```
dSdteqn[t_] = c + m - β S[t] II[t] / (S[t] + EE[t] + II[t]) - μS S[t] - D[S[t], t]
dEEdteqn[t_] =
  (1 - ε) β S[t] II[t] / (S[t] + EE[t] + II[t]) - δ EE[t] - μE EE[t] - D[EE[t], t]
dIIdteqn[t_] = ε β S[t] II[t] / (S[t] + EE[t] + II[t]) + δ EE[t] - μI II[t] - D[II[t], t]
```

$$c + m - \mu S\, S[t] - \frac{\beta\, II[t]\, S[t]}{EE[t] + II[t] + S[t]} - S'[t]$$

$$-\delta\, EE[t] - \mu E\, EE[t] + \frac{\beta\,(1 - \epsilon)\, II[t]\, S[t]}{EE[t] + II[t] + S[t]} - EE'[t]$$

$$\delta\, EE[t] - \mu I\, II[t] + \frac{\beta\, \epsilon\, II[t]\, S[t]}{EE[t] + II[t] + S[t]} - II'[t]$$

```
yEeqn[t_] = kE EE[t] - yE[t]
yIeqn[t_] = kI II[t] - yI[t]
```

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

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

```
yEmap[t_] = Solve[yEeqn[t] == 0, EE[t]][[1]]
yImap[t_] = Solve[yIeqn[t] == 0, II[t]][[1]]
```

$$\left\{ EE[t] \to \frac{yE[t]}{kE} \right\}$$

$$\left\{ II[t] \to \frac{yI[t]}{kI} \right\}$$

```
dSdteqn2[t_] = dSdteqn[t] /. yEmap[t] /. D[yEmap[t], t] /. yImap[t] /. D[yImap[t], t]
dEEdteqn2[t_] =
  dEEdteqn[t] /. yEmap[t] /. D[yEmap[t], t] /. yImap[t] /. D[yImap[t], t]
dIIdteqn2[t_] = dIIdteqn[t] /. yEmap[t] /. D[yEmap[t], t] /. yImap[t] /. D[yImap[t], t]
```

$$c + m - \mu S\, S[t] - \frac{\beta\, S[t]\, yI[t]}{kI\left(S[t] + \frac{yE[t]}{kE} + \frac{yI[t]}{kI}\right)} - S'[t]$$

$$-\frac{\delta\, yE[t]}{kE} - \frac{\mu E\, yE[t]}{kE} + \frac{\beta\,(1 - \epsilon)\, S[t]\, yI[t]}{kI\left(S[t] + \frac{yE[t]}{kE} + \frac{yI[t]}{kI}\right)} - \frac{yE'[t]}{kE}$$

$$\frac{\delta\, yE[t]}{kE} - \frac{\mu I\, yI[t]}{kI} + \frac{\beta\, \epsilon\, S[t]\, yI[t]}{kI\left(S[t] + \frac{yE[t]}{kE} + \frac{yI[t]}{kI}\right)} - \frac{yI'[t]}{kI}$$

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

$$\left\{ S[t] \to -\frac{(kI\, yE[t] + kE\, yI[t])\,(kI\, \delta\, yE[t] - kE\, \mu I\, yI[t] - kE\, yI'[t])}{kE\, kI\,(kI\, \delta\, yE[t] + kE\, \beta\, \epsilon\, yI[t] - kE\, \mu I\, yI[t] - kE\, yI'[t])} \right\}$$

```
dSdteqn3[t_] = dSdteqn2[t] /. Smap[t] /. D[Smap[t], t]
dEEdteqn3[t_] = dEEdteqn2[t] /. Smap[t] /. D[Smap[t], t]
```

$$c + m + \frac{\mu S \, (kI \, yE[t] + kE \, yI[t]) \, (kI \, \delta \, yE[t] - kE \, \mu I \, yI[t] - kE \, yI'[t])}{kE \, kI \, (kI \, \delta \, yE[t] + kE \, \beta \in yI[t] - kE \, \mu I \, yI[t] - kE \, yI'[t])} +$$

$$\frac{(kI \, \delta \, yE[t] - kE \, \mu I \, yI[t] - kE \, yI'[t]) \, (kI \, yE'[t] + kE \, yI'[t])}{kE \, kI \, (kI \, \delta \, yE[t] + kE \, \beta \in yI[t] - kE \, \mu I \, yI[t] - kE \, yI'[t])} +$$

$$(\beta \, yI[t] \, (kI \, yE[t] + kE \, yI[t]) \, (kI \, \delta \, yE[t] - kE \, \mu I \, yI[t] - kE \, yI'[t])) \Big/$$

$$\Big(kE \, kI^2 \, (kI \, \delta \, yE[t] + kE \, \beta \in yI[t] - kE \, \mu I \, yI[t] - kE \, yI'[t])$$

$$\Big(\frac{yE[t]}{kE} + \frac{yI[t]}{kI} - \frac{(kI \, yE[t] + kE \, yI[t]) \, (kI \, \delta \, yE[t] - kE \, \mu I \, yI[t] - kE \, yI'[t])}{kE \, kI \, (kI \, \delta \, yE[t] + kE \, \beta \in yI[t] - kE \, \mu I \, yI[t] - kE \, yI'[t])} \Big) \Big) +$$

$$\frac{(kI \, yE[t] + kE \, yI[t]) \, (kI \, \delta \, yE'[t] - kE \, \mu I \, yI'[t] - kE \, yI''[t])}{kE \, kI \, (kI \, \delta \, yE[t] + kE \, \beta \in yI[t] - kE \, \mu I \, yI[t] - kE \, yI'[t])} -$$

$$((kI \, yE[t] + kE \, yI[t]) \, (kI \, \delta \, yE[t] - kE \, \mu I \, yI[t] - kE \, yI'[t])$$

$$(kI \, \delta \, yE'[t] + kE \, \beta \in yI'[t] - kE \, \mu I \, yI'[t] - kE \, yI''[t])) \Big/$$

$$\Big(kE \, kI \, (kI \, \delta \, yE[t] + kE \, \beta \in yI[t] - kE \, \mu I \, yI[t] - kE \, yI'[t])^2 \Big)$$

$$-\frac{\delta \, yE[t]}{kE} - \frac{\mu E \, yE[t]}{kE} - \frac{yE'[t]}{kE} -$$

$$(\beta \, (1 - \in) \, yI[t] \, (kI \, yE[t] + kE \, yI[t]) \, (kI \, \delta \, yE[t] - kE \, \mu I \, yI[t] - kE \, yI'[t])) \Big/$$

$$\Big(kE \, kI^2 \, (kI \, \delta \, yE[t] + kE \, \beta \in yI[t] - kE \, \mu I \, yI[t] - kE \, yI'[t])$$

$$\Big(\frac{yE[t]}{kE} + \frac{yI[t]}{kI} - ((kI \, yE[t] + kE \, yI[t]) \, (kI \, \delta \, yE[t] - kE \, \mu I \, yI[t] - kE \, yI'[t])) \Big/$$

$$(kE \, kI \, (kI \, \delta \, yE[t] + kE \, \beta \in yI[t] - kE \, \mu I \, yI[t] - kE \, yI'[t])) \Big) \Big)$$

```
IPOPish1[t_] = Simplify[Denominator[Together[dSdteqn3[t]]] Together[dSdteqn3[t]]]
IPOPish2[t_] = Simplify[Denominator[Together[dEEdteqn3[t]]] Together[dEEdteqn3[t]]]
```

$$kI^3 \, \delta^2 \, (\delta + \in \mu S) \, yE[t]^3 +$$

$$kI^2 \, \delta \, yE[t]^2 \, (kE \, kI \, (c + m) \, \delta \in + kE \, (-3 \, \delta \, \mu I + \delta \in \mu S - 2 \in \mu I \, \mu S + \beta \in (2 \, \delta + \in \mu S)) \, yI[t] +$$

$$kI \, \delta \in yE'[t] + kE \, (\delta \, (-3 + \in) - \in (\beta \in + 2 \, \mu S)) \, yI'[t]) + kE \, kI \, yE[t]$$

$$\Big(kE \, (\beta^2 \, \delta \in^2 + \beta \in (-4 \, \delta \, \mu I + \delta \in \mu S - \in \mu I \, \mu S) + \mu I \, (3 \, \delta \, \mu I - 2 \, \delta \in \mu S + \in \mu I \, \mu S)) \, yI[t]^2 +$$

$$yI'[t] \, (-2 \, kE \, kI \, (c + m) \, \delta \in - 2 \, kI \, \delta \in yE'[t] + kE \, (\delta \, (3 - 2 \in) + \in (\beta \in + \mu S)) \, yI'[t]) +$$

$$yI[t] \, (2 \, kI \, \delta \in (\beta \in - \mu I) \, yE'[t] - kE \, (-2 \in \mu I \, \mu S + \beta \in (4 \, \delta + \in \mu S) + 2 \, \delta \, ((-3 + \in) \, \mu I + \in \mu S))$$

$$yI'[t] + kE \in (2 \, kI \, (c + m) \, \delta \, (\beta \in - \mu I) - \beta \in yI''[t]))) +$$

$$kE^2 \, \Big(-kE \, (\beta \in - \mu I) \, \mu I \, (\beta \in - \mu I + \in \mu S) \, yI[t]^3 + yI'[t]^2$$

$$(kE \, kI \, (c + m) \in + kI \in yE'[t] + kE \, (-1 + \in) \, yI'[t]) +$$

$$yI[t] \, yI'[t] \, (-2 \, kE \, kI \, (c + m) \in (\beta \in - \mu I) + kI \in (-\beta \in + 2 \, \mu I) \, yE'[t] +$$

$$kE \, (2 \, \beta \in + (-3 + 2 \in) \, \mu I + \in \mu S) \, yI'[t]) + yI[t]^2 \, \Big(kI \in (\beta \in (\delta - \mu I) + \mu I^2) \, yE'[t] +$$

$$kE \, \Big(-(\beta^2 \in^2 + \beta \in ((-4 + \in) \, \mu I + \in \mu S) - \mu I \, ((-3 + \in) \, \mu I + 2 \in \mu S)) \, yI'[t] +$$

$$\in (kI \, (c + m) \, (-\beta \in + \mu I)^2 - \beta \in yI''[t]) \Big) \Big) \Big)$$

$$-kI \, (\delta + \in \mu E) \, yE[t] - kE \, (-1 + \in) \, \mu I \, yI[t] - kI \in yE'[t] + kE \, yI'[t] - kE \in yI'[t]$$

```
Monos1 = Sort[
   MonomialList[IPOPish1[t], {yI[t], yI'[t], yI''[t], yE[t], yE'[t], yE''[t]}]]
Monos2 = Sort[MonomialList[IPOPish2[t],
    {yI[t], yI'[t], yI''[t], yE[t], yE'[t], yE''[t]}]]
```

$\{ \left(c\ kE\ kI^3\ \delta^2\ \epsilon + kE\ kI^3\ m\ \delta^2\ \epsilon \right) yE[t]^2,\ \left(kI^3\ \delta^3 + kI^3\ \delta^2\ \epsilon\ \mu S \right) yE[t]^3,$

$\left(2\ c\ kE^2\ kI^2\ \beta\ \delta\ \epsilon^2 + 2\ kE^2\ kI^2\ m\ \beta\ \delta\ \epsilon^2 - 2\ c\ kE^2\ kI^2\ \delta\ \epsilon\ \mu I - 2\ kE^2\ kI^2\ m\ \delta\ \epsilon\ \mu I \right) yE[t]\ yI[t],$

$\left(2\ kE\ kI^2\ \beta\ \delta^2\ \epsilon - 3\ kE\ kI^2\ \delta^2\ \mu I + kE\ kI^2\ \delta^2\ \epsilon\ \mu S + kE\ kI^2\ \beta\ \delta\ \epsilon^2\ \mu S - 2\ kE\ kI^2\ \delta\ \epsilon\ \mu I\ \mu S \right)$

$\quad yE[t]^2\ yI[t],\ \left(c\ kE^3\ kI\ \beta^2\ \epsilon^3 + kE^3\ kI\ m\ \beta^2\ \epsilon^3 - 2\ c\ kE^3\ kI\ \beta\ \epsilon^2\ \mu I - \right.$

$\quad\quad \left. 2\ kE^3\ kI\ m\ \beta\ \epsilon^2\ \mu I + c\ kE^3\ kI\ \epsilon\ \mu I^2 + kE^3\ kI\ m\ \epsilon\ \mu I^2 \right) yI[t]^2,$

$\left(kE^2\ kI\ \beta^2\ \delta\ \epsilon^2 - 4\ kE^2\ kI\ \beta\ \delta\ \epsilon\ \mu I + 3\ kE^2\ kI\ \delta\ \mu I^2 + kE^2\ kI\ \beta\ \delta\ \epsilon^2\ \mu S - \right.$

$\quad\quad \left. 2\ kE^2\ kI\ \delta\ \epsilon\ \mu I\ \mu S - kE^2\ kI\ \beta\ \epsilon^2\ \mu I\ \mu S + kE^2\ kI\ \epsilon\ \mu I^2\ \mu S \right) yE[t]\ yI[t]^2,$

$\left(-kE^3\ \beta^2\ \epsilon^2\ \mu I + 2\ kE^3\ \beta\ \epsilon\ \mu I^2 - kE^3\ \mu I^3 - kE^3\ \beta\ \epsilon^2\ \mu I\ \mu S + kE^3\ \epsilon\ \mu I^2\ \mu S \right) yI[t]^3,$

$kI^3\ \delta^2\ \epsilon\ yE[t]^2\ yE'[t],\ \left(2\ kE\ kI^2\ \beta\ \delta\ \epsilon^2 - 2\ kE\ kI^2\ \delta\ \epsilon\ \mu I \right) yE[t]\ yI[t]\ yE'[t],$

$\left(kE^2\ kI\ \beta\ \delta\ \epsilon^2 - kE^2\ kI\ \beta\ \epsilon^2\ \mu I + kE^2\ kI\ \epsilon\ \mu I^2 \right) yI[t]^2\ yE'[t],$

$\left(-2\ c\ kE^2\ kI^2\ \delta\ \epsilon - 2\ kE^2\ kI^2\ m\ \delta\ \epsilon \right) yE[t]\ yI'[t],$

$\left(-3\ kE\ kI^2\ \delta^2 + kE\ kI^2\ \delta^2\ \epsilon - kE\ kI^2\ \beta\ \delta\ \epsilon^2 - 2\ kE\ kI^2\ \delta\ \epsilon\ \mu S \right) yE[t]^2\ yI'[t],$

$\left(-2\ c\ kE^3\ kI\ \beta\ \epsilon^2 - 2\ kE^3\ kI\ m\ \beta\ \epsilon^2 + 2\ c\ kE^3\ kI\ \epsilon\ \mu I + 2\ kE^3\ kI\ m\ \epsilon\ \mu I \right) yI[t]\ yI'[t],$

$\left(-4\ kE^2\ kI\ \beta\ \delta\ \epsilon + 6\ kE^2\ kI\ \delta\ \mu I - 2\ kE^2\ kI\ \delta\ \epsilon\ \mu I - \right.$

$\quad\quad \left. 2\ kE^2\ kI\ \delta\ \epsilon\ \mu S - kE^2\ kI\ \beta\ \epsilon^2\ \mu S + 2\ kE^2\ kI\ \epsilon\ \mu I\ \mu S \right) yE[t]\ yI[t]\ yI'[t],$

$\left(-kE^3\ \beta^2\ \epsilon^2 + 4\ kE^3\ \beta\ \epsilon\ \mu I - kE^3\ \beta\ \epsilon^2\ \mu I - 3\ kE^3\ \mu I^2 + kE^3\ \epsilon\ \mu I^2 - kE^3\ \beta\ \epsilon^2\ \mu S + 2\ kE^3\ \epsilon\ \mu I\ \mu S \right)$

$\quad yI[t]^2\ yI'[t],\ -2\ kE\ kI^2\ \delta\ \epsilon\ yE[t]\ yE'[t]\ yI'[t],$

$\left(-kE^2\ kI\ \beta\ \epsilon^2 + 2\ kE^2\ kI\ \epsilon\ \mu I \right) yI[t]\ yE'[t]\ yI'[t],\ \left(c\ kE^3\ kI\ \epsilon + kE^3\ kI\ m\ \epsilon \right) yI'[t]^2,$

$\left(3\ kE^2\ kI\ \delta - 2\ kE^2\ kI\ \delta\ \epsilon + kE^2\ kI\ \beta\ \epsilon^2 + kE^2\ kI\ \epsilon\ \mu S \right) yE[t]\ yI'[t]^2,$

$\left(2\ kE^3\ \beta\ \epsilon - 3\ kE^3\ \mu I + 2\ kE^3\ \epsilon\ \mu I + kE^3\ \epsilon\ \mu S \right) yI[t]\ yI'[t]^2,\ kE^2\ kI\ \epsilon\ yE'[t]\ yI'[t]^2,$

$\left(-kE^3 + kE^3\ \epsilon \right) yI'[t]^3,\ -kE^2\ kI\ \beta\ \epsilon^2\ yE[t]\ yI[t]\ yI''[t],\ -kE^3\ \beta\ \epsilon^2\ yI[t]^2\ yI''[t] \}$

$\{ \left(-kI\ \delta - kI\ \epsilon\ \mu E \right) yE[t],\ \left(kE\ \mu I - kE\ \epsilon\ \mu I \right) yI[t],\ -kI\ \epsilon\ yE'[t],\ \left(kE - kE\ \epsilon \right) yI'[t] \}$

```
Last[Monos2]
```

$\left(kE - kE\ \epsilon \right) yI'[t]$

```
MonicMonos1 = Monos1 / (Last[Monos1] /.
    {yI[t] → 1, yI'[t] → 1, yI''[t] → 1, yE[t] → 1, yE'[t] → 1, yE''[t] → 1})
MonicMonos2 = Monos2 / (Last[Monos2] /. {yI[t] → 1, yI'[t] → 1,
    yI''[t] → 1, yE[t] → 1, yE'[t] → 1, yE''[t] → 1})
```

$\left\{ -\frac{\left(c\ kE\ kI^3\ \delta^2\ \epsilon + kE\ kI^3\ m\ \delta^2\ \epsilon \right) yE[t]^2}{kE^3\ \beta\ \epsilon^2},\ -\frac{\left(kI^3\ \delta^3 + kI^3\ \delta^2\ \epsilon\ \mu S \right) yE[t]^3}{kE^3\ \beta\ \epsilon^2},\ -\frac{1}{kE^3\ \beta\ \epsilon^2} \right.$

$\left(2\ c\ kE^2\ kI^2\ \beta\ \delta\ \epsilon^2 + 2\ kE^2\ kI^2\ m\ \beta\ \delta\ \epsilon^2 - 2\ c\ kE^2\ kI^2\ \delta\ \epsilon\ \mu I - 2\ kE^2\ kI^2\ m\ \delta\ \epsilon\ \mu I \right) yE[t]\ yI[t],$

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

$\quad yE[t]^2\ yI[t],\ -\frac{1}{kE^3\ \beta\ \epsilon^2} \left(c\ kE^3\ kI\ \beta^2\ \epsilon^3 + kE^3\ kI\ m\ \beta^2\ \epsilon^3 - 2\ c\ kE^3\ kI\ \beta\ \epsilon^2\ \mu I - \right.$

$\quad\quad \left. 2\ kE^3\ kI\ m\ \beta\ \epsilon^2\ \mu I + c\ kE^3\ kI\ \epsilon\ \mu I^2 + kE^3\ kI\ m\ \epsilon\ \mu I^2 \right) yI[t]^2,$

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

$$-\frac{1}{kE^3\,\beta\,\epsilon^2}\left(-kE^3\,\beta^2\,\epsilon^2\,\mu I + 2\,kE^3\,\beta\,\epsilon\,\mu I^2 - kE^3\,\mu I^3 - kE^3\,\beta\,\epsilon^2\,\mu I\,\mu S + kE^3\,\epsilon\,\mu I^2\,\mu S\right)yI[t]^3,$$

$$-\frac{kI^3\,\delta^2\,yE[t]^2\,yE'[t]}{kE^3\,\beta\,\epsilon},$$

$$-\frac{\left(2\,kE\,kI^2\,\beta\,\delta\,\epsilon^2 - 2\,kE\,kI^2\,\delta\,\epsilon\,\mu I\right)yE[t]\,yI[t]\,yE'[t]}{kE^3\,\beta\,\epsilon^2},$$

$$-\frac{\left(kE^2\,kI\,\beta\,\delta\,\epsilon^2 - kE^2\,kI\,\beta\,\epsilon^2\,\mu I + kE^2\,kI\,\epsilon\,\mu I^2\right)yI[t]^2\,yE'[t]}{kE^3\,\beta\,\epsilon^2},$$

$$-\frac{\left(-2\,c\,kE^2\,kI^2\,\delta\,\epsilon - 2\,kE^2\,kI^2\,m\,\delta\,\epsilon\right)yE[t]\,yI'[t]}{kE^3\,\beta\,\epsilon^2},$$

$$-\frac{1}{kE^3\,\beta\,\epsilon^2}\left(-3\,kE\,kI^2\,\delta^2 + kE\,kI^2\,\delta^2\,\epsilon - kE\,kI^2\,\beta\,\delta\,\epsilon^2 - 2\,kE\,kI^2\,\delta\,\epsilon\,\mu S\right)yE[t]^2\,yI'[t],$$

$$-\frac{1}{kE^3\,\beta\,\epsilon^2}\left(-2\,c\,kE^3\,kI\,\beta\,\epsilon^2 - 2\,kE^3\,kI\,m\,\beta\,\epsilon^2 + 2\,c\,kE^3\,kI\,\epsilon\,\mu I + 2\,kE^3\,kI\,m\,\epsilon\,\mu I\right)yI[t]\,yI'[t],$$

$$-\frac{1}{kE^3\,\beta\,\epsilon^2}\left(-4\,kE^2\,kI\,\beta\,\delta\,\epsilon + 6\,kE^2\,kI\,\delta\,\mu I - 2\,kE^2\,kI\,\delta\,\epsilon\,\mu I - 2\,kE^2\,kI\,\delta\,\epsilon\,\mu S -\right.$$
$$\left. kE^2\,kI\,\beta\,\epsilon^2\,\mu S + 2\,kE^2\,kI\,\epsilon\,\mu I\,\mu S\right)yE[t]\,yI[t]\,yI'[t],\ -\frac{1}{kE^3\,\beta\,\epsilon^2}$$
$$\left(-kE^3\,\beta^2\,\epsilon^2 + 4\,kE^3\,\beta\,\epsilon\,\mu I - kE^3\,\beta\,\epsilon^2\,\mu I - 3\,kE^3\,\mu I^2 + kE^3\,\epsilon\,\mu I^2 - kE^3\,\beta\,\epsilon^2\,\mu S + 2\,kE^3\,\epsilon\,\mu I\,\mu S\right)$$
$$yI[t]^2\,yI'[t],\ \frac{2\,kI^2\,\delta\,yE[t]\,yE'[t]\,yI'[t]}{kE^2\,\beta\,\epsilon},$$

$$-\frac{\left(-kE^2\,kI\,\beta\,\epsilon^2 + 2\,kE^2\,kI\,\epsilon\,\mu I\right)yI[t]\,yE'[t]\,yI'[t]}{kE^3\,\beta\,\epsilon^2},\ -\frac{\left(c\,kE^3\,kI\,\epsilon + kE^3\,kI\,m\,\epsilon\right)yI'[t]^2}{kE^3\,\beta\,\epsilon^2},$$

$$-\frac{1}{kE^3\,\beta\,\epsilon^2}\left(3\,kE^2\,kI\,\delta - 2\,kE^2\,kI\,\delta\,\epsilon + kE^2\,kI\,\beta\,\epsilon^2 + kE^2\,kI\,\epsilon\,\mu S\right)yE[t]\,yI'[t]^2,$$

$$-\frac{\left(2\,kE^3\,\beta\,\epsilon - 3\,kE^3\,\mu I + 2\,kE^3\,\epsilon\,\mu I + kE^3\,\epsilon\,\mu S\right)yI[t]\,yI'[t]^2}{kE^3\,\beta\,\epsilon^2},$$

$$-\frac{kI\,yE'[t]\,yI'[t]^2}{kE\,\beta\,\epsilon},\ -\frac{\left(-kE^3 + kE^3\,\epsilon\right)yI'[t]^3}{kE^3\,\beta\,\epsilon^2},$$

$$\frac{kI\,yE[t]\,yI[t]\,yI''[t]}{kE},\ yI[t]^2\,yI''[t]\Big\}$$

$$\left\{\frac{\left(-kI\,\delta - kI\,\epsilon\,\mu E\right)yE[t]}{kE - kE\,\epsilon},\ \frac{\left(kE\,\mu I - kE\,\epsilon\,\mu I\right)yI[t]}{kE - kE\,\epsilon},\ -\frac{kI\,\epsilon\,yE'[t]}{kE - kE\,\epsilon},\ yI'[t]\right\}$$

```
Coeffs1 = MonicMonos1 /.
   {yI[t] → 1, yI'[t] → 1, yI''[t] → 1, yE[t] → 1, yE'[t] → 1, yE''[t] → 1}
Coeffs2 = MonicMonos2 /. {yI[t] → 1, yI'[t] → 1,
   yI''[t] → 1, yE[t] → 1, yE'[t] → 1, yE''[t] → 1}
```

$$\Big\{ -\frac{c\, kE\, kI^3\, \delta^2\, \epsilon + kE\, kI^3\, m\, \delta^2\, \epsilon}{kE^3\, \beta\, \epsilon^2}, \; -\frac{kI^3\, \delta^3 + kI^3\, \delta^2\, \epsilon\, \mu S}{kE^3\, \beta\, \epsilon^2},$$

$$-\frac{1}{kE^3\, \beta\, \epsilon^2}\Big(2\, c\, kE^2\, kI^2\, \beta\, \delta\, \epsilon^2 + 2\, kE^2\, kI^2\, m\, \beta\, \delta\, \epsilon^2 - 2\, c\, kE^2\, kI^2\, \delta\, \epsilon\, \mu I - 2\, kE^2\, kI^2\, m\, \delta\, \epsilon\, \mu I\Big),$$

$$-\frac{1}{kE^3\, \beta\, \epsilon^2}\Big(2\, kE\, kI^2\, \beta\, \delta^2\, \epsilon - 3\, kE\, kI^2\, \delta^2\, \mu I + kE\, kI^2\, \delta^2\, \epsilon\, \mu S + kE\, kI^2\, \beta\, \delta\, \epsilon^2\, \mu S - 2\, kE\, kI^2\, \delta\, \epsilon\, \mu I\, \mu S\Big),$$

$$-\frac{1}{kE^3\, \beta\, \epsilon^2}\Big(c\, kE^3\, kI\, \beta^2\, \epsilon^3 + kE^3\, kI\, m\, \beta^2\, \epsilon^3 -$$
$$2\, c\, kE^3\, kI\, \beta\, \epsilon^2\, \mu I - 2\, kE^3\, kI\, m\, \beta\, \epsilon^2\, \mu I + c\, kE^3\, kI\, \epsilon\, \mu I^2 + kE^3\, kI\, m\, \epsilon\, \mu I^2\Big),$$

$$-\frac{1}{kE^3\, \beta\, \epsilon^2}\Big(kE^2\, kI\, \beta^2\, \delta\, \epsilon^2 - 4\, kE^2\, kI\, \beta\, \delta\, \epsilon\, \mu I + 3\, kE^2\, kI\, \delta\, \mu I^2 + kE^2\, kI\, \beta\, \delta\, \epsilon^2\, \mu S -$$
$$2\, kE^2\, kI\, \delta\, \epsilon\, \mu I\, \mu S - kE^2\, kI\, \beta\, \epsilon^2\, \mu I\, \mu S + kE^2\, kI\, \epsilon\, \mu I^2\, \mu S\Big),$$

$$-\frac{1}{kE^3\, \beta\, \epsilon^2}\Big(-kE^3\, \beta^2\, \epsilon^2\, \mu I + 2\, kE^3\, \beta\, \epsilon\, \mu I^2 - kE^3\, \mu I^3 - kE^3\, \beta\, \epsilon^2\, \mu I\, \mu S + kE^3\, \epsilon\, \mu I^2\, \mu S\Big),$$

$$-\frac{kI^3\, \delta^2}{kE^3\, \beta\, \epsilon}, \; -\frac{2\, kE\, kI^2\, \beta\, \delta\, \epsilon^2 - 2\, kE\, kI^2\, \delta\, \epsilon\, \mu I}{kE^3\, \beta\, \epsilon^2},$$

$$-\frac{kE^2\, kI\, \beta\, \delta\, \epsilon^2 - kE^2\, kI\, \beta\, \epsilon^2\, \mu I + kE^2\, kI\, \epsilon\, \mu I^2}{kE^3\, \beta\, \epsilon^2},$$

$$-\frac{-2\, c\, kE^2\, kI^2\, \delta\, \epsilon - 2\, kE^2\, kI^2\, m\, \delta\, \epsilon}{kE^3\, \beta\, \epsilon^2},$$

$$-\frac{-3\, kE\, kI^2\, \delta^2 + kE\, kI^2\, \delta^2\, \epsilon - kE\, kI^2\, \beta\, \delta\, \epsilon^2 - 2\, kE\, kI^2\, \delta\, \epsilon\, \mu S}{kE^3\, \beta\, \epsilon^2},$$

$$-\frac{-2\, c\, kE^3\, kI\, \beta\, \epsilon^2 - 2\, kE^3\, kI\, m\, \beta\, \epsilon^2 + 2\, c\, kE^3\, kI\, \epsilon\, \mu I + 2\, kE^3\, kI\, m\, \epsilon\, \mu I}{kE^3\, \beta\, \epsilon^2},$$

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

$$\frac{2\, kI^2\, \delta}{kE^2\, \beta\, \epsilon}, \; -\frac{-kE^2\, kI\, \beta\, \epsilon^2 + 2\, kE^2\, kI\, \epsilon\, \mu I}{kE^3\, \beta\, \epsilon^2}, \; -\frac{c\, kE^3\, kI\, \epsilon + kE^3\, kI\, m\, \epsilon}{kE^3\, \beta\, \epsilon^2},$$

$$-\frac{3\, kE^2\, kI\, \delta - 2\, kE^2\, kI\, \delta\, \epsilon + kE^2\, kI\, \beta\, \epsilon^2 + kE^2\, kI\, \epsilon\, \mu S}{kE^3\, \beta\, \epsilon^2},$$

$$-\frac{2\, kE^3\, \beta\, \epsilon - 3\, kE^3\, \mu I + 2\, kE^3\, \epsilon\, \mu I + kE^3\, \epsilon\, \mu S}{kE^3\, \beta\, \epsilon^2}, \; -\frac{kI}{kE\, \beta\, \epsilon}, \; -\frac{-kE^3 + kE^3\, \epsilon}{kE^3\, \beta\, \epsilon^2}, \; \frac{kI}{kE}, \; 1\Big\}$$

$$\Big\{ \frac{-kI\, \delta - kI\, \epsilon\, \mu E}{kE - kE\, \epsilon}, \; \frac{kE\, \mu I - kE\, \epsilon\, \mu I}{kE - kE\, \epsilon}, \; -\frac{kI\, \epsilon}{kE - kE\, \epsilon}, \; 1\Big\}$$

```
Coeffs = Simplify[Union[Coeffs1, Coeffs2]]
```

$$\left\{ 1, \frac{kI}{kE}, -\frac{kI}{kE\,\beta\,\epsilon}, \frac{2\,kI^2\,\delta}{kE^2\,\beta\,\epsilon}, -\frac{kI^3\,\delta^2}{kE^3\,\beta\,\epsilon}, \frac{kI\,\epsilon}{kE\,(-1+\epsilon)}, \frac{1-\epsilon}{\beta\,\epsilon^2}, -\frac{kI\,(c+m)}{\beta\,\epsilon}, \right.$$

$$\frac{2\,kI^2\,(c+m)\,\delta}{kE\,\beta\,\epsilon}, -\frac{kI^3\,(c+m)\,\delta^2}{kE^2\,\beta\,\epsilon}, \frac{kI\,(\delta+\epsilon\,\mu E)}{kE\,(-1+\epsilon)}, \mu I, \frac{kI\,(\beta\,\epsilon-2\,\mu I)}{kE\,\beta\,\epsilon},$$

$$\frac{2\,kI\,(c+m)\,(\beta\,\epsilon-\mu I)}{\beta\,\epsilon}, \frac{2\,kI^2\,\delta\,(-\beta\,\epsilon+\mu I)}{kE^2\,\beta\,\epsilon}, -\frac{2\,kI^2\,(c+m)\,\delta\,(\beta\,\epsilon-\mu I)}{kE\,\beta\,\epsilon},$$

$$-\frac{kI\,\left(\beta\,\epsilon\,(\delta-\mu I)+\mu I^2\right)}{kE\,\beta\,\epsilon}, -\frac{kI\,(c+m)\,(-\beta\,\epsilon+\mu I)^2}{\beta\,\epsilon}, -\frac{2\,\beta\,\epsilon-3\,\mu I+2\,\epsilon\,\mu I+\epsilon\,\mu S}{\beta\,\epsilon^2},$$

$$\frac{kI\,(\delta\,(-3+2\,\epsilon)-\epsilon\,(\beta\,\epsilon+\mu S))}{kE\,\beta\,\epsilon^2}, \frac{kI^2\,\delta\,(-\delta\,(-3+\epsilon)+\epsilon\,(\beta\,\epsilon+2\,\mu S))}{kE^2\,\beta\,\epsilon^2},$$

$$-\frac{kI^3\,\delta^2\,(\delta+\epsilon\,\mu S)}{kE^3\,\beta\,\epsilon^2}, \beta+\mu I-\frac{4\,\mu I}{\epsilon}+\mu S-\frac{\mu I\,((-3+\epsilon)\,\mu I+2\,\epsilon\,\mu S)}{\beta\,\epsilon^2},$$

$$\frac{kI\,(-2\,\epsilon\,\mu I\,\mu S+\beta\,\epsilon\,(4\,\delta+\epsilon\,\mu S)+2\,\delta\,((-3+\epsilon)\,\mu I+\epsilon\,\mu S))}{kE\,\beta\,\epsilon^2},$$

$$-\frac{kI^2\,\delta\,(-3\,\delta\,\mu I+\delta\,\epsilon\,\mu S-2\,\epsilon\,\mu I\,\mu S+\beta\,\epsilon\,(2\,\delta+\epsilon\,\mu S))}{kE^2\,\beta\,\epsilon^2}, \frac{(\beta\,\epsilon-\mu I)\,\mu I\,(\beta\,\epsilon-\mu I+\epsilon\,\mu S)}{\beta\,\epsilon^2},$$

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

```
xCoeffs = Coeffs /.
  {β → a1, δ → a2, ε → a3, µS → a4, µE → a5, µI → a6, c → a7, kE → a8, kI → a9, m → a10}
```

$$\left\{1, \frac{a9}{a8}, -\frac{a9}{a1\,a3\,a8}, \frac{2\,a2\,a9^2}{a1\,a3\,a8^2}, -\frac{a2^2\,a9^3}{a1\,a3\,a8^3}, \frac{a3\,a9}{(-1+a3)\,a8}, \frac{1-a3}{a1\,a3^2}, -\frac{(a10+a7)\,a9}{a1\,a3}, \right.$$

$$\frac{2\,a2\,(a10+a7)\,a9^2}{a1\,a3\,a8}, -\frac{a2^2\,(a10+a7)\,a9^3}{a1\,a3\,a8^2}, \frac{(a2+a3\,a5)\,a9}{(-1+a3)\,a8}, a6, \frac{(a1\,a3-2\,a6)\,a9}{a1\,a3\,a8},$$

$$\frac{2\,(a1\,a3-a6)\,(a10+a7)\,a9}{a1\,a3}, \frac{2\,a2\,(-a1\,a3+a6)\,a9^2}{a1\,a3\,a8^2}, -\frac{2\,a2\,(a1\,a3-a6)\,(a10+a7)\,a9^2}{a1\,a3\,a8},$$

$$-\frac{\left(a1\,a3\,(a2-a6)+a6^2\right)\,a9}{a1\,a3\,a8}, -\frac{(-a1\,a3+a6)^2\,(a10+a7)\,a9}{a1\,a3}, -\frac{2\,a1\,a3+a3\,a4-3\,a6+2\,a3\,a6}{a1\,a3^2},$$

$$\frac{(a2\,(-3+2\,a3)-a3\,(a1\,a3+a4))\,a9}{a1\,a3^2\,a8}, \frac{a2\,(-a2\,(-3+a3)+a3\,(a1\,a3+2\,a4))\,a9^2}{a1\,a3^2\,a8^2},$$

$$-\frac{a2^2\,(a2+a3\,a4)\,a9^3}{a1\,a3^2\,a8^3}, a1+a4+a6-\frac{4\,a6}{a3}-\frac{a6\,(2\,a3\,a4+(-3+a3)\,a6)}{a1\,a3^2},$$

$$\frac{(a1\,a3\,(4\,a2+a3\,a4)-2\,a3\,a4\,a6+2\,a2\,(a3\,a4+(-3+a3)\,a6))\,a9}{a1\,a3^2\,a8},$$

$$-\frac{a2\,(a2\,a3\,a4+a1\,a3\,(2\,a2+a3\,a4)-3\,a2\,a6-2\,a3\,a4\,a6)\,a9^2}{a1\,a3^2\,a8^2},$$

$$\frac{(a1\,a3-a6)\,(a1\,a3+a3\,a4-a6)\,a6}{a1\,a3^2}, -\frac{1}{a1\,a3^2\,a8}$$

$$\left.\left(a1^2\,a2\,a3^2+a1\,a3\,(a2\,a3\,a4-4\,a2\,a6-a3\,a4\,a6)+a6\,(-2\,a2\,a3\,a4+3\,a2\,a6+a3\,a4\,a6)\right)\,a9\right\}$$

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

MessageTemplate[Solve , svars , Equations may not give solutions for all "solve" variables. ,

2 , 78 , 2 , 33 627 900 467 745 714 090 , Local]

$$\left\{\left\{β → a1, δ → a2, ε → a3, µS → a4, µE → a5, µI → a6, kE → \frac{a8\,kI}{a9}, m → \frac{a10\,a9+a7\,a9-c\,kI}{kI}\right\}\right\}$$