{kE \beta \in}, \\
& - \frac{\left(-kE^3 + kE^3 \in \right) yI^{(0,1)}[t, a]^3}{kE^3 \beta \epsilon^2}, \\
& \quad \frac{kI yE[t, a] yI[t, a] yI^{(0,2)}[t, a]}{kE}, \\
& yI[t, a]^2 yI^{(0,2)}[t, a], \\
& - \frac{kI^3 \delta^2 yE[t, a]^2 yE^{(1,0)}[t, a]}{kE^3 \beta \in}, \\
& - \frac{1}{kE^3 \beta \epsilon^2} \left(2 kE kI^2 \beta \delta \epsilon^2 yE[t, a] - 2 kE kI^2 \delta \in \mu I yE[t, a] \right) yI[t, a] yE^{(1,0)}[t, a], \\
& - \frac{1}{kE^3 \beta \epsilon^2} \left(kE^2 kI \beta \delta \epsilon^2 - kE^2 kI \beta \epsilon^2 \mu I + kE^2 kI \in \mu I^2 \right) yI[t, a]^2 yE^{(1,0)}[t, a], \\
& \quad \frac{2 kI^2 \delta yE[t, a] yI^{(0,1)}[t, a] yE^{(1,0)}[t, a]}{kE^2 \beta \in}, \\
& - \frac{1}{kE^3 \beta \epsilon^2} \left(-kE^2 kI \beta \epsilon^2 + 2 kE^2 kI \in \mu I \right) yI[t, a] yI^{(0,1)}[t, a] yE^{(1,0)}[t, a], \\
& - \frac{kI yI^{(0,1)}[t, a]^2 yE^{(1,0)}[t, a]}{kE \beta \in}, \\
& - \frac{1}{kE^3 \beta \epsilon^2} \left(-3 kE kI^2 \delta^2 yE[t, a]^2 + kE kI^2 \delta^2 \in yE[t, a]^2 - \right. \\
& \quad \left. kE kI^2 \beta \delta \epsilon^2 yE[t, a]^2 - 2 kE kI^2 \delta \in \mu S yE[t, a]^2 \right) yI^{(1,0)}[t, a], - \frac{1}{kE^3 \beta \epsilon^2} \\
& \quad \left(-4 kE^2 kI \beta \delta \in yE[t, a] + 6 kE^2 kI \delta \mu I yE[t, a] - 2 kE^2 kI \delta \in \mu I yE[t, a] - 2 kE^2 kI \delta \in \mu S \right. \\
& \quad \left. yE[t, a] - kE^2 kI \beta \epsilon^2 \mu S yE[t, a] + 2 kE^2 kI \in \mu I \mu S yE[t, a] \right) yI[t, a] yI^{(1,0)}[t, a],
\end{aligned}$$

$$\begin{aligned}
& - \frac{1}{kE^3 \beta \epsilon^2} \left(-kE^3 \beta^2 \epsilon^2 + 4 kE^3 \beta \epsilon \mu I - kE^3 \beta \epsilon^2 \mu I - 3 kE^3 \mu I^2 + kE^3 \epsilon \mu I^2 - kE^3 \beta \epsilon^2 \mu S + \right. \\
& \quad \left. 2 kE^3 \epsilon \mu I \mu S \right) yI[t, a]^2 yI^{(1,0)}[t, a], \frac{2 kI^2 \delta yE[t, a] yE^{(0,1)}[t, a] yI^{(1,0)}[t, a]}{kE^2 \beta \epsilon}, \\
& - \frac{1}{kE^3 \beta \epsilon^2} \left(-kE^2 kI \beta \epsilon^2 + 2 kE^2 kI \epsilon \mu I \right) yI[t, a] yE^{(0,1)}[t, a] yI^{(1,0)}[t, a], \\
& - \frac{1}{kE^3 \beta \epsilon^2} \left(6 kE^2 kI \delta yE[t, a] - 4 kE^2 kI \delta \epsilon yE[t, a] + \right. \\
& \quad \left. 2 kE^2 kI \beta \epsilon^2 yE[t, a] + 2 kE^2 kI \epsilon \mu S yE[t, a] \right) yI^{(0,1)}[t, a] yI^{(1,0)}[t, a], \\
& - \frac{1}{kE^3 \beta \epsilon^2} \left(4 kE^3 \beta \epsilon - 6 kE^3 \mu I + 4 kE^3 \epsilon \mu I + 2 kE^3 \epsilon \mu S \right) yI[t, a] yI^{(0,1)}[t, a] yI^{(1,0)}[t, a], \\
& - \frac{2 kI yE^{(0,1)}[t, a] yI^{(0,1)}[t, a] yI^{(1,0)}[t, a]}{kE \beta \epsilon}, \\
& - \frac{\left(-3 kE^3 + 3 kE^3 \epsilon \right) yI^{(0,1)}[t, a]^2 yI^{(1,0)}[t, a]}{kE^3 \beta \epsilon^2}, \\
& \frac{2 kI^2 \delta yE[t, a] yE^{(1,0)}[t, a] yI^{(1,0)}[t, a]}{kE^2 \beta \epsilon}, \\
& - \frac{1}{kE^3 \beta \epsilon^2} \left(-kE^2 kI \beta \epsilon^2 + 2 kE^2 kI \epsilon \mu I \right) yI[t, a] yE^{(1,0)}[t, a] yI^{(1,0)}[t, a], \\
& - \frac{2 kI yI^{(0,1)}[t, a] yE^{(1,0)}[t, a] yI^{(1,0)}[t, a]}{kE \beta \epsilon}, - \frac{1}{kE^3 \beta \epsilon^2} \\
& \left(3 kE^2 kI \delta yE[t, a] - 2 kE^2 kI \delta \epsilon yE[t, a] + kE^2 kI \beta \epsilon^2 yE[t, a] + kE^2 kI \epsilon \mu S yE[t, a] \right) \\
& yI^{(1,0)}[t, a]^2, - \frac{1}{kE^3 \beta \epsilon^2} \left(2 kE^3 \beta \epsilon - 3 kE^3 \mu I + 2 kE^3 \epsilon \mu I + kE^3 \epsilon \mu S \right) yI[t, a] yI^{(1,0)}[t, a]^2, \\
& - \frac{kI yE^{(0,1)}[t, a] yI^{(1,0)}[t, a]^2}{kE \beta \epsilon}, - \frac{\left(-3 kE^3 + 3 kE^3 \epsilon \right) yI^{(0,1)}[t, a] yI^{(1,0)}[t, a]^2}{kE^3 \beta \epsilon^2}, \\
& - \frac{kI yE^{(1,0)}[t, a] yI^{(1,0)}[t, a]^2}{kE \beta \epsilon}, \\
& - \frac{\left(-kE^3 + kE^3 \epsilon \right) yI^{(1,0)}[t, a]^3}{kE^3 \beta \epsilon^2}, \\
& \frac{2 kI yE[t, a] yI[t, a] yI^{(1,1)}[t, a]}{kE}, \\
& 2 yI[t, a]^2 yI^{(1,1)}[t, a], \\
& \frac{kI yE[t, a] yI[t, a] yI^{(2,0)}[t, a]}{kE}, yI[t, a]^2 yI^{(2,0)}[t, a] \}
\end{aligned}$$

$$\left\{ \frac{-kI \delta yE[t, a] - kI \in \mu E yE[t, a]}{kE - kE \in}, \frac{(kE \mu I - kE \in \mu I) yI[t, a]}{kE - kE \in}, \right. \\ \left. - \frac{kI \in yE^{(0,1)}[t, a]}{kE - kE \in}, yI^{(0,1)}[t, a], - \frac{kI \in yE^{(1,0)}[t, a]}{kE - kE \in}, yI^{(1,0)}[t, a] \right\}$$

$$\text{Coeffs1} = \text{MonicMonos1} /. \{yI[t, a] \rightarrow 1, D[yI[t, a], t] \rightarrow 1, \\ D[yI[t, a], a] \rightarrow 1, D[yI[t, a], t, a] \rightarrow 1, D[yI[t, a], \{t, 2\}] \rightarrow 1, \\ D[yI[t, a], \{a, 2\}] \rightarrow 1, yE[t, a] \rightarrow 1, D[yE[t, a], t] \rightarrow 1, D[yE[t, a], a] \rightarrow 1, \\ D[yE[t, a], t, a] \rightarrow 1, D[yE[t, a], \{t, 2\}] \rightarrow 1, D[yE[t, a], \{a, 2\}] \rightarrow 1\} \\ \text{Coeffs2} = \text{MonicMonos2} /. \{yI[t, a] \rightarrow 1, D[yI[t, a], t] \rightarrow 1, D[yI[t, a], a] \rightarrow 1, \\ D[yI[t, a], t, a] \rightarrow 1, D[yI[t, a], \{t, 2\}] \rightarrow 1, D[yI[t, a], \{a, 2\}] \rightarrow 1, \\ yE[t, a] \rightarrow 1, D[yE[t, a], t] \rightarrow 1, D[yE[t, a], a] \rightarrow 1, \\ D[yE[t, a], t, a] \rightarrow 1, D[yE[t, a], \{t, 2\}] \rightarrow 1, D[yE[t, a], \{a, 2\}] \rightarrow 1\}$$

$$\left\{ - \frac{kI^3 \delta^3 + kI^3 \delta^2 \in \mu S}{kE^3 \beta \epsilon^2}, \right. \\ - \frac{1}{kE^3 \beta \epsilon^2} \left(2 kE kI^2 \beta \delta^2 \in - 3 kE kI^2 \delta^2 \mu I + kE kI^2 \delta^2 \in \mu S + kE kI^2 \beta \delta \epsilon^2 \mu S - 2 kE kI^2 \delta \in \mu I \mu S \right), \\ - \frac{1}{kE^3 \beta \epsilon^2} \left(kE^2 kI \beta^2 \delta \epsilon^2 - 4 kE^2 kI \beta \delta \in \mu I + 3 kE^2 kI \delta \mu I^2 + \right. \\ \left. kE^2 kI \beta \delta \epsilon^2 \mu S - 2 kE^2 kI \delta \in \mu I \mu S - kE^2 kI \beta \epsilon^2 \mu I \mu S + kE^2 kI \in \mu I^2 \mu S \right), \\ - \frac{1}{kE^3 \beta \epsilon^2} \left(-kE^3 \beta^2 \epsilon^2 \mu I + 2 kE^3 \beta \in \mu I^2 - kE^3 \mu I^3 - kE^3 \beta \epsilon^2 \mu I \mu S + kE^3 \in \mu I^2 \mu S \right), \\ - \frac{kI^3 \delta^2}{kE^3 \beta \epsilon} - \frac{2 kE kI^2 \beta \delta \epsilon^2 - 2 kE kI^2 \delta \in \mu I}{kE^3 \beta \epsilon^2}, \\ - \frac{kE^2 kI \beta \delta \epsilon^2 - kE^2 kI \beta \epsilon^2 \mu I + kE^2 kI \in \mu I^2}{kE^3 \beta \epsilon^2}, \\ - \frac{-3 kE kI^2 \delta^2 + kE kI^2 \delta^2 \in - kE kI^2 \beta \delta \epsilon^2 - 2 kE kI^2 \delta \in \mu S}{kE^3 \beta \epsilon^2}, \\ - \frac{1}{kE^3 \beta \epsilon^2} \left(-4 kE^2 kI \beta \delta \in + 6 kE^2 kI \delta \mu I - 2 kE^2 kI \delta \in \mu I - \right. \\ \left. 2 kE^2 kI \delta \in \mu S - kE^2 kI \beta \epsilon^2 \mu S + 2 kE^2 kI \in \mu I \mu S \right), - \frac{1}{kE^3 \beta \epsilon^2} \\ \left(-kE^3 \beta^2 \epsilon^2 + 4 kE^3 \beta \in \mu I - kE^3 \beta \epsilon^2 \mu I - 3 kE^3 \mu I^2 + kE^3 \in \mu I^2 - kE^3 \beta \epsilon^2 \mu S + 2 kE^3 \in \mu I \mu S \right), \\ \frac{2 kI^2 \delta}{kE^2 \beta \epsilon} - \frac{-kE^2 kI \beta \epsilon^2 + 2 kE^2 kI \in \mu I}{kE^3 \beta \epsilon^2}, - \frac{3 kE^2 kI \delta - 2 kE^2 kI \delta \in + kE^2 kI \beta \epsilon^2 + kE^2 kI \in \mu S}{kE^3 \beta \epsilon^2}, \\ - \frac{2 kE^3 \beta \in - 3 kE^3 \mu I + 2 kE^3 \in \mu I + kE^3 \in \mu S}{kE^3 \beta \epsilon^2}, - \frac{kI}{kE \beta \epsilon}, \\ - \frac{-kE^3 + kE^3 \in}{kE^3 \beta \epsilon^2}, \frac{kI}{kE}, 1, - \frac{kI^3 \delta^2}{kE^3 \beta \epsilon}, - \frac{2 kE kI^2 \beta \delta \epsilon^2 - 2 kE kI^2 \delta \in \mu I}{kE^3 \beta \epsilon^2}, \\ - \frac{kE^2 kI \beta \delta \epsilon^2 - kE^2 kI \beta \epsilon^2 \mu I + kE^2 kI \in \mu I^2}{kE^3 \beta \epsilon^2}, \frac{2 kI^2 \delta}{kE^2 \beta \epsilon}, - \frac{-kE^2 kI \beta \epsilon^2 + 2 kE^2 kI \in \mu I}{kE^3 \beta \epsilon^2}, \left. \right\}$$

$$\begin{aligned}
& -\frac{kI}{kE\beta\epsilon}, -\frac{-3kE kI^2\delta^2 + kE kI^2\delta^2\epsilon - kE kI^2\beta\delta\epsilon^2 - 2kE kI^2\delta\epsilon\mu S}{kE^3\beta\epsilon^2}, \\
& -\frac{1}{kE^3\beta\epsilon^2} \left(-4kE^2 kI\beta\delta\epsilon + 6kE^2 kI\delta\mu I - 2kE^2 kI\delta\epsilon\mu I - \right. \\
& \quad \left. 2kE^2 kI\delta\epsilon\mu S - kE^2 kI\beta\epsilon^2\mu S + 2kE^2 kI\epsilon\mu I\mu S \right), -\frac{1}{kE^3\beta\epsilon^2} \\
& \quad \left(-kE^3\beta^2\epsilon^2 + 4kE^3\beta\epsilon\mu I - kE^3\beta\epsilon^2\mu I - 3kE^3\mu I^2 + kE^3\epsilon\mu I^2 - kE^3\beta\epsilon^2\mu S + 2kE^3\epsilon\mu I\mu S \right), \\
& \frac{2kI^2\delta}{kE^2\beta\epsilon}, -\frac{-kE^2 kI\beta\epsilon^2 + 2kE^2 kI\epsilon\mu I}{kE^3\beta\epsilon^2}, -\frac{6kE^2 kI\delta - 4kE^2 kI\delta\epsilon + 2kE^2 kI\beta\epsilon^2 + 2kE^2 kI\epsilon\mu S}{kE^3\beta\epsilon^2}, \\
& -\frac{4kE^3\beta\epsilon - 6kE^3\mu I + 4kE^3\epsilon\mu I + 2kE^3\epsilon\mu S}{kE^3\beta\epsilon^2}, -\frac{2kI}{kE\beta\epsilon}, \\
& -\frac{-3kE^3 + 3kE^3\epsilon}{kE^3\beta\epsilon^2}, \frac{2kI^2\delta}{kE^2\beta\epsilon}, -\frac{-kE^2 kI\beta\epsilon^2 + 2kE^2 kI\epsilon\mu I}{kE^3\beta\epsilon^2}, \\
& -\frac{2kI}{kE\beta\epsilon}, -\frac{3kE^2 kI\delta - 2kE^2 kI\delta\epsilon + kE^2 kI\beta\epsilon^2 + kE^2 kI\epsilon\mu S}{kE^3\beta\epsilon^2}, \\
& -\frac{2kE^3\beta\epsilon - 3kE^3\mu I + 2kE^3\epsilon\mu I + kE^3\epsilon\mu S}{kE^3\beta\epsilon^2}, -\frac{kI}{kE\beta\epsilon}, \\
& -\frac{-3kE^3 + 3kE^3\epsilon}{kE^3\beta\epsilon^2}, -\frac{kI}{kE\beta\epsilon}, -\frac{-kE^3 + kE^3\epsilon}{kE^3\beta\epsilon^2}, \frac{2kI}{kE}, 2, \frac{kI}{kE}, 1 \} \\
& \left\{ \frac{-kI\delta - kI\epsilon\mu E}{kE - kE\epsilon}, \frac{kE\mu I - kE\epsilon\mu I}{kE - kE\epsilon}, -\frac{kI\epsilon}{kE - kE\epsilon}, 1, -\frac{kI\epsilon}{kE - kE\epsilon}, 1 \right\}
\end{aligned}$$

Coeffs = Union[Coeffs1, Coeffs2]

$$\begin{aligned}
& \left\{ 1, 2, \frac{kI}{kE}, \frac{2kI}{kE}, -\frac{2kI}{kE\beta\epsilon}, -\frac{kI}{kE\beta\epsilon}, \frac{2kI^2\delta}{kE^2\beta\epsilon}, -\frac{kI^3\delta^2}{kE^3\beta\epsilon}, -\frac{kI\epsilon}{kE-kE\epsilon}, -\frac{-kE^3+kE^3\epsilon}{kE^3\beta\epsilon^2}, \right. \\
& -\frac{-3kE^3+3kE^3\epsilon}{kE^3\beta\epsilon^2}, \frac{-kI\delta-kI\epsilon\mu E}{kE-kE\epsilon}, \frac{kE\mu I-kE\epsilon\mu I}{kE-kE\epsilon}, -\frac{-kE^2kI\beta\epsilon^2+2kE^2kI\epsilon\mu I}{kE^3\beta\epsilon^2}, \\
& -\frac{2kE kI^2\beta\delta\epsilon^2-2kE kI^2\delta\epsilon\mu I}{kE^3\beta\epsilon^2}, -\frac{kE^2kI\beta\delta\epsilon^2-kE^2kI\beta\epsilon^2\mu I+kE^2kI\epsilon\mu I^2}{kE^3\beta\epsilon^2}, \\
& -\frac{2kE^3\beta\epsilon-3kE^3\mu I+2kE^3\epsilon\mu I+kE^3\epsilon\mu S}{kE^3\beta\epsilon^2}, -\frac{4kE^3\beta\epsilon-6kE^3\mu I+4kE^3\epsilon\mu I+2kE^3\epsilon\mu S}{kE^3\beta\epsilon^2}, \\
& -\frac{3kE^2kI\delta-2kE^2kI\delta\epsilon+kE^2kI\beta\epsilon^2+kE^2kI\epsilon\mu S}{kE^3\beta\epsilon^2}, \\
& -\frac{6kE^2kI\delta-4kE^2kI\delta\epsilon+2kE^2kI\beta\epsilon^2+2kE^2kI\epsilon\mu S}{kE^3\beta\epsilon^2}, \\
& -\frac{-3kE kI^2\delta^2+kE kI^2\delta^2\epsilon-kE kI^2\beta\delta\epsilon^2-2kE kI^2\delta\epsilon\mu S}{kE^3\beta\epsilon^2}, -\frac{kI^3\delta^3+kI^3\delta^2\epsilon\mu S}{kE^3\beta\epsilon^2}, -\frac{1}{kE^3\beta\epsilon^2} \\
& \left(-kE^3\beta^2\epsilon^2+4kE^3\beta\epsilon\mu I-kE^3\beta\epsilon^2\mu I-3kE^3\mu I^2+kE^3\epsilon\mu I^2-kE^3\beta\epsilon^2\mu S+2kE^3\epsilon\mu I\mu S \right), \\
& -\frac{1}{kE^3\beta\epsilon^2} \left(-4kE^2kI\beta\delta\epsilon+6kE^2kI\delta\mu I-2kE^2kI\delta\epsilon\mu I- \right. \\
& \left. 2kE^2kI\delta\epsilon\mu S-kE^2kI\beta\epsilon^2\mu S+2kE^2kI\epsilon\mu I\mu S \right), \\
& -\frac{1}{kE^3\beta\epsilon^2} \left(2kE kI^2\beta\delta^2\epsilon-3kE kI^2\delta^2\mu I+kE kI^2\delta^2\epsilon\mu S+kE kI^2\beta\delta\epsilon^2\mu S-2kE kI^2\delta\epsilon\mu I\mu S \right), \\
& -\frac{1}{kE^3\beta\epsilon^2} \left(-kE^3\beta^2\epsilon^2\mu I+2kE^3\beta\epsilon\mu I^2-kE^3\mu I^3-kE^3\beta\epsilon^2\mu I\mu S+kE^3\epsilon\mu I^2\mu S \right), \\
& -\frac{1}{kE^3\beta\epsilon^2} \left(kE^2kI\beta^2\delta\epsilon^2-4kE^2kI\beta\delta\epsilon\mu I+3kE^2kI\delta\mu I^2+ \right. \\
& \left. kE^2kI\beta\delta\epsilon^2\mu S-2kE^2kI\delta\epsilon\mu I\mu S-kE^2kI\beta\epsilon^2\mu I\mu S+kE^2kI\epsilon\mu I^2\mu S \right) \}
\end{aligned}$$

xCoeffs =

Coeffs /. { $\beta \rightarrow a1$, $\delta \rightarrow a2$, $\epsilon \rightarrow a3$, $\mu S \rightarrow a4$, $\mu E \rightarrow a5$, $\mu I \rightarrow a6$, $c \rightarrow a7$, $kE \rightarrow a8$, $kI \rightarrow a9$ }

$$\left\{ 1, 2, \frac{a9}{a8}, \frac{2 a9}{a8}, -\frac{2 a9}{a1 a3 a8}, -\frac{a9}{a1 a3 a8}, \frac{2 a2 a9^2}{a1 a3 a8^2}, -\frac{a2^2 a9^3}{a1 a3 a8^3}, -\frac{a3 a9}{a8 - a3 a8}, -\frac{-a8^3 + a3 a8^3}{a1 a3^2 a8^3}, \right. \\ -\frac{-3 a8^3 + 3 a3 a8^3}{a1 a3^2 a8^3}, -\frac{-a2 a9 - a3 a5 a9}{a8 - a3 a8}, \frac{a6 a8 - a3 a6 a8}{a8 - a3 a8}, -\frac{-a1 a3^2 a8^2 a9 + 2 a3 a6 a8^2 a9}{a1 a3^2 a8^3}, \\ -\frac{2 a1 a2 a3^2 a8 a9^2 - 2 a2 a3 a6 a8 a9^2}{a1 a3^2 a8^3}, -\frac{a1 a2 a3^2 a8^2 a9 - a1 a3^2 a6 a8^2 a9 + a3 a6^2 a8^2 a9}{a1 a3^2 a8^3}, \\ -\frac{2 a1 a3 a8^3 + a3 a4 a8^3 - 3 a6 a8^3 + 2 a3 a6 a8^3}{a1 a3^2 a8^3}, \\ -\frac{4 a1 a3 a8^3 + 2 a3 a4 a8^3 - 6 a6 a8^3 + 4 a3 a6 a8^3}{a1 a3^2 a8^3}, \\ -\frac{3 a2 a8^2 a9 - 2 a2 a3 a8^2 a9 + a1 a3^2 a8^2 a9 + a3 a4 a8^2 a9}{a1 a3^2 a8^3}, \\ -\frac{6 a2 a8^2 a9 - 4 a2 a3 a8^2 a9 + 2 a1 a3^2 a8^2 a9 + 2 a3 a4 a8^2 a9}{a1 a3^2 a8^3}, \\ -\frac{1}{a1 a3^2 a8^3} \left(-3 a2^2 a8 a9^2 + a2^2 a3 a8 a9^2 - a1 a2 a3^2 a8 a9^2 - 2 a2 a3 a4 a8 a9^2 \right), \\ -\frac{a2^3 a9^3 + a2^2 a3 a4 a9^3}{a1 a3^2 a8^3}, -\frac{1}{a1 a3^2 a8^3} \left(-a1^2 a3^2 a8^3 - a1 a3^2 a4 a8^3 + \right. \\ \left. 4 a1 a3 a6 a8^3 - a1 a3^2 a6 a8^3 + 2 a3 a4 a6 a8^3 - 3 a6^2 a8^3 + a3 a6^2 a8^3 \right), \\ -\frac{1}{a1 a3^2 a8^3} \left(-4 a1 a2 a3 a8^2 a9 - 2 a2 a3 a4 a8^2 a9 - a1 a3^2 a4 a8^2 a9 + 6 a2 a6 a8^2 a9 - \right. \\ \left. 2 a2 a3 a6 a8^2 a9 + 2 a3 a4 a6 a8^2 a9 \right), -\frac{1}{a1 a3^2 a8^3} \left(2 a1 a2^2 a3 a8 a9^2 + \right. \\ \left. a2^2 a3 a4 a8 a9^2 + a1 a2 a3^2 a4 a8 a9^2 - 3 a2^2 a6 a8 a9^2 - 2 a2 a3 a4 a6 a8 a9^2 \right), \\ -\frac{1}{a1 a3^2 a8^3} \left(-a1^2 a3^2 a6 a8^3 - a1 a3^2 a4 a6 a8^3 + 2 a1 a3 a6^2 a8^3 + a3 a4 a6^2 a8^3 - a6^3 a8^3 \right), \\ \left. -\frac{1}{a1 a3^2 a8^3} \left(a1^2 a2 a3^2 a8^2 a9 + a1 a2 a3^2 a4 a8^2 a9 - 4 a1 a2 a3 a6 a8^2 a9 - \right. \right. \\ \left. \left. 2 a2 a3 a4 a6 a8^2 a9 - a1 a3^2 a4 a6 a8^2 a9 + 3 a2 a6^2 a8^2 a9 + a3 a4 a6^2 a8^2 a9 \right) \right\}$$

Solve[Coeffs == xCoeffs, { β , δ , ϵ , μS , μE , μI , c , kE , kI }]

MessageTemplate[Solve, svars, Equations may not give solutions for all "solve" variables.,
2, 49, 2, 33627886200554543902, Local]

$$\left\{ \left\{ \beta \rightarrow a1, \delta \rightarrow a2, \epsilon \rightarrow a3, \mu S \rightarrow a4, \mu E \rightarrow a5, \mu I \rightarrow a6, kE \rightarrow \frac{a8 kI}{a9} \right\} \right\}$$