```
> #Ok to post Homework
  #Jeton Hida, Assignment 19, November 8 2021
  read "/Users/jeton/Desktop/Math 336/M19.txt"
> print(SIRSdemo)
```

proc$(N, IN, \gamma, \nu, h, A)$ **(1)**

local L, β, i;

print(*This is a numerical demonstration of the R0 phenomenon in the SIRS model using discretization with mesh size=*, h, *and letting it run until time t=*, A);

print(*with population size*, N, *and fixed parameters nu=*, ν, *and gamma=*, γ);

print(*where we change beta from 0.2*nu/N to 4*nu/N*);

print(*Recall that the epidemic will persist if beta exceeds nu/N, that in this case is*, ν / N);

print(*We start with* , IN, *infected individuals, 0 removed and hence*, $N - IN$, *susceptible*);

print(*We will show what happens once time is close to*, A);

for i **by** 2 **to** 40 **do**

$\beta := 1/10 * i * \nu / N$;

print(*beta is*, $1/10 * i$, *times the threshold value*);

$L := Dis2(SIRS(s, i, \beta, \gamma, \nu, N), s, i, [N - IN, IN], h, A)$;

print(*the long-term behavior is*);

print([*op*(*nops*(L) − 3 ..*nops*(L), L)])

end do

end proc

```
> #i. nu=1, gamma=3
  SIRSdemo(1000,200,3,1,.01,10)
```

This is a numerical demonstration of the R0 phenomenon in the SIRS model using discretization with mesh size=, 0.01, *and letting it run until time t=*, 10

with population size, 1000, *and fixed parameters nu=*, 1, *and gamma=*, 3

*where we change beta from 0.2*nu/N to 4*nu/N*

Recall that the epidemic will persist if beta exceeds nu/N, that in this case is, $\frac{1}{1000}$

We start with , 200, *infected individuals, 0 removed and hence*, 800, *susceptible*

We will show what happens once time is close to, 10

beta is, $\frac{1}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [998.9666995, 0.9909989667]], [9.99, [998.9666995, 0.9909989667]], [10.00, [998.9666995, 0.9909989667]], [10.01, [998.9666995, 0.9909989667]]]

beta is, $\frac{3}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [996.7009881, 2.978970309]], [9.99, [996.7009881, 2.978970309]], [10.00, [996.7009881, 2.978970309]], [10.01, [996.7009881, 2.978970309]]]

beta is, $\frac{1}{2}$, *times the threshold value*

the long-term behavior is

[[9.98, [994.1715221, 4.974854288]], [9.99, [994.1715221, 4.974854288]], [10.00, [994.1715221, 4.974854288]], [10.01, [994.1715221, 4.974854288]]]

beta is, $\frac{7}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [991.3807432, 6.978577656]], [9.99, [991.3807432, 6.978577656]], [10.00, [991.3807432, 6.978577656]], [10.01, [991.3807432, 6.978577656]]]

beta is, $\frac{9}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [988.3315033, 8.990054852]], [9.99, [988.3315033, 8.990054852]], [10.00, [988.3315033, 8.990054852]], [10.01, [988.3315033, 8.990054852]]]

beta is, $\frac{11}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [985.0270559, 11.00918827]], [9.99, [985.0270559, 11.00918827]], [10.00, [985.0270559, 11.00918827]], [10.01, [985.0270559, 11.00918827]]]

beta is, $\frac{13}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [981.4710448, 13.03586861]], [9.99, [981.4710448, 13.03586861]], [10.00, [981.4710448, 13.03586861]], [10.01, [981.4710448, 13.03586861]]]

beta is, $\frac{3}{2}$, *times the threshold value*

the long-term behavior is

[[9.98, [977.6674922, 15.06997519]], [9.99, [977.6674922, 15.06997519]], [10.00, [977.6674922, 15.06997519]], [10.01, [977.6674922, 15.06997519]]]

beta is, $\frac{17}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [973.6207848, 17.11137641]], [9.99, [973.6207848, 17.11137641]], [10.00, [973.6207848, 17.11137641]], [10.01, [973.6207848, 17.11137641]]]

beta is, $\frac{19}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [969.3356593, 19.15993017]], [9.99, [969.3356593, 19.15993017]], [10.00, [969.3356593, 19.15993017]], [10.01, [969.3356593, 19.15993017]]]

$$beta\ is,\ \frac{21}{10},\ times\ the\ threshold\ value$$

the long-term behavior is

[[9.98, [964.8171858, 21.21548438]], [9.99, [964.8171858, 21.21548438]], [10.00, [964.8171858, 21.21548438]], [10.01, [964.8171858, 21.21548438]]]

$$beta\ is,\ \frac{23}{10},\ times\ the\ threshold\ value$$

the long-term behavior is

[[9.98, [960.0707508, 23.27787743]], [9.99, [960.0707508, 23.27787743]], [10.00, [960.0707508, 23.27787743]], [10.01, [960.0707508, 23.27787743]]]

$$beta\ is,\ \frac{5}{2},\ times\ the\ threshold\ value$$

the long-term behavior is

[[9.98, [955.1020392, 25.34693877]], [9.99, [955.1020392, 25.34693877]], [10.00, [955.1020392, 25.34693877]], [10.01, [955.1020392, 25.34693877]]]

$$beta\ is,\ \frac{27}{10},\ times\ the\ threshold\ value$$

the long-term behavior is

[[9.98, [949.9170149, 27.42248950]], [9.99, [949.9170149, 27.42248950]], [10.00, [949.9170149, 27.42248950]], [10.01, [949.9170149, 27.42248950]]]

$$beta\ is,\ \frac{29}{10},\ times\ the\ threshold\ value$$

the long-term behavior is

[[9.98, [944.5219011, 29.50434292]], [9.99, [944.5219011, 29.50434292]], [10.00, [944.5219011, 29.50434292]], [10.01, [944.5219011, 29.50434292]]]

$$beta\ is,\ \frac{31}{10},\ times\ the\ threshold\ value$$

the long-term behavior is

[[9.98, [938.9231598, 31.59230516]], [9.99, [938.9231598, 31.59230516]], [10.00, [938.9231598, 31.59230516]], [10.01, [938.9231598, 31.59230516]]]

$$beta\ is,\ \frac{33}{10},\ times\ the\ threshold\ value$$

the long-term behavior is

[[9.98, [933.1274712, 33.68617582]], [9.99, [933.1274712, 33.68617582]], [10.00, [933.1274712, 33.68617582]], [10.01, [933.1274712, 33.68617582]]]

beta is, $\frac{7}{2}$, *times the threshold value*

the long-term behavior is

[[9.98, [927.1417118, 35.78574860]], [9.99, [927.1417118, 35.78574860]], [10.00, [927.1417118, 35.78574860]], [10.01, [927.1417118, 35.78574860]]]

beta is, $\frac{37}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [920.9729335, 37.89081195]], [9.99, [920.9729335, 37.89081195]], [10.00, [920.9729335, 37.89081195]], [10.01, [920.9729335, 37.89081195]]]

beta is, $\frac{39}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [914.6283415, 40.00114971]], [9.99, [914.6283415, 40.00114971]], [10.00, [914.6283415, 40.00114971]], [10.01, [914.6283415, 40.00114971]]] **(2)**

```
> #For beta = .3*N/nu there are over 996 individuals removed, for
  beta = .9*N/nu there are over 977 individuals removed, for beta =
  3.9*N/nu there are over 927 individuals removed.
```

```
> #ii. nu = 2, gamma = 3
> SIRSdemo(1000,200,3,2,.01,10)
```

This is a numerical demonstration of the R0 phenomenon in the SIRS model using discretization with mesh size=, 0.01, *and letting it run until time t=*, 10

with population size, 1000, *and fixed parameters nu=*, 2, *and gamma=*, 3

*where we change beta from 0.2*nu/N to 4*nu/N*

Recall that the epidemic will persist if beta exceeds nu/N, that in this case is, $\frac{1}{500}$

We start with , 200, *infected individuals, 0 removed and hence*, 800, *susceptible*

We will show what happens once time is close to, 10

beta is, $\frac{1}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [998.9334028, 0.9819978668]], [9.99, [998.9334028, 0.9819978668]], [10.00, [998.9334028, 0.9819978668]], [10.01, [998.9334028, 0.9819978668]]]

beta is, $\frac{3}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [996.4021571, 2.957935239]], [9.99, [996.4021571, 2.957935239]], [10.00, [996.4021571, 2.957935239]], [10.01, [996.4021571, 2.957935239]]]

beta is, $\frac{1}{2}$, *times the threshold value*

the long-term behavior is

[[9.98, [993.3444243, 4.949667221]], [9.99, [993.3444243, 4.949667221]], [10.00, [993.3444243, 4.949667221]], [10.01, [993.3444243, 4.949667221]]]

beta is, $\frac{7}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [989.7667603, 6.956997143]], [9.99, [989.7667603, 6.956997143]], [10.00, [989.7667603, 6.956997143]], [10.01, [989.7667603, 6.956997143]]]

beta is, $\frac{9}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [985.6773407, 8.979679729]], [9.99, [985.6773407, 8.979679729]], [10.00, [985.6773407, 8.979679729]], [10.01, [985.6773407, 8.979679729]]]

beta is, $\frac{11}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [981.0859054, 11.01742279]], [9.99, [981.0859054, 11.01742279]], [10.00, [981.0859054, 11.01742279]], [10.01, [981.0859054, 11.01742279]]]

beta is, $\frac{13}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [976.0036901, 13.06988925]], [9.99, [976.0036901, 13.06988925]], [10.00, [976.0036901, 13.06988925]], [10.01, [976.0036901, 13.06988925]]]

beta is, $\frac{3}{2}$, *times the threshold value*

the long-term behavior is

[[9.98, [970.4433482, 15.13669951]], [9.99, [970.4433482, 15.13669951]], [10.00, [970.4433482, 15.13669951]], [10.01, [970.4433482, 15.13669951]]]

beta is, $\frac{17}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [964.4188616, 17.21743410]], [9.99, [964.4188616, 17.21743410]], [10.00, [964.4188616, 17.21743410]], [10.01, [964.4188616, 17.21743410]]]

beta is, $\frac{19}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [957.9454447, 19.31163661]], [9.99, [957.9454447, 19.31163661]], [10.00, [957.9454447, 19.31163661]], [10.01, [957.9454447, 19.31163661]]]

beta is, $\frac{21}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [951.0394389, 21.41881679]], [9.99, [951.0394389, 21.41881679]], [10.00, [951.0394389, 21.41881679]], [10.01, [951.0394389, 21.41881679]]]

beta is, $\frac{23}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [943.7182031, 23.53845386]], [9.99, [943.7182031, 23.53845386]], [10.00, [943.7182031, 23.53845386]], [10.01, [943.7182031, 23.53845386]]]

beta is, $\frac{5}{2}$, *times the threshold value*

the long-term behavior is

[[9.98, [935.9999984, 25.67000000]], [9.99, [935.9999984, 25.67000000]], [10.00, [935.9999984, 25.67000000]], [10.01, [935.9999984, 25.67000000]]]

beta is, $\frac{27}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [927.9038703, 27.81288384]], [9.99, [927.9038703, 27.81288384]], [10.00, [927.9038703, 27.81288384]], [10.01, [927.9038703, 27.81288384]]]

beta is, $\frac{29}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [919.4495282, 29.96651411]], [9.99, [919.4495282, 29.96651411]], [10.00, [919.4495282, 29.96651411]], [10.01, [919.4495282, 29.96651411]]]

beta is, $\frac{31}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [910.6572255, 32.13028319]], [9.99, [910.6572255, 32.13028319]], [10.00, [910.6572255, 32.13028319]], [10.01, [910.6572255, 32.13028319]]]

beta is, $\frac{33}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [901.5476397, 34.30357076]], [9.99, [901.5476397, 34.30357076]], [10.00, [901.5476397, 34.30357076]], [10.01, [901.5476397, 34.30357076]]]

beta is, $\frac{7}{2}$, *times the threshold value*

the long-term behavior is

[[9.98, [892.1417551, 36.48574730]], [9.99, [892.1417551, 36.48574730]], [10.00, [892.1417551, 36.48574730]], [10.01, [892.1417551, 36.48574730]]]

beta is, $\frac{37}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [882.4607475, 38.67617753]], [9.99, [882.4607475, 38.67617753]], [10.00,
[882.4607475, 38.67617753]], [10.01, [882.4607475, 38.67617753]]]

beta is, $\frac{39}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [872.5258747, 40.87422371]], [9.99, [872.5258747, 40.87422371]], [10.00, **(3)**
[872.5258747, 40.87422371]], [10.01, [872.5258747, 40.87422371]]]

```
> #For beta = .3*N/nu there are over 996 individuals removed, for
  beta = .9*N/nu there are over 970 individuals removed, for beta =
  3.9*N/nu there are over 882 individuals removed.
```

```
> #iii. nu=3, gamma=7
> SIRSdemo(1000,200,7,3,.01,10)
```

This is a numerical demonstration of the R0 phenomenon in the SIRS model using discretization with mesh size=, 0.01, *and letting it run until time t=*, 10

with population size, 1000, *and fixed parameters nu=*, 3, *and gamma=*, 7

*where we change beta from 0.2*nu/N to 4*nu/N*

Recall that the epidemic will persist if beta exceeds nu/N, that in this case is, $\frac{3}{1000}$

We start with , 200, *infected individuals, 0 removed and hence*, 800, *susceptible*

We will show what happens once time is close to, 10

beta is, $\frac{1}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [998.9571869, 0.9729968716]], [9.99, [998.9571869, 0.9729968716]], [10.00,
[998.9571869, 0.9729968716]], [10.01, [998.9571869, 0.9729968716]]]

beta is, $\frac{3}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [996.6155905, 2.936908621]], [9.99, [996.6155905, 2.936908621]], [10.00,
[996.6155905, 2.936908621]], [10.01, [996.6155905, 2.936908621]]]

beta is, $\frac{1}{2}$, *times the threshold value*

the long-term behavior is

[[9.98, [993.9350689, 4.924545130]], [9.99, [993.9350689, 4.924545130]], [10.00,
[993.9350689, 4.924545130]], [10.01, [993.9350689, 4.924545130]]]

beta is, $\frac{7}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [990.9190693, 6.935665103]], [9.99, [990.9190693, 6.935665103]], [10.00, [990.9190693, 6.935665103]], [10.01, [990.9190693, 6.935665103]]]

beta is, $\frac{9}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [987.5717147, 8.969979927]], [9.99, [987.5717147, 8.969979927]], [10.00, [987.5717147, 8.969979927]], [10.01, [987.5717147, 8.969979927]]]

beta is, $\frac{11}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [983.8977865, 11.02715490]], [9.99, [983.8977865, 11.02715490]], [10.00, [983.8977865, 11.02715490]], [10.01, [983.8977865, 11.02715490]]]

beta is, $\frac{13}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [979.9027040, 13.10681067]], [9.99, [979.9027040, 13.10681067]], [10.00, [979.9027040, 13.10681067]], [10.01, [979.9027040, 13.10681067]]]

beta is, $\frac{3}{2}$, *times the threshold value*

the long-term behavior is

[[9.98, [975.5925002, 15.20852494]], [9.99, [975.5925002, 15.20852494]], [10.00, [975.5925002, 15.20852494]], [10.01, [975.5925002, 15.20852494]]]

beta is, $\frac{17}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [970.9737953, 17.33183428]], [9.99, [970.9737953, 17.33183428]], [10.00, [970.9737953, 17.33183428]], [10.01, [970.9737953, 17.33183428]]]

beta is, $\frac{19}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [966.0537675, 19.47623623]], [9.99, [966.0537675, 19.47623623]], [10.00, [966.0537675, 19.47623623]], [10.01, [966.0537675, 19.47623623]]]

beta is, $\frac{21}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [960.8401210, 21.64119148]], [9.99, [960.8401210, 21.64119148]], [10.00, [960.8401210, 21.64119148]], [10.01, [960.8401210, 21.64119148]]]

beta is, $\frac{23}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [955.3410529, 23.82612625]], [9.99, [955.3410529, 23.82612625]], [10.00, [955.3410529, 23.82612625]], [10.01, [955.3410529, 23.82612625]]]

beta is, $\frac{5}{2}$, *times the threshold value*

the long-term behavior is

[[9.98, [949.5652167, 26.03043478]], [9.99, [949.5652167, 26.03043478]], [10.00, [949.5652167, 26.03043478]], [10.01, [949.5652167, 26.03043478]]]

beta is, $\frac{27}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [943.5216861, 28.25348193]], [9.99, [943.5216861, 28.25348193]], [10.00, [943.5216861, 28.25348193]], [10.01, [943.5216861, 28.25348193]]]

beta is, $\frac{29}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [937.2199158, 30.49460585]], [9.99, [937.2199158, 30.49460585]], [10.00, [937.2199158, 30.49460585]], [10.01, [937.2199158, 30.49460585]]]

beta is, $\frac{31}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [930.6697029, 32.75312075]], [9.99, [930.6697029, 32.75312075]], [10.00, [930.6697029, 32.75312075]], [10.01, [930.6697029, 32.75312075]]]

beta is, $\frac{33}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [923.8811464, 35.02831970]], [9.99, [923.8811464, 35.02831970]], [10.00, [923.8811464, 35.02831970]], [10.01, [923.8811464, 35.02831970]]]

beta is, $\frac{7}{2}$, *times the threshold value*

the long-term behavior is

[[9.98, [916.8646074, 37.31947743]], [9.99, [916.8646074, 37.31947743]], [10.00, [916.8646074, 37.31947743]], [10.01, [916.8646074, 37.31947743]]]

beta is, $\frac{37}{10}$, *times the threshold value*

the long-term behavior is

$[[9.98, [909.6306685, 39.62585316]], [9.99, [909.6306685, 39.62585316]], [10.00, [909.6306685, 39.62585316]], [10.01, [909.6306685, 39.62585316]]]$

beta is, $\frac{39}{10}$, *times the threshold value*

the long-term behavior is

$[[9.98, [902.1900937, 41.94669340]], [9.99, [902.1900937, 41.94669340]], [10.00, [902.1900937, 41.94669340]], [10.01, [902.1900937, 41.94669340]]]$ **(4)**

```
> #For beta = .3*N/nu there are over 996 individuals removed, for
  beta = .9*N/nu there are over 975 individuals removed, for beta =
  3.9*N/nu there are over 909 individuals removed.
> #Number 2
> F:=RandNice([x,y],8)
```

$F := [(5-3x-8y)(1-8x-5y), (2-3x-2y)(2-4x-8y)]$ **(5)**

```
> EquPts(F,[x,y])
```

$\left\{[-8, 13], \left[-3, \frac{7}{4}\right], \left[-\frac{1}{22}, \frac{3}{11}\right], \left[\frac{1}{3}, \frac{1}{2}\right]\right\}$ **(6)**

```
> evalf(StEquPts(F,[x,y]))
```

$\{[-0.04545454545, 0.2727272727]\}$ **(7)**

```
> Dis2(F,x,y,[-1/22+.1,3/11+.1],.01,10):
> op(nops(%)-3..nops(%),%)
```

$[9.98, [-0.04545454593, 0.2727272734]], [9.99, [-0.04545454593, 0.2727272734]], [10.00, [-0.04545454593, 0.2727272734]], [10.01, [-0.04545454593, 0.2727272734]]$ **(8)**

```
> Dis2(F,x,y,[-8+.1,13+.1],.01,10):
> op(nops(%)-3..nops(%),%)
```

$[9.98, [\text{Float}(\infty), \text{Float}(\infty)]], [9.99, [\text{Float}(\infty), \text{Float}(\infty)]], [10.00, [\text{Float}(\infty), \text{Float}(\infty)]], [10.01, [\text{Float}(\infty), \text{Float}(\infty)]]$ **(9)**

```
> Dis2(F,x,y,[-3+.1,7/4+.1],.01,10):
> op(nops(%)-3..nops(%),%)
```

$[9.98, [\text{Float}(\infty), \text{Float}(\infty)]], [9.99, [\text{Float}(\infty), \text{Float}(\infty)]], [10.00, [\text{Float}(\infty), \text{Float}(\infty)]], [10.01, [\text{Float}(\infty), \text{Float}(\infty)]]$ **(10)**

```
> Dis2(F,x,y,[1/3+.1,1/2+.1],.01,10):
> op(nops(%)-3..nops(%),%)
```

$[9.98, [\text{Float}(\infty), \text{Float}(\infty)]], [9.99, [\text{Float}(\infty), \text{Float}(\infty)]], [10.00, [\text{Float}(\infty), \text{Float}(\infty)]], [10.01, [\text{Float}(\infty), \text{Float}(\infty)]]$ **(11)**

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

$F := [(5-4x-5y)(6-2x-3y), (7-8x-2y)(6-4x-y)]$ **(12)**

```
> EquPts(F,[x,y])
```

$\left\{\left[\frac{6}{5}, \frac{6}{5}\right], \left[\frac{9}{20}, \frac{17}{10}\right], \left[\frac{25}{16}, -\frac{1}{4}\right], \left[\frac{25}{32}, \frac{3}{8}\right]\right\}$ **(13)**

```
> evalf(StEquPts(F,[x,y]))
```

$\{[1.562500000, -0.2500000000]\}$ **(14)**

```
> Dis2(F,x,y,[25/16+.1,1/4+.1],.01,10):
> op(nops(%)-3..nops(%),%)
```

(15)

$[9.98, [1.562500001, -0.2500000031]], [9.99, [1.562500001, -0.2500000031]], [10.00, [1.562500001, -0.2500000031]], [10.01, [1.562500001, -0.2500000031]]$ **(15)**

```
> Dis2(F,x,y,[6/5+.1,6/5+.1],.01,10):
> op(nops(%)-3..nops(%),%)
```

[9.98, [Float(∞), Float(∞)]], [9.99, [Float(∞), Float(∞)]], [10.00, [Float(∞), Float(∞)]], [10.01, [Float(∞), Float(∞)]] **(16)**

```
> Dis2(F,x,y,[9/20+.1,17/10+.1],.01,10):
> op(nops(%)-3..nops(%),%)
```

[9.98, [Float(∞), Float(∞)]], [9.99, [Float(∞), Float(∞)]], [10.00, [Float(∞), Float(∞)]], [10.01, [Float(∞), Float(∞)]] **(17)**

```
> Dis2(F,x,y,[25/32+.1,3/8+.1],.01,10):
> op(nops(%)-3..nops(%),%)
```

[9.98, [Float(∞), Float(∞)]], [9.99, [Float(∞), Float(∞)]], [10.00, [Float(∞), Float(∞)]], [10.01, [Float(∞), Float(∞)]] **(18)**

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

$$F := [(5-3x-8y)(1-6x-5y), (6-7x-4y)(7-3x-6y)]$$ **(19)**

```
> EquPts(F,[x,y])
```

$$\left\{\left[-\frac{29}{21}, \frac{13}{7}\right], \left[\frac{7}{11}, \frac{17}{44}\right], \left[\frac{13}{3}, -1\right], \left[\frac{26}{11}, -\frac{29}{11}\right]\right\}$$ **(20)**

```
> StEquPts(F,[x,y])
```

$$\varnothing$$ **(21)**

```
> Dis2(F,x,y,[-29/21+.1,13/7+.1],.01,10):
> op(nops(%)-3..nops(%),%)
```

[9.98, [Float(∞), Float(∞)]], [9.99, [Float(∞), Float(∞)]], [10.00, [Float(∞), Float(∞)]], [10.01, [Float(∞), Float(∞)]] **(22)**

```
> Dis2(F,x,y,[7/11+.1,17/44+.1],.01,10):
> op(nops(%)-3..nops(%),%)
```

[9.98, [Float(∞), Float(∞)]], [9.99, [Float(∞), Float(∞)]], [10.00, [Float(∞), Float(∞)]], [10.01, [Float(∞), Float(∞)]] **(23)**

```
> Dis2(F,x,y,[13/3+.1,-1+.1],.01,10):
> op(nops(%)-3..nops(%),%)
```

[9.98, [Float(∞), Float(∞)]], [9.99, [Float(∞), Float(∞)]], [10.00, [Float(∞), Float(∞)]], [10.01, [Float(∞), Float(∞)]] **(24)**

```
> Dis2(F,x,y,[26/11+.1,-29/11+.1],.01,10):
> op(nops(%)-3..nops(%),%)
```

[9.98, [Float(∞), Float(∞)]], [9.99, [Float(∞), Float(∞)]], [10.00, [Float(∞), Float(∞)]], [10.01, [Float(∞), Float(∞)]] **(25)**

```
> #Number 3
> F:=SIRS(s,i,beta,gamma,nu,N)
```

$$F := [-\beta s i + \gamma (N - s - i), \beta s i - \nu i]$$ **(26)**

```
> EquPts(F,[s,i])
```

$$\left\{[N, 0], \left[\frac{\nu}{\beta}, \frac{\gamma (N\beta - \nu)}{\beta (\gamma + \nu)}\right]\right\}$$ **(27)**

```
> #Confirms Equations (29a)&(29b) in Edelstein-Keshet's book.
> #Number 4
> print(SIRS)
```

$$\mathbf{proc}(s, i, \beta, \gamma, \nu, N)\ \ [-\beta * s * i + \gamma * (N - s - i), \beta * s * i - \nu * i]\ \mathbf{end\ proc} \qquad (28)$$

```
> Chemostat:=proc(N,C,a1,a2):
  [a1*(C/(1+C))*N-N,-(C/(1+C))*N-C+a2]
  end
```

$$Chemostat := \mathbf{proc}(N, C, a1, a2) \qquad (29)$$

$$[a1 * C * N / (C + 1) - N, - C * N / (C + 1) - C + a2]$$

end proc

```
> F:=Chemostat(N,C,a1,a2)
```

$$F := \left[\frac{a1\, C\, N}{C + 1} - N, - \frac{C\, N}{C + 1} - C + a2 \right] \qquad (30)$$

```
> EquPts(F,[N,C])
```

$$\left\{ [0, a2], \left[\frac{a1\, (a2\, a1 - a2 - 1)}{a1 - 1}, \frac{1}{a1 - 1} \right] \right\} \qquad (31)$$

```
> #Confirmed Equations (25a)&(25b) in Edelstein-Keshet's book.
```