```
> restart;
  with(plots):
  xp:=y;
  yp:=-x-mu*(1-x^2)*y;
```

$$xp := y$$

$$yp := -x - \mu\left(-x^2 + 1\right) y \qquad (1)$$

```
> mu:=0.1:
  rho:=2:
  ode:=dsolve({diff(x(t),t)=subs(x=x(t),y=y(t),xp),diff(y(t),t)=
  subs(x=x(t),y=y(t),yp),x(0)=rho,y(0)=0},numeric,output=
  listprocedure);
```

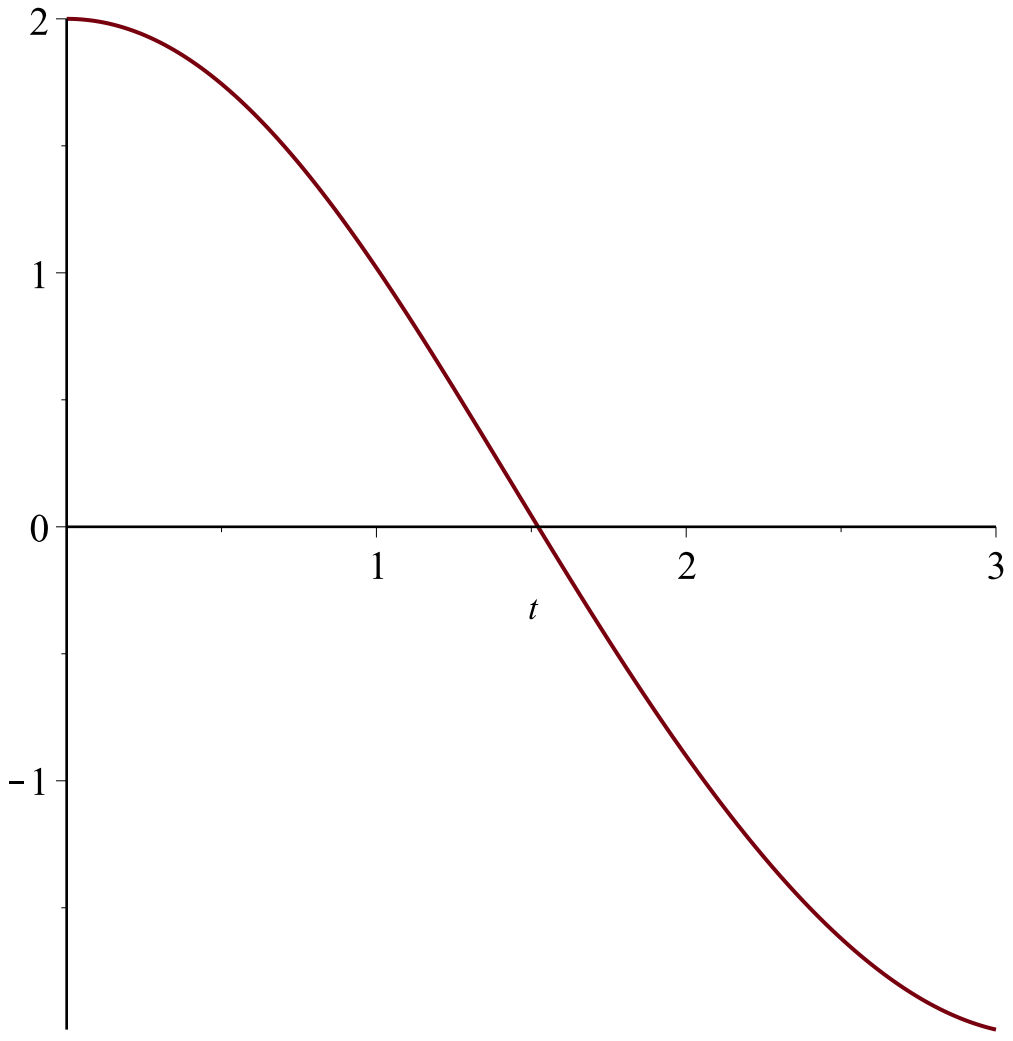
$$ode := [t = \mathbf{proc}(t) \ \ldots \ \mathbf{end\ proc}, x(t) = \mathbf{proc}(t) \ \ldots \ \mathbf{end\ proc}, y(t) = \mathbf{proc}(t) \ \ldots \ \mathbf{end\ proc}] \qquad (2)$$

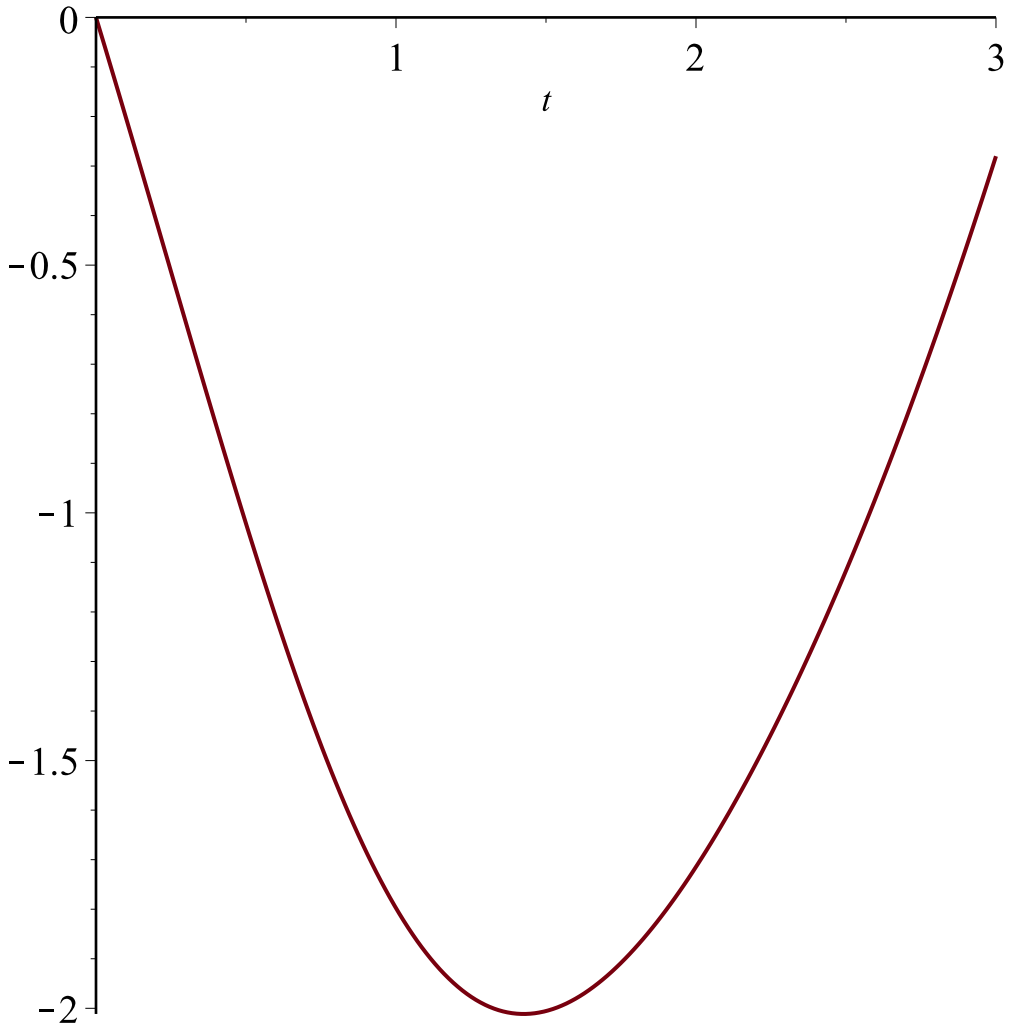
```
> xt:=eval(x(t),ode);
  yt:=eval(y(t),ode);
```

$$xt := \mathbf{proc}(t) \ \ldots \ \mathbf{end\ proc}$$

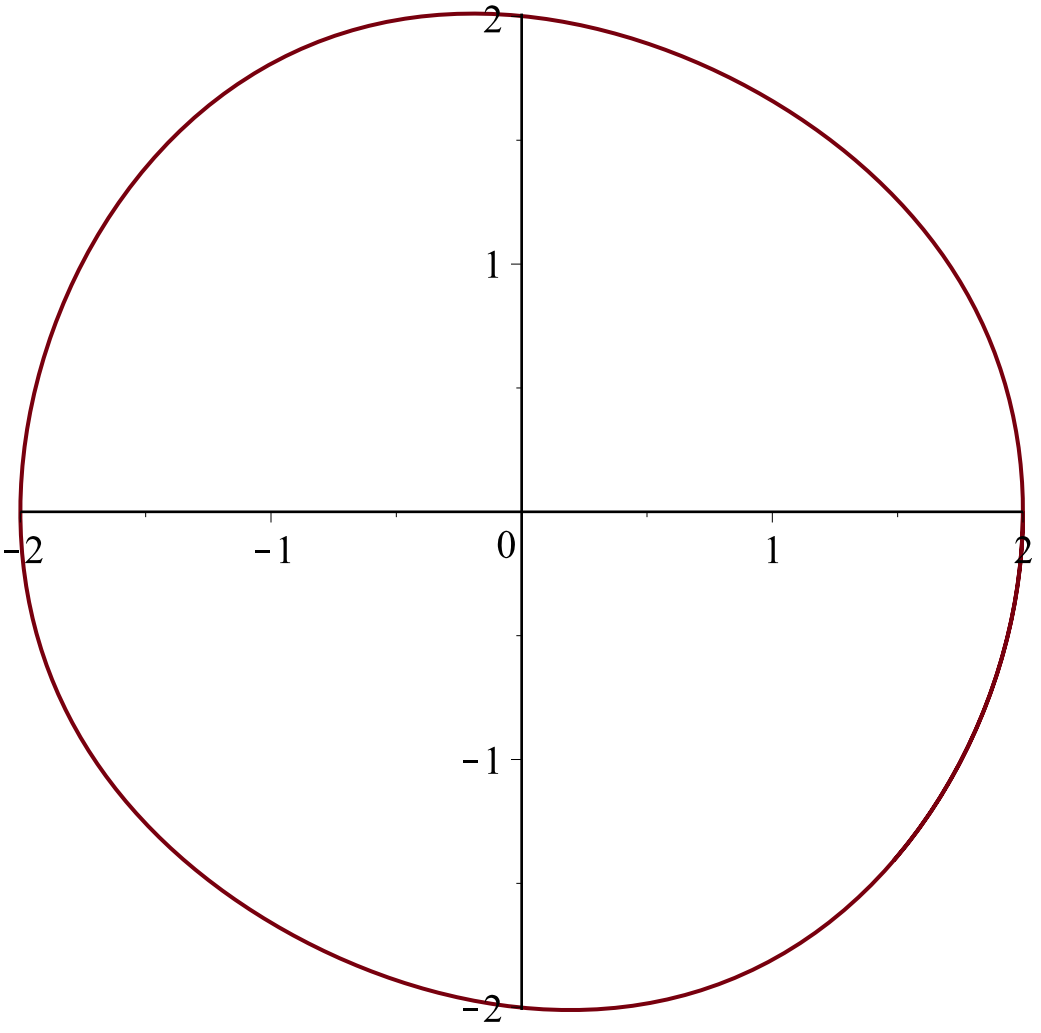
$$yt := \mathbf{proc}(t) \ \ldots \ \mathbf{end\ proc} \qquad (3)$$

```
> plot(xt(t),t=0..3);
  plot(yt(t),t=0..3);
```





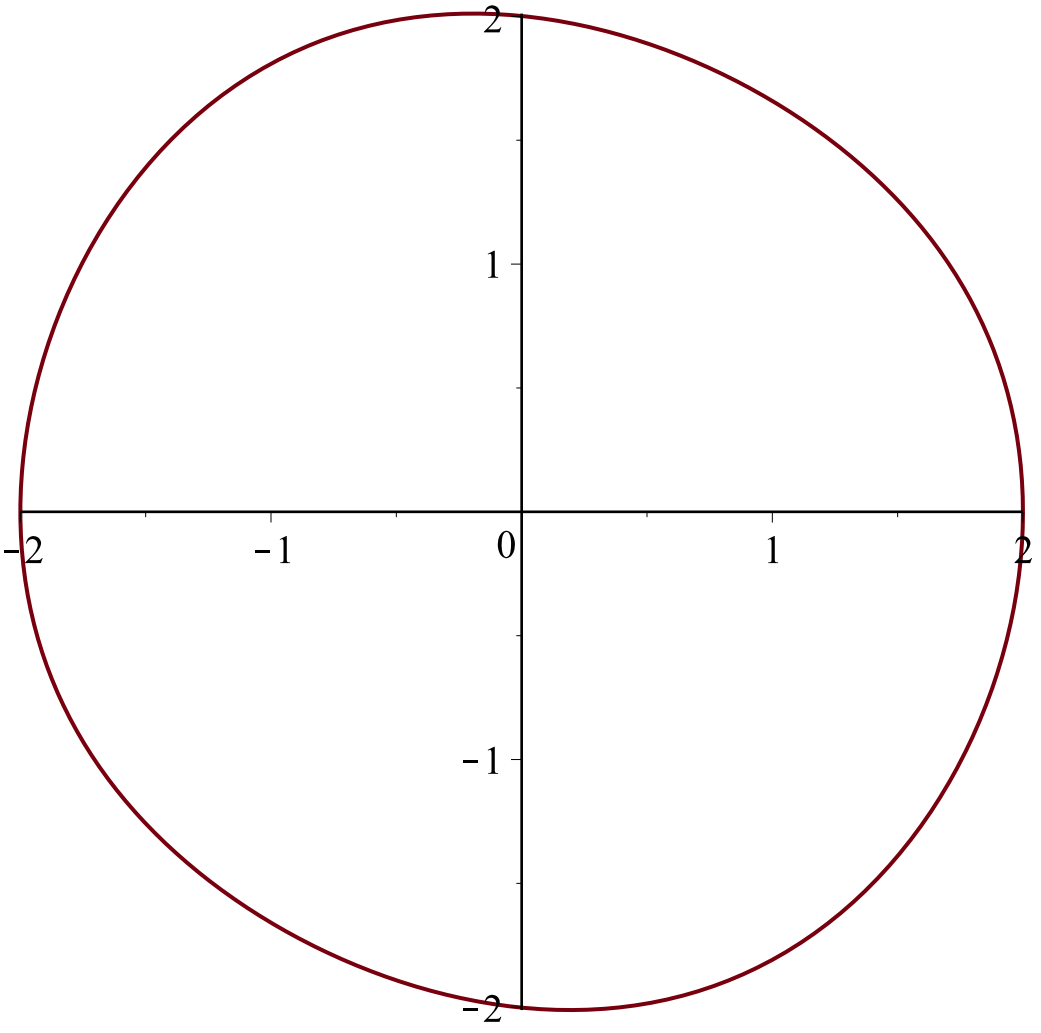

```
> plot([xt(t),yt(t),t=0..7]);
```




```
> T:=fsolve(yt(t),t=6..7);
```

$$T := 6.287099726 \tag{4}$$

```
> plot([xt(t),yt(t),t=0..T]);
```




```
> xt(T);
  yt(T);
```

$$1.99990995133099$$

$$-2.41623247018014\ 10^{-10} \qquad (5)$$

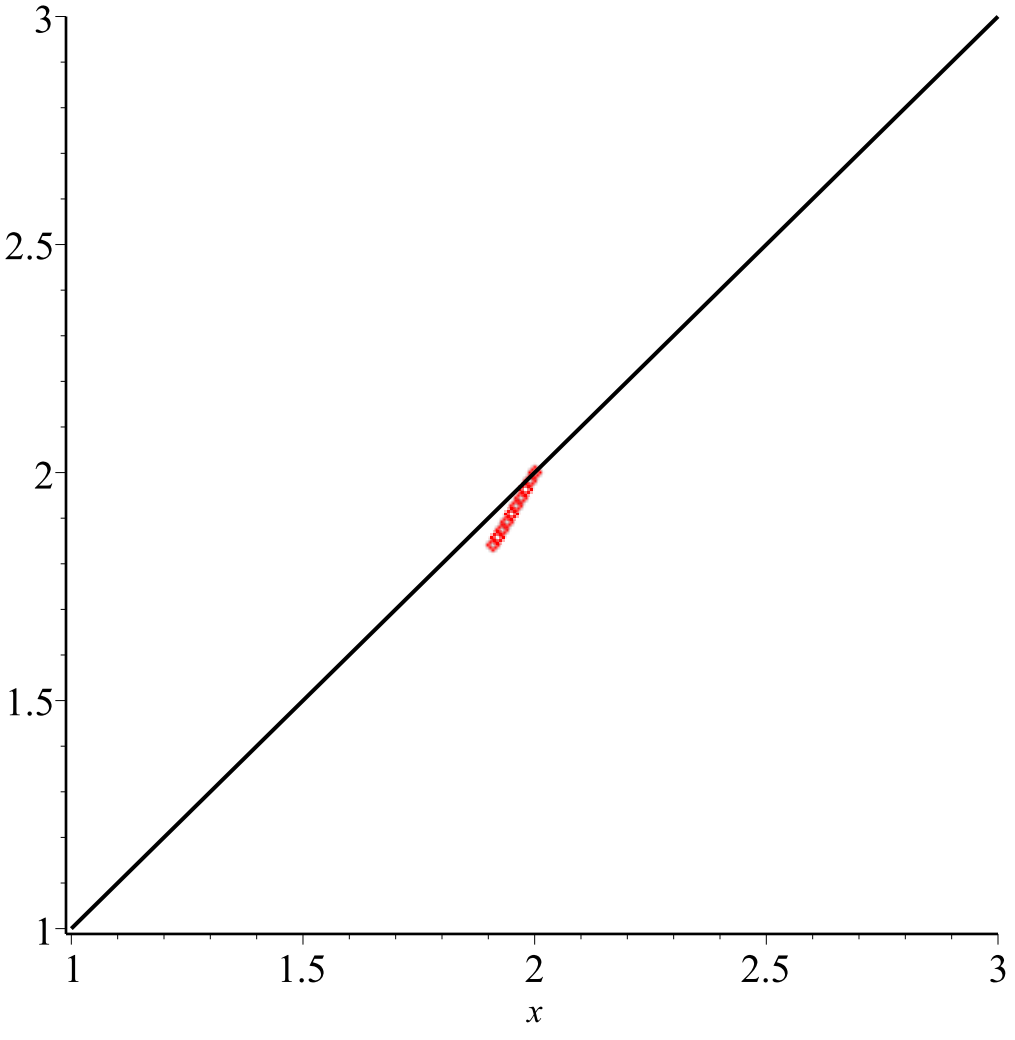
```
> T:=2*Pi:
> gg:=[]:
  ggr:=[]:
  rho:=2:
  h:=1/100:
  for i from 1 to 10 do
  ode:=dsolve({diff(x(t),t)=subs(x=x(t),y=y(t),xp),diff(y(t),t)=
  subs(x=x(t),y=y(t),yp),x(0)=rho,y(0)=0},numeric,output=
  listprocedure);
  xt:=eval(x(t),ode);
  yt:=eval(y(t),ode);
  T:=fsolve(yt(t),t=T);
  xt(T);
  yt(T);
  xt(T)-rho;
  ggr:=[op(ggr),[rho,xt(T)-rho]]:
  rho:=rho+h:
  od:
  rho:=2:
  for i from 1 to 10 do
  ode:=dsolve({diff(x(t),t)=subs(x=x(t),y=y(t),xp),diff(y(t),t)=
  subs(x=x(t),y=y(t),yp),x(0)=rho,y(0)=0},numeric,output=
```

```
   listprocedure);
   xt:=eval(x(t),ode);
   yt:=eval(y(t),ode);
   T:=fsolve(yt(t),t=T);
   xt(T);
   yt(T);
   xt(T)-rho;
   gg:=[[rho,xt(T)],op(gg)]:
   ggr:=[[rho,xt(T)-rho],op(ggr)]:
   rho:=rho-h:
   od:
```

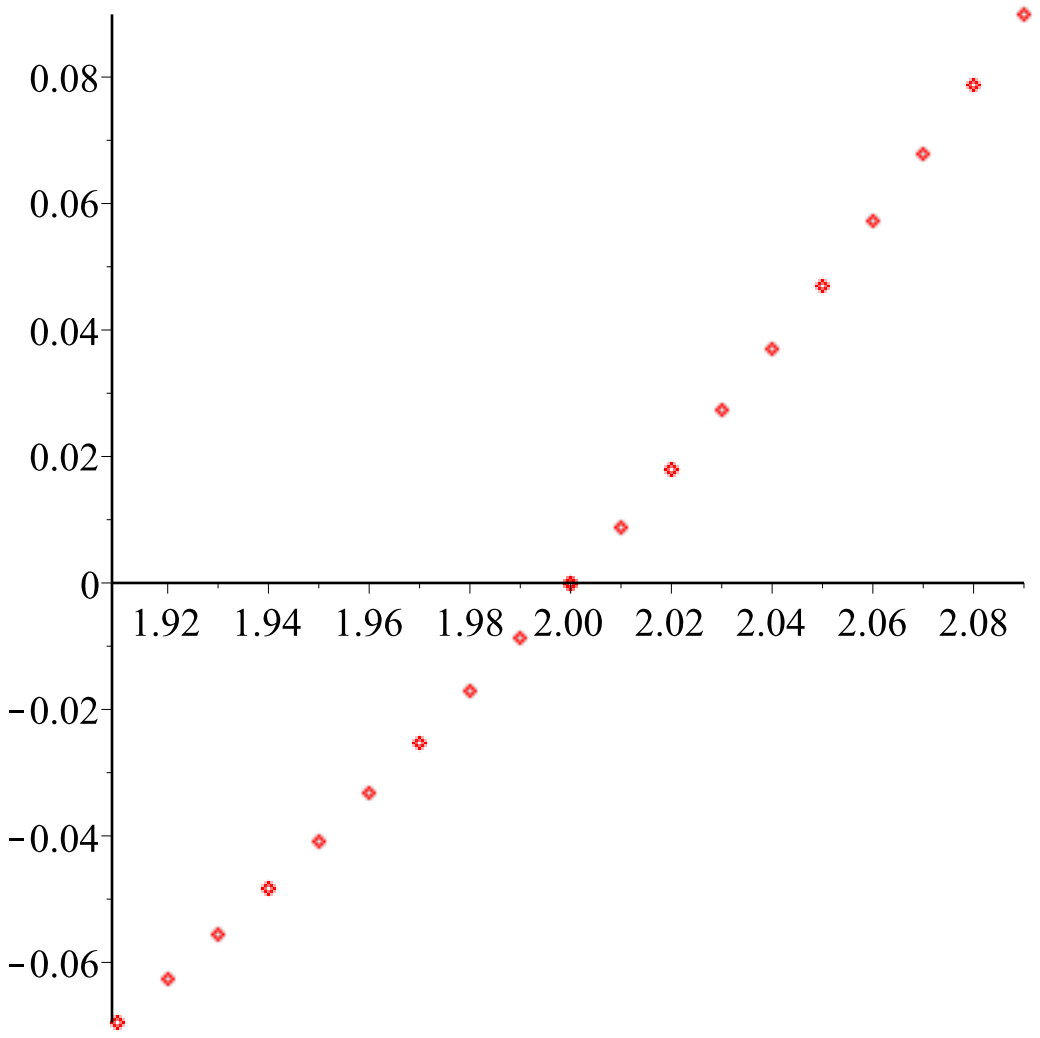
```
> gg;
```

$$\left[\left[\frac{191}{100}, 1.84049155987496\right], \left[\frac{48}{25}, 1.85734300311462\right], \left[\frac{193}{100}, 1.87439645450823\right], \left[\frac{97}{50}, 1.89165732654538\right], \left[\frac{39}{20}, 1.90913124534768\right], \left[\frac{49}{25}, 1.92682406241711\right], \left[\frac{197}{100}, 1.94474186700165\right], \left[\frac{99}{50}, 1.96289099941006\right], \left[\frac{199}{100}, 1.98127330288330\right], [2, 1.99990995133099]\right] \quad (6)$$

```
> pgg:=pointplot(gg,color=red):
> pbis:=plot([x],x=1..3,color=black):
> display(pgg,pbis);
```



```
> pointplot(ggr,color=red);
```




```
> restart;
  Digits:=40:
  with(plots):
  xp:=y;
  yp:=-x-mu*(1-x^2)*y;
```

$$xp := y$$

$$yp := -x - \mu\left(-x^2 + 1\right) y \tag{7}$$

```
> mu:=0.2:
```

```
> retorn:=proc(rho,T,mu)
  xp:=y;
  yp:=-x-mu*(1-x^2)*y;
  ode:=dsolve({diff(x(t),t)=subs(x=x(t),y=y(t),xp),diff(y(t),t)=
  subs(x=x(t),y=y(t),yp),x(0)=rho,y(0)=0},numeric,output=
  listprocedure);
  xt:=eval(x(t),ode);
  yt:=eval(y(t),ode);
  T0:=fsolve(yt(t),t=T);
  xt(T0);
  yt(T0);
  return([T0,xt(T0)-rho]);
  end;
```

```
Warning, `xp` is implicitly declared local to procedure `retorn`
Warning, `yp` is implicitly declared local to procedure `retorn`
Warning, `ode` is implicitly declared local to procedure `retorn`
Warning, `xt` is implicitly declared local to procedure `retorn`
Warning, `yt` is implicitly declared local to procedure `retorn`
Warning, `T0` is implicitly declared local to procedure `retorn`
```

```
retorn := proc(rho, T, mu)
    local xp, yp, ode, xt, yt, T0;
    xp := y;
    yp := -x - mu*(-x^2+1)*y;
    ode := dsolve({diff(x(t),t) = subs(x = x(t), y = y(t), xp), diff(y(t),t) = subs(x = x(t),
    y = y(t), yp), x(0) = rho, y(0) = 0}, numeric, output = listprocedure);
    xt := eval(x(t), ode);
    yt := eval(y(t), ode);
    T0 := fsolve(yt(t), t = T);
    xt(T0);
    yt(T0);
    return [T0, xt(T0) - rho]
end proc
```

(8)

```
> a1:=2;
  a2:=2.1;
  f1:=retorn(2,2*Pi,mu)[2];
  f2:=retorn(2.1,2*Pi,mu)[2];
```

$$a1 := 2$$

$$a2 := 2.1$$

$$f1 := -0.00104789119016241874278477 1782908428543$$

$$f2 := 0.35607620519015402713807704328995 8600212$$

(9)

```
> for i from 1 to 10 do
  aa:=-(a1*f2-a2*f1)/(-f2+f1):
  fa:=retorn(aa,2*Pi,mu)[2];
  a1:=a2:
  f1:=f2:
  a2:=aa:
  f2:=fa:
  od;
```

$$aa := 2.000293424946897583582099169191721681229$$

$$fa := -0.000304993425158514779730364013124011541$$

$$a1 := 2.1$$

$$f1 := 0.35607620519015402713807704328995 8600212$$

$$a2 := 2.000293424946897583582099169191721681229$$

$$f2 := -0.000304993425158514779730364013124011541$$

$$aa := 2.000378754503996625271615997496965555774$$

$$fa := -0.000088718045070522001209652413442768308$$

$$a1 := 2.000293424946897583582099169191721681229$$

$$f1 := -0.000304993425158514779730364013124011541$$

$$a2 := 2.000378754503996625271615997496965555774$$
$$f2 := -0.000088718045070522001209652413442768308$$
$$aa := 2.000413757431696858448095375896995941869$$
$$fa := 3.088444214344992672769486305 1012\ 10^{-8}$$
$$a1 := 2.000378754503996625271615997496965555774$$
$$f1 := -0.000088718045070522001209652413442768308$$
$$a2 := 2.000413757431696858448095375896995941869$$
$$f2 := 3.088444214344992672769486305 1012\ 10^{-8}$$
$$aa := 2.000413745250751112449715010469187744989$$
$$fa := -3.126322645964116305271048034\ 10^{-12}$$
$$a1 := 2.000413757431696858448095375896995941869$$
$$f1 := 3.088444214344992672769486305 1012\ 10^{-8}$$
$$a2 := 2.000413745250751112449715010469187744989$$
$$f2 := -3.126322645964116305271048034\ 10^{-12}$$
$$aa := 2.000413745251984021624057292876539874121$$
$$fa := -1.10156591005650059854\ 10^{-19}$$
$$a1 := 2.000413745250751112449715010469187744989$$
$$f1 := -3.126322645964116305271048034\ 10^{-12}$$
$$a2 := 2.000413745251984021624057292876539874121$$
$$f2 := -1.10156591005650059854\ 10^{-19}$$
$$aa := 2.000413745251984021667499090742752726962$$
$$fa := 3.92635559\ 10^{-31}$$
$$a1 := 2.000413745251984021624057292876539874121$$
$$f1 := -1.10156591005650059854\ 10^{-19}$$
$$a2 := 2.000413745251984021667499090742752726962$$
$$f2 := 3.92635559\ 10^{-31}$$
$$aa := 2.000413745251984021667499090742597885618$$
$$fa := -2.41369\ 10^{-34}$$
$$a1 := 2.000413745251984021667499090742752726962$$
$$f1 := 3.92635559\ 10^{-31}$$
$$a2 := 2.000413745251984021667499090742597885618$$
$$f2 := -2.41369\ 10^{-34}$$
$$aa := 2.000413745251984021667499090742597980747$$
$$fa := 5.75885\ 10^{-34}$$
$$a1 := 2.000413745251984021667499090742597885618$$
$$f1 := -2.41369\ 10^{-34}$$
$$a2 := 2.000413745251984021667499090742597980747$$
$$f2 := 5.75885\ 10^{-34}$$
$$aa := 2.000413745251984021667499090742597913713$$
$$fa := -4.19345\ 10^{-34}$$
$$a1 := 2.000413745251984021667499090742597980747$$
$$f1 := 5.75885\ 10^{-34}$$

$$a2 := 2.000413745251984021667499090742597913713$$

$$f2 := -4.19345\ 10^{-34}$$

$$aa := 2.000413745251984021667499090742597941958$$

$$fa := 1.0423\ 10^{-35}$$

$$a1 := 2.000413745251984021667499090742597913713$$

$$f1 := -4.19345\ 10^{-34}$$

$$a2 := 2.000413745251984021667499090742597941958$$

$$f2 := 1.0423\ 10^{-35} \quad \textbf{(10)}$$

```
> retorn(2.0004137452,2*Pi,0.2);
```

$$[6.298876167,\ -2.48498999155800\ 10^{-11}] \quad \textbf{(11)}$$