

1.) $\frac{dx}{dt} = x - y$, $\frac{dy}{dt} = y - x$, $x(0) = 1$, $y(0) = 1$

To find SS:

$$\begin{cases} 0 = x - y \\ 0 = y - x \end{cases} \Rightarrow \text{SS: } (x, x)$$

$$\frac{dx}{dt} + \frac{dy}{dt} = x - y + y - x \Rightarrow \frac{d(x+y)}{dt} = 0$$

$$x + y = \int dt \Rightarrow x + y = C \text{ for } C \in \mathbb{R}$$

$$x(0) + y(0) = 1 + 1 = 2 = C$$

$$\Rightarrow y(t) = -x(t) + 2$$

$$\frac{dx}{dt} = x + x - 2 = 2x(t) - 2 = 2(x - 1)$$

$$\int \frac{1}{x-1} dx = \int 2 dt \Rightarrow \ln|x-1| = 2t + C_1$$

$$x - 1 = e^{2t+C_1} \Rightarrow x = C_1 e^{2t} + 1$$

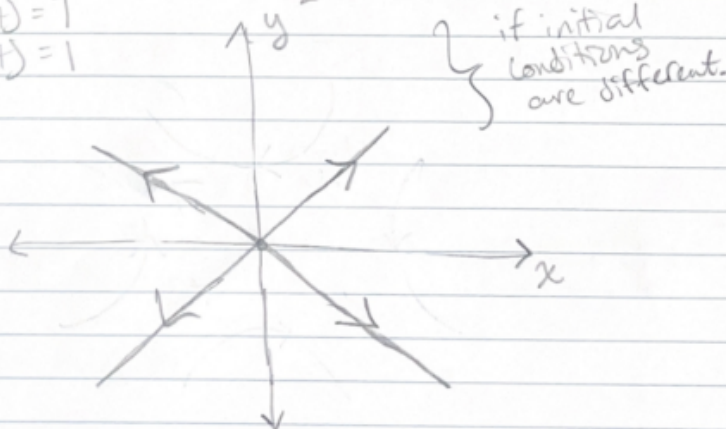
$$x(0) = C_1 e^{2 \cdot 0} + 1 = 1 \Rightarrow C_1 = 0, x(t) = 1$$

$$\frac{dy}{dt} = y + y - 2 = 2(y - 1) \Rightarrow y(t) = C_2 e^{2t} + 1$$

$$y(0) = C_2 e^{2 \cdot 0} + 1 = 1 \Rightarrow C_2 = 0$$

$$\Rightarrow x(t) = 1$$

$$\Rightarrow y(t) = 1$$



1.

2.) $x(t) = \frac{1}{2} + \frac{e^{2t}}{2}$, $y(t) = -\frac{e^{2t}}{2} + \frac{1}{2}$

The initial conditions are different,
so I got different equations.

2.

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3. A := RandomMatrix(2, 2);
S := dsolve({diff(x(t), t) = A[1, 1]*x(t) + A[1, 2]*y(t), diff(y(t), t) = A[2, 1]*y(t) + A[2, 2]*x(t), x(0) = 1,
y(0) = 1}, {x(t), y(t)});
plot([subs(S, x(t)), subs(S, y(t)), t = 0 .. 10]);

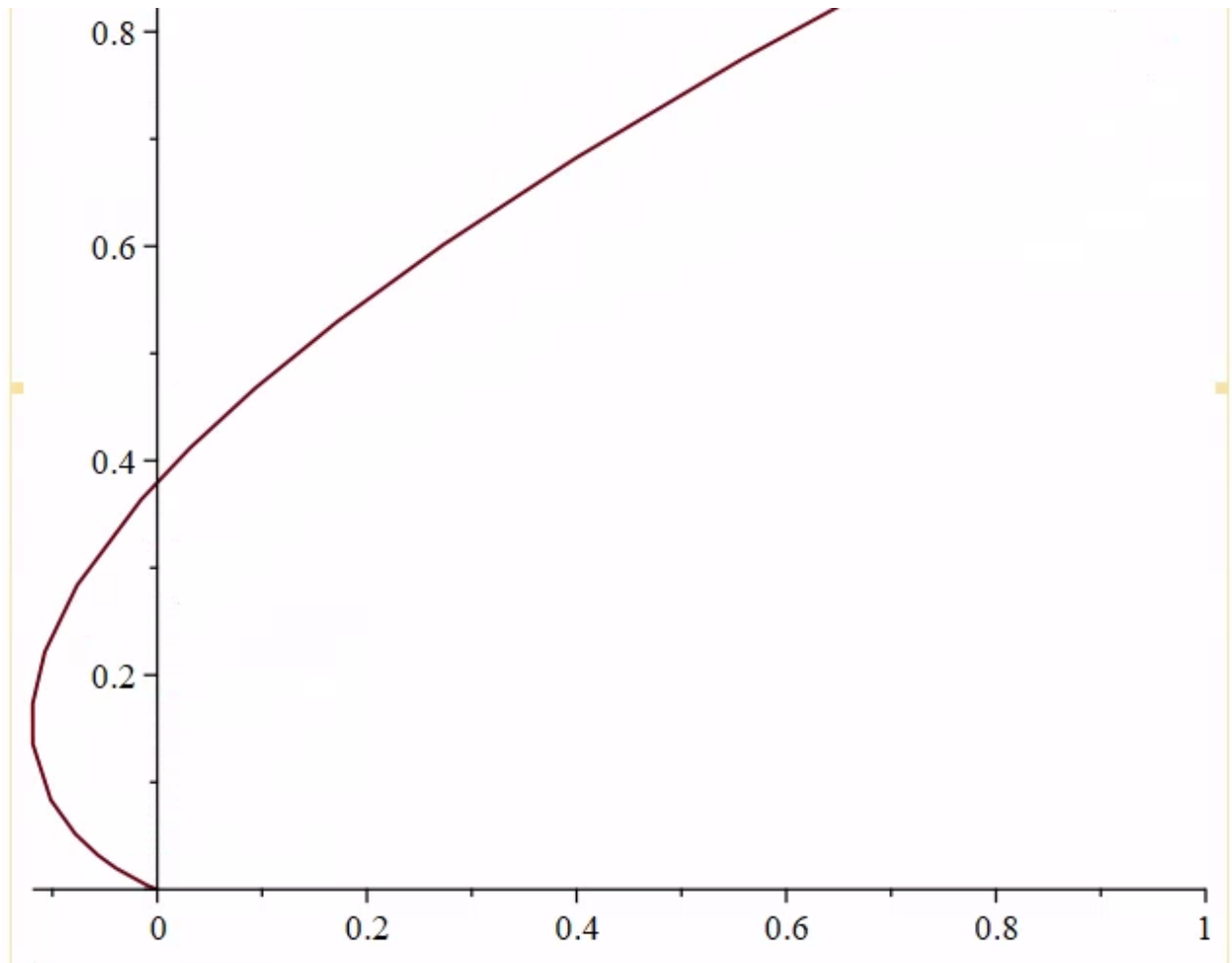
```

```
Matrix( [[-93, -72], [-76, -2]])
```

```

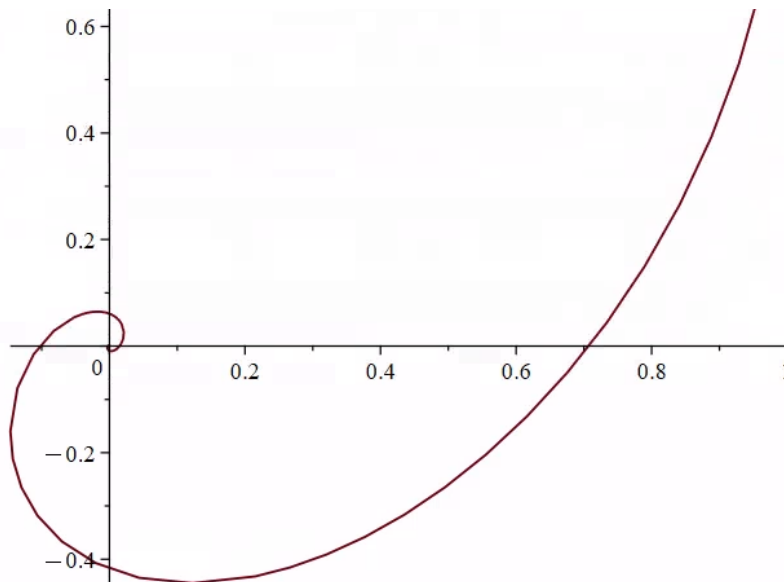
S := {x(t) = (1/2 - (161*sqrt(865))/1730)*exp((-169 + sqrt(865))*t/2) + (1/2 +
(161*sqrt(865))/1730)*exp(-((169 + sqrt(865))*t/2), y(t) = -((1/2 -
(161*sqrt(865))/1730)*exp((-169 + sqrt(865))*t/2)*sqrt(865))/144 + ((1/2 +
(161*sqrt(865))/1730)*exp(-((169 + sqrt(865))*t/2)*sqrt(865))/144 - 17*(1/2 -
(161*sqrt(865))/1730)*exp((-169 + sqrt(865))*t/2)/144 - 17*(1/2 +
(161*sqrt(865))/1730)*exp(-((169 + sqrt(865))*t/2)/144}

```



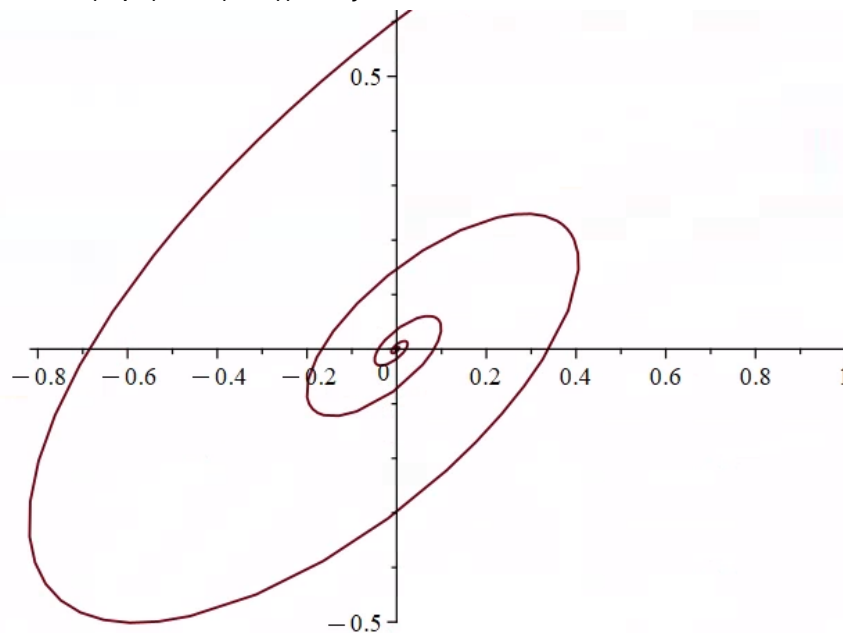
```
Matrix(2, 2, [[-50, 45], [-22, -81]])
```

$S := \{x(t) = \exp(-36*t)*((31*\sqrt{3449}*\sin(\sqrt{3449}*t))/3449 + \cos(\sqrt{3449}*t)), y(t) = -\exp(-36*t)*((3015*\sqrt{3449}*\sin(\sqrt{3449}*t))/3449 - 45*\cos(\sqrt{3449}*t))/45\}$



Matrix(2, 2, [[31, -80], [-50, 43]])

$S := \{x(t) = \exp(-(19*t)/2)*(-(79*\sqrt{7199}*\sin(\sqrt{7199}*t/2))/7199 + \cos(\sqrt{7199}*t/2)), y(t) = \exp(-(19*t)/2)*((800*\sqrt{7199}*\sin(\sqrt{7199}*t/2))/7199 + 160*\cos(\sqrt{7199}*t/2))/160\}$



4. $A := \text{RandomMatrix}(2, 2); F := \text{Volterra}(A[1, 1], A[1, 2], A[2, 1], A[2, 2], x, y);$

```
local(D):-1; D := Dis(F, [x, y], [5, 6], 0.01, 10)[-1]; plot([subs(D[2], x(t)), subs(D[3], y(t)), t = 0 .. 10]);
```

```
F := [-82 x y + 52 x, 72 x y + 13 y]
```

```
D := [10.01, [Float(infinity), -Float(infinity)]]
```

Error, invalid input: subs received [Float(infinity), Float(-infinity)], which is not valid for its 1st argument

```
A := RandomMatrix(2, 2);
F := Volterra(A[1, 1], A[1, 2], A[2, 1], A[2, 2], x, y);
_local(D):-1; D := Dis(F, [x, y], [5, 6], 0.01, 10)[-1];
plot([subs(D[2], x(t)), subs(D[3], y(t)), t = 0 .. 10]);
```

```
F := [32 x y + 29 x, -x y - 70 y]
```

```
D := [10.01, [-Float(infinity), Float(infinity)]]
```

Error, invalid input: subs received [Float(-infinity), Float(infinity)], which is not valid for its 1st argument

```
A := RandomMatrix(2, 2);
F := Volterra(A[1, 1], A[1, 2], A[2, 1], A[2, 2], x, y);
_local(D):-1; D := Dis(F, [x, y], [5, 6], 0.01, 10)[-1];
plot([subs(D[2], x(t)), subs(D[3], y(t)), t = 0 .. 10]);
F := [-41 x y - 82 x, 91 x y + 70 y]
```

```
D := [10.01, [Float(infinity), -Float(infinity)]]
```

Error, invalid input: subs received [Float(infinity), Float(-infinity)], which is not valid for its 1st argument
NULL;

```
A := RandomMatrix(2, 3);
F := Lotka(A[1, 1], A[1, 2], A[1, 3], A[2, 1], A[2, 2], A[2, 3], N1, N2);
_local(D):-1; D := Dis(F, [N1, N2], [5, 6], 0.01, 10)[-1];
plot([subs(D[2], x(t)), subs(D[3], y(t)), t = 0 .. 10]);
[ 5          38          ]
F := [- -- N1 (-44 - N1 + 38 N2), -- N2 (-91 - N2 - 91 N1)]
[ 44          91          ]
```

```
D := [10.01, [Float(undefined), Float(undefined)]]
```

```
A := RandomMatrix(2, 3);
```

```

F := Lotka(A[1, 1], A[1, 2], A[1, 3], A[2, 1], A[2, 2], A[2, 3], N1, N2);
_local(D);-1;D := Dis(F, [N1, N2], [5, 6], 0.01, 10)[-1];
plot([subs(D[2], x(t)), subs(D[3], y(t)), t = 0 .. 10]);
[ 5 78 ]
F := [- -- N1 (-26 - N1 + 20 N2), -- N2 (-61 - N2 + 4 N1)]
[ 13 61 ]

D := [10.01, [Float(infinity), -Float(infinity)]]

```

```

A := RandomMatrix(2, 3);
F := Lotka(A[1, 1], A[1, 2], A[1, 3], A[2, 1], A[2, 2], A[2, 3], N1, N2);
_local(D);-1;D := Dis(F, [N1, N2], [5, 6], 0.01, 10)[-1];
plot([subs(D[2], x(t)), subs(D[3], y(t)), t = 0 .. 10]);
[ 62 95 ]
F := [- -- N1 (9 - N1 - 88 N2), -- N2 (-83 - N2 - 63 N1)]
[ 9 83 ]

D := [10.01, [Float(infinity), Float(infinity)]]

```

```

F := VolterraM(2, 6, 19, 12, 1, x, y);
_local(D);-1;D := Dis(F, [x, y], [5, 6], 0.01, 10)[-1];
plot([subs(F[1], x(t)), subs(F[2], y(t)), t = 0 .. 10]);
[ / 1 \ ]
F := [2 x |1 - -- x| - 6 x y, x y - 19 y]
[ \ 12 / ]

[ [ -41]]
D := [10.01, [11.999999942, 4.490655983 10 ]]

```

```

F := VolterraM(5, 6, 13, 25, 0.3, x, y);
_local(D);-1;D := Dis(F, [x, y], [5, 6], 0.01, 10)[-1];
plot([subs(F[1], x(t)), subs(F[2], y(t)), t = 0 .. 10]);
[ / 1 \ ]
F := [5 x |1 - -- x| - 6 x y, -13 y + 0.3 x y]
[ \ 25 / ]

[ [ -28]]
D := [10.01, [24.999999990, 6.342716098 10 ]]

```

```

F := VolterraM(5, 7, 43, 5, 3, x, y);

```

```

_local(D);-1;D := Dis(F, [x, y], [5, 6], 0.01, 10)[-1];
plot([subs(F[1], x(t)), subs(F[2], y(t)), t = 0 .. 10]);
      [ / 1 \
      F := [5 x |1 - - x| - 7 x y, 3 x y - 43 y]
      [ \ 5 /
      [ [ -145]]
D := [10.01, [4.9999999990, 2.157473629 10  ]]]

```