```
> #Hrudai Battini Hw19
  read "/Users/hb334/Documents/M19.txt";
> #1
  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 people
  op(nops(L2)-3..nops(L2),L2); #45 people
  op(nops(L3)-3..nops(L3),L3); #156 people

  #ii
  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 people
  op(nops(P2)-3..nops(P2),P2); #80 people
  op(nops(P3)-3..nops(P3),P3); #307 people

  #iii
  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 people
  op(nops(B2)-3..nops(B2),B2); #45 people
  op(nops(B3)-3..nops(B3),B3); #224 people
```

proc$(s, i, \text{beta}, \text{gamma}, \text{nu}, N)$

$[-\text{beta}*s*i+\text{gamma}*(N-s-i), \text{beta}*s*i-\text{nu}*i]$

end proc

$$N := 1000$$

$$\nu := 1$$

$$F := [-0.0003000000000\, s\, i + 3000 - 3\, s - 3\, i,\ 0.0003000000000\, s\, i - i]$$

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

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

[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)**

```
> #2
  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);

  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);
```

```
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);
```

$$F := [(5-5x-2y)(6-4x-3y), (2-4x-2y)(3-7x-5y)]$$

$$ept := \left\{[-21, 30], [3, -5], \left[-\frac{3}{2}, 4\right], \left[\frac{19}{11}, -\frac{20}{11}\right]\right\}$$

$$pt := [3, -5]$$

[9.98, [2.999999983, −4.999999962]], [9.99, [2.999999983, −4.999999962]], [10.00, [2.999999983, −4.999999962]], [10.01, [2.999999983, −4.999999962]]

[9.98, [Float(∞), Float(∞)]], [9.99, [Float(∞), Float(∞)]], [10.00, [Float(∞), Float(∞)]], [10.01, [Float(∞), Float(∞)]]

$$F := [(7-5x-2y)(3-6x-y), (3-2x-y)(4-x-7y)]$$

$$ept2 := \left\{[0, 3], [1, 1], \left[\frac{17}{41}, \frac{21}{41}\right], \left[\frac{41}{33}, \frac{13}{33}\right]\right\}$$

$$pt2 := \left[\frac{17}{41}, \frac{21}{41}\right]$$

[9.98, [0.4146341461, 0.5121951224]], [9.99, [0.4146341461, 0.5121951224]], [10.00, [0.4146341461, 0.5121951224]], [10.01, [0.4146341461, 0.5121951224]]

[9.98, [Float(∞), Float(∞)]], [9.99, [Float(∞), Float(∞)]], [10.00, [Float(∞), Float(∞)]], [10.01, [Float(∞), Float(∞)]]

$$F := [(6-4x-7y)(1-2x-y), (7-7x-7y)(2-2x-5y)]$$

$$ept3 := \left\{[0, 1], \left[\frac{1}{3}, \frac{2}{3}\right], \left[\frac{3}{8}, \frac{1}{4}\right], \left[\frac{8}{3}, -\frac{2}{3}\right]\right\}$$

$$pt3 := \left[\frac{3}{8}, \frac{1}{4}\right]$$

[9.98, [0.3750000013, 0.2499999991]], [9.99, [0.3750000013, 0.2499999991]], [10.00, [0.3750000013, 0.2499999991]], [10.01, [0.3750000013, 0.2499999991]]

[9.98, [Float(∞), Float(∞)]], [9.99, [Float(∞), Float(∞)]], [10.00, [Float(∞), Float(∞)]], [10.01, [Float(∞), Float(∞)]] **(2)**

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

  EquPts(F,[s,i]); #Return for S and I and R can be derived.
```

```
proc(s, i, beta, gamma, nu, N)
    [ − beta*s*i + gamma*(N − s − i), beta*s*i − nu*i]
end proc
```

$$F := [-\beta s i + \gamma (J - s - i), \beta s i - i]$$

$$\left\{ [J, 0], \left[\frac{1}{\beta}, \frac{\gamma (J\beta - 1)}{\beta (\gamma + 1)} \right] \right\} \tag{3}$$

```
> #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]);#Dispalyed as [25b,25a].
```

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

$$\left\{ [0, a2], \left[\frac{a1\, (a2\, a1 - a2 - 1)}{a1 - 1}, \frac{1}{a1 - 1} \right] \right\} \tag{4}$$

```
>
```