```
> #Julian Jimenez Hw19
  read "/Users/jjj104/Documents/M19.txt";
```

```
> #Question 1i

  print(SIRS);
  #i
  N := 1000;
  nu := 1;
  F := SIRS(s, i, 0.3 * nu / N, 3, nu, N);
  F2 := SIRS(s, i, 0.9 * nu / N, 3, nu, N);
  F3 := SIRS(s, i, 3.9 * nu / N, 3, nu, N);
  L := Dis2(F, s, i, [1000, 200], 0.01, 1) :
  L2 := Dis2(F2, s, i, [1000, 200], 0.01, 1) :
  L3 := Dis2(F3, s, i, [1000, 200], 0.01, 1) :
  op(nops(L) - 3 ..nops(L), L); #38 Deaths
  op(nops(L2) - 3 ..nops(L2), L2); #45 deaths
  op(nops(L3) - 3 ..nops(L3), L3); #156 deaths

  #Question 1ii
   nu2 := 2;
  G := SIRS(s, i, 0.3 * nu2 / N, 3, nu2, N);
  G2 := SIRS(s, i, 0.9 * nu2 / N, 3, nu2, N);
  G3 := SIRS(s, i, 3.9 * nu2 / N, 3, nu2, N);
  P := Dis2(G, s, i, [1000, 200], 0.01, 1) :
  P2 := Dis2(G2, s, i, [1000, 200], 0.01, 1) :
  P3 := Dis2(G3, s, i, [1000, 200], 0.01, 1) :
  op(nops(P) - 3 ..nops(P), P); #38 deaths
  op(nops(P2) - 3 ..nops(P2), P2); #80 deaths
  op(nops(P3) - 3 ..nops(P3), P3); #307 deaths

   #Question 1iii
   nu3 := 3;
  A := SIRS(s, i, 0.3 * nu3 / N, 7, nu3, N);
  A2 := SIRS(s, i, 0.9 * nu3 / N, 7, nu3, N);
  A3 := SIRS(s, i, 3.9 * nu3 / N, 7, nu3, N);
  B := Dis2(A, s, i, [1000, 200], 0.01, 1) :
  B2 := Dis2(A2, s, i, [1000, 200], 0.01, 1) :
  B3 := Dis2(A3, s, i, [1000, 200], 0.01, 1) :
  op(nops(B) - 3 ..nops(B), B); #14 deaths
  op(nops(B2) - 3 ..nops(B2), B2); #45 deaths
  op(nops(B3) - 3 ..nops(B3), B3); #224 deaths
        proc(s, i, β, γ, ν, N)  [ − β * s * i + γ * (N − s − i), β * s * i − ν * i] end proc
                                        N := 1000
                                        ν := 1
          F := [ -0.0003000000000 s i + 3000 − 3 s − 3 i, 0.0003000000000 s i − i]
```

$$F2 := [-0.0009000000000\, s\, i + 3000 - 3\, s - 3\, i,\ 0.0009000000000\, s\, i - i]$$

$$F3 := [-0.003900000000\, s\, i + 3000 - 3\, s - 3\, i,\ 0.003900000000\, s\, i - i]$$

[0.98, [873.8788959, 97.87805546]], [0.99, [874.4695866, 97.15587561]], [1.00, [875.0659431, 96.43919643]], [1.01, [875.6676169, 95.72797644]]

[0.98, [798.1621275, 158.1743141]], [0.99, [798.3357956, 157.7288097]], [1.00, [798.5205724, 157.2848066]], [1.01, [798.7160546, 156.8423149]]

[0.98, [277.0085804, 570.6966052]], [0.99, [275.4119984, 571.1550655]], [1.00, [273.8801710, 571.5783302]], [1.01, [272.4112011, 571.9677618]]

$$v2 := 2$$

$$G := [-0.0006000000000\, s\, i + 3000 - 3\, s - 3\, i,\ 0.0006000000000\, s\, i - 2\, i]$$

$$G2 := [-0.001800000000\, s\, i + 3000 - 3\, s - 3\, i,\ 0.001800000000\, s\, i - 2\, i]$$

$$G3 := [-0.007800000000\, s\, i + 3000 - 3\, s - 3\, i,\ 0.007800000000\, s\, i - 2\, i]$$

[0.98, [913.3710930, 48.09333999]], [0.99, [914.2635976, 47.39503559]], [1.00, [915.1538493, 46.70712421]], [1.01, [916.0415549, 46.02944696]]

[0.98, [797.9516805, 121.5475876]], [0.99, [798.6208987, 120.8624396]], [1.00, [799.2989796, 120.1826097]], [1.01, [799.9854188, 119.5080706]]

[0.98, [222.9883628, 470.3243021]], [0.99, [224.0085888, 469.0982101]], [1.00, [225.0189866, 467.9126441]], [1.01, [226.0184778, 466.7669511]]

$$v3 := 3$$

$$A := [-0.0009000000000\, s\, i + 7000 - 7\, s - 7\, i,\ 0.0009000000000\, s\, i - 3\, i]$$

$$A2 := [-0.002700000000\, s\, i + 7000 - 7\, s - 7\, i,\ 0.002700000000\, s\, i - 3\, i]$$

$$A3 := [-0.01170000000\, s\, i + 7000 - 7\, s - 7\, i,\ 0.01170000000\, s\, i - 3\, i]$$

[0.98, [962.0577954, 23.61110356]], [0.99, [962.8565353, 23.10720767]], [1.00, [963.6388330, 22.61423177]], [1.01, [964.4049909, 22.13193239]]

[0.98, [858.5496617, 95.86786924]], [0.99, [859.5181368, 95.21413098]], [1.00, [860.4772446, 94.56734041]], [1.01, [861.4270515, 93.92739240]]

[0.98, [256.1433805, 520.1113867]], [0.99, [256.2184454, 520.0951465]], [1.00, [256.2853114, 520.0834746]], [1.01, [256.3445950, 520.0758718]] **(1)**

```
> #Question 2i
  F := RandNice([x, y], 8);
  ept := EquPts(F, [x, y]);
  pt := StEquPts(F, [x, y])[1];
  Q := Dis2(F, x, y, pt + [0.1, 0.1], 0.01, 10) : #Stable
  op(nops(Q) - 3 ..nops(Q), Q);
  Q := Dis2(F, x, y, ept[1] + [0.1, 0.1], 0.01, 10) :
  op(nops(Q) - 3 ..nops(Q), Q);

   # Question 2ii
  F := RandNice([x, y], 8);
```

```
ept2 := EquPts(F, [x, y]);
pt2 := StEquPts(F, [x, y])[1];
Q2 := Dis2(F, x, y, pt2 + [0.1, 0.1], 0.01, 10) :
op(nops(Q2) - 3 ..nops(Q2), Q2);
Q2 := Dis2(F, x, y, ept2[1] + [0.1, 0.1], 0.01, 10) :
op(nops(Q2) - 3 ..nops(Q2), Q2);

#Questionc2iii
F := RandNice([x, y], 8);
ept3 := EquPts(F, [x, y]);
pt3 := StEquPts(F, [x, y])[1];
Q3 := Dis2(F, x, y, pt3 + [0.1, 0.1], 0.01, 10) :
op(nops(Q3) - 3 ..nops(Q3), Q3);
Q3 := Dis2(F, x, y, ept3[1] + [0.1, 0.1], 0.01, 10) :
op(nops(Q3) - 3 ..nops(Q3), Q3);
```

$$F := RandNice([x, y], 8)$$

$$ept := EquPts(RandNice([x, y], 8), [x, y])$$

$$pt := StEquPts(RandNice([x, y], 8), [x, y])_1$$

$$y, StEquPts(RandNice([x, y], 8), [x, y])_1 + [0.1, 0.1], 0.01, 10$$

$$y, EquPts(RandNice([x, y], 8), [x, y])_1 + [0.1, 0.1], 0.01, 10$$

$$F := RandNice([x, y], 8)$$

$$ept2 := EquPts(RandNice([x, y], 8), [x, y])$$

$$pt2 := StEquPts(RandNice([x, y], 8), [x, y])_1$$

$$y, StEquPts(RandNice([x, y], 8), [x, y])_1 + [0.1, 0.1], 0.01, 10$$

$$y, EquPts(RandNice([x, y], 8), [x, y])_1 + [0.1, 0.1], 0.01, 10$$

$$F := RandNice([x, y], 8)$$

$$ept3 := EquPts(RandNice([x, y], 8), [x, y])$$

$$pt3 := StEquPts(RandNice([x, y], 8), [x, y])_1$$

$$y, StEquPts(RandNice([x, y], 8), [x, y])_1 + [0.1, 0.1], 0.01, 10$$

$$y, EquPts(RandNice([x, y], 8), [x, y])_1 + [0.1, 0.1], 0.01, 10 \quad \textbf{(2)}$$

(3)

```
> #Question 3
print(SIRS);
F := SIRS(s, i, beta, gamma, nu, J);
EquPts(F, [s, i]);
```

$$SIRS$$

$$F := SIRS(s, i, \beta, \gamma, \nu, J)$$

$$EquPts(SIRS(s, i, \beta, \gamma, \nu, J), [s, i]) \quad \textbf{(4)}$$

```
> #Question 4
```

```
Chemostat := proc(n, c, a1, a2)
[a1*(c/(1+c))*n-n,-c/(1+c)*n-c+a2]:
end:
C := Chemostat(n, c, a1, a2);
EquPts(C, [n, c]);
```

$$C := \left[\frac{a1\ c\ n}{c+1} - n,\ -\frac{c\ n}{c+1} - c + a2 \right]$$

$$EquPts\left(\left[\frac{a1\ c\ n}{c+1} - n,\ -\frac{c\ n}{c+1} - c + a2 \right], [n, c] \right) \quad \textbf{(5)}$$