In[1]:= `Solve[x^2 + 3 x == 5, x]`

Out[1]= $\left\{\left\{x \to \frac{1}{2}\left(-3-\sqrt{29}\right)\right\}, \left\{x \to \frac{1}{2}\left(-3+\sqrt{29}\right)\right\}\right\}$

In[2]:= `NSolve[x^2 + 3 x == 5, x]`

Out[2]= $\{\{x \to -4.19258\}, \{x \to 1.19258\}\}$

Дифференцирование и интегрирование

In[3]:= `Sin'[x]`

Out[3]= `Cos[x]`

In[4]:= `Sin''[x]`

Out[4]= `-Sin[x]`

In[5]:= `Sin'''''[x]`

Out[5]= `Cos[x]`

```
 ' [э]  ≠ `[ё]
'' [ээ] ≠ "[Э]
```

In[6]:= `D[f[x], x]`

Out[6]= `f′[x]`

In[7]:= `Integrate[Sin[x], x]`

Out[7]= `-Cos[x]`

In[8]:= `NIntegrate[Sin[x], {x, 0, 1}]`

Out[8]= `0.459698`

In[9]:= $\int \mathrm{Sin}[x]\, dx$

Out[9]= `-Cos[x]`

In[10]:= $\int_1^3 \mathrm{Sin}[x]\, dx$

Out[10]= `2 Sin[1] Sin[2]`

Дифференциальные уравнения

In[11]:=
```
sol = DSolve[x''[t] == -x[t], x, t]
```
Out[11]=
```
{{x → Function[{t}, C[1] Cos[t] + C[2] Sin[t]]}}
```

```
= (Set[]) ≠ == (Equal[])
```

In[12]:=
```
x /. sol
```
Out[12]=
```
{Function[{t}, C[1] Cos[t] + C[2] Sin[t]]}
```

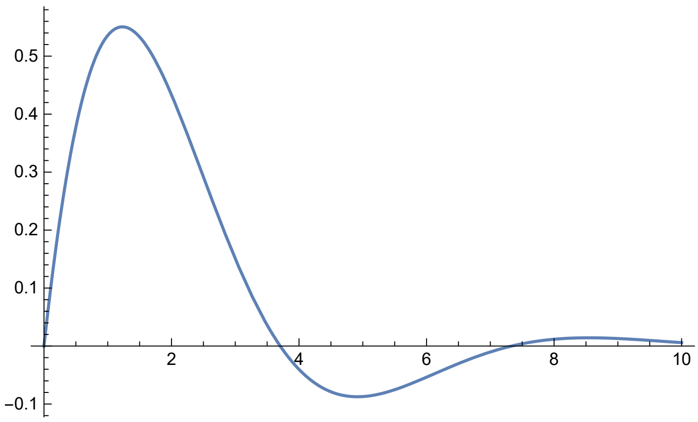
In[13]:=
```
x[t] /. sol[[1]]
```
Out[13]=
```
C[1] Cos[t] + C[2] Sin[t]
```

In[14]:=
```
DSolve[x''[t] == -x'[t] - Sin[x[t]], x, t]
```
Solve: Inverse functions are being used by Solve, so some solutions may not be found; use Reduce for complete solution information.

Out[14]=
```
DSolve[x''[t] == -Sin[x[t]] - x'[t], x, t]
```

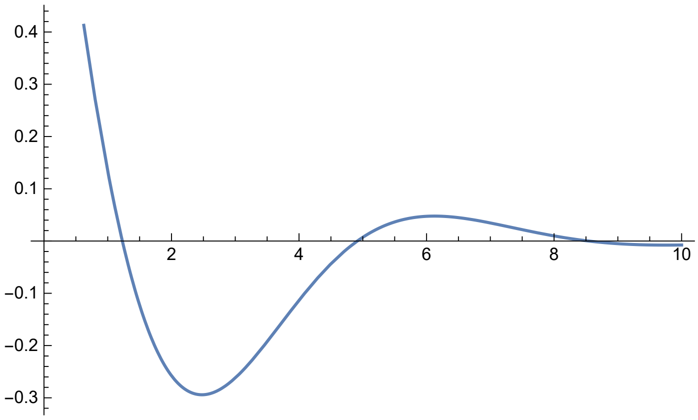
In[15]:=
```
sol = NDSolve[{
    x''[t] == -x'[t] - Sin[x[t]],
    x'[0] == 1, x[0] == 0
   },
   x, {t, 0, 10}][[1]]
```
Out[15]=
```
{x → InterpolatingFunction[ Domain: {{0., 10.}} Output: scalar ]}
```

In[16]:=
```
Plot[x[t] /. sol, {t, 0, 10}]
```
Out[16]=

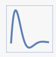


In[17]:=
```
Plot[x'[t] /. sol, {t, 0, 10}]
```

Out[17]=



In[18]:=
```
sol⟦1, 2⟧
```

Out[18]=
```
InterpolatingFunction[
```


```
Domain: {{0., 10.}}
Output: scalar
]
```

In[19]:=
```
sol⟦1, 2⟧ // FullForm
```

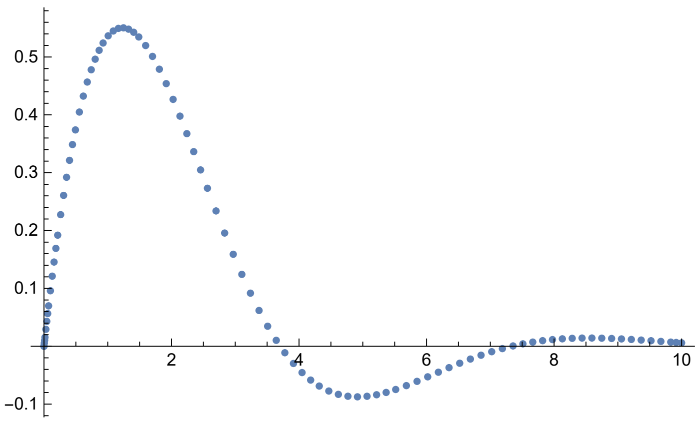
Out[19]//FullForm=
```
InterpolatingFunction[List[List[0.`, 10.`]],
 List[5, 7, 2, List[95], List[4], 0, 0, 0, 0, Automatic, List[], List[], False],
 List[List[0.`, 0.00012881477960713136`, 0.00025762955921426273`,
   0.005327767389502259`, 0.010397905219790254`, 0.015468043050078251`,
   0.029726577718662512`, 0.04398511238724677`, 0.05824364705583103`,
   0.07250218172441529`, 0.10101925106158381`, 0.12953632039875235`,
   0.15805338973592087`, 0.1865704590730894`, 0.2150875284102579`, 0.2614546743236672`,
   0.3078218202370765`, 0.3541889661504858`, 0.4005561120638951`, 0.44692325797730437`,
   0.49329040389071366`, 0.5552653705403386`, 0.6172403371899636`,
   0.6792153038395886`, 0.7411902704892136`, 0.8031652371388386`, 0.8651402037884636`,
   0.9271151704380886`, 1.007064876171164`, 1.0870145819042394`, 1.1669642876373147`,
   1.2469139933703903`, 1.3268636991034657`, 1.406813404836541`, 1.4867631105696164`,
   1.5944503223369106`, 1.7021375341042047`, 1.8098247458714987`, 1.9175119576387927`,
   2.0251991694060867`, 2.132886381173381`, 2.2405735929406747`, 2.348260804707969`,
   2.455948016475263`, 2.563635228242557`, 2.6985226860308513`, 2.8334101438191457`,
   2.96829760160744`, 3.1031850593957344`, 3.2380725171840288`, 3.372959974972323`,
   3.5078474327606175`, 3.642734890548912`, 3.7776223483372062`, 3.9125098061255006`,
   4.047397263913795`, 4.182284721702089`, 4.317172179490384`, 4.467039249932534`,
   4.616906320374683`, 4.766773390816834`, 4.916640461258983`, 5.066507531701133`,
   5.216374602143283`, 5.366241672585433`, 5.516108743027583`, 5.6834050653437025`,
   5.850701387659822`, 6.017997709975942`, 6.185294032292061`, 6.352590354608181`,
   6.519886676924301`, 6.687182999240421`, 6.854479321556541`, 7.02177564387266`,
   7.18907196618878`, 7.3563682885049`, 7.51099228678624`, 7.665616285067581`,
   7.820240283348921`, 7.974864281630262`, 8.129488279911603`, 8.284112278192943`,
   8.438736276474284`, 8.593271639813402`, 8.74780700315252`, 8.902342366491638`,
   9.056877729830756`, 9.211413093169874`, 9.365948456508992`, 9.52048381984810‌8`,
   9.674998342099531`, 9.829512864350955`, 9.914756432175476`, 10.`]],
 List[Developer`PackedArrayForm, List[0, 3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33,
   36, 39, 42, 45, 48, 51, 54, 57, 60, 63, 66, 69, 72, 75, 78, 81, 84, 87, 90, 93,
   96, 99, 102, 105, 108, 111, 114, 117, 120, 123, 126, 129, 132, 135, 138, 141,
   144, 147, 150, 153, 156, 159, 162, 165, 168, 171, 174, 177, 180, 183, 186, 189,
   192, 195, 198, 201, 204, 207, 210, 213, 216, 219, 222, 225, 228, 231, 234, 237,
   240, 243, 246, 249, 252, 255, 258, 261, 264, 267, 270, 273, 276, 279, 282, 285],
```

```
List[0.`, 1.`, -1.`, 0.00012879818635968613`, 0.9998711852225304`,
 -0.9999999834063964`, 0.00025757977947275 3`, 0.9997423704493351`,
 -0.999999950223822`, 0.005313558335388999`, 0.994672268737965`,
 -0.999985802069664`, 0.010343831124274096`, 0.9896023039193905`,
 -0.9999459505890234`, 0.015348399170303353`, 0.9845326062950723`,
 -0.9998804028614702`, 0.02928476087109962`, 0.9702777884521445`,
 -0.9995583637909795`, 0.043017910075557844`, 0.9560290506102118`,
 -0.9990336942780046`, 0.05654795336833417`, 0.941789234463489`,
 -0.9983070557916477`, 0.06987503843971349`, 0.9275612133258471`,
 -0.9973794046892609`, 0.09592112524137911`, 0.8991519682773133`,
 -0.9949260691960694`, 0.12115816364799736`, 0.8708239388183642`,
 -0.991685899970549`, 0.1455887967296786`, 0.842599347103214`, -0.9876743690972863`,
 0.16921628098011413`, 0.8144999365163058`, -0.9829098121220212`,
 0.19204448965342674`, 0.7865468893547609`, -0.9774130856565458`,
 0.2274673229633877`, 0.7414620330914264`, -0.966972845112585`, 0.2608115697125803`,
 0.6969026428579842`, -0.9547674025826551`, 0.29210344450082754`,
 0.6529478280477873`, -0.9409150322680252`, 0.321372707255403 3`, 0.6096710895149559`,
 -0.9255403756973436`, 0.34865238935712634`, 0.5671400485645718`,
 -0.9087716363487942`, 0.3739785190141259`, 0.5254163458938845`,
 -0.8907381882173875`, 0.40484681269749084`, 0.47100438625864344`,
 -0.8648823473057964`, 0.43239373721792684`, 0.41824998506678585`,
 -0.8372954164156383`, 0.45672515804328084`, 0.36725151634926667`,
 -0.8082628176701362`, 0.4779525014885487`, 0.31809017802647505`,
 -0.7780522660806484`, 0.49619172416388946`, 0.270831195367147`,
 -0.746911189064716 2`, 0.5115623633206954`, 0.22552512845045347`,
 -0.7150653229700732`, 0.524186670600621`, 0.1822092331205169`, -0.6827182786540017`,
 0.5366171276128134`, 0.12930976703168492`, -0.6405413032486691`,
 0.544953374337614`, 0.07979217093457243`, -0.5981703896769183`,
 0.5494660917256282`, 0.03366015879703533`, -0.5558921429886357`,
 0.5504253930518668`, -0.00910355185552614`, -0.5139462874219438`,
 0.5480992884329272`, -0.04853375070455941`, -0.47253213148696416`,
 0.542752407512823 6`, -0.08467976274403487`, -0.43181504194946424`,
 0.5346449390119674`, -0.11760298315657045`, -0.3919325760384724`,
 0.5198098450389864`, -0.15698192512826284`, -0.3397331826709709`,
 0.5010331337427406`, -0.19084303652861778`, -0.2894889037726508`,
 0.4788972778746775`, -0.2194075742540388`, -0.2413932100018278`, 0.45395986149275`,
 -0.24291603869825176`, -0.19561172023847528`, 0.4267516501610872`,
 -0.2616256474969983`, -0.1522903210791966`, 0.397774895804632`,
 -0.27580847331987735`, -0.11155944942881552`, 0.3675018227489095`,
 -0.285749869403146`, -0.07353531741429219`, 0.3363732811953528`,
 -0.2917468998492968`, -0.03831890058358445`, 0.3047975786288743`,
 -0.2941065773326672`, -0.00599351297152384`, 0.2731495166898576`,
 -0.29314379801965246`, 0.023378276369108334`, 0.233923108178588`,
 -0.28774092955827363`, 0.05594537044248174`, 0.19570745670713457`,
 -0.27826302554652044`, 0.08380248781249207`, 0.15900949121376776`,
 -0.26534264165643623`, 0.10700236842566731`, 0.1242515115581996`,
 -0.2496004416362959`, 0.12566839049999695`, 0.09177342916601634`,
 -0.23163585058790495`, 0.139991192057779`, 0.061836223416496784`,
 -0.21201842274708443`, 0.150221600223996`, 0.03462649110114822`,
 -0.19128036132960594`, 0.15666079134810856`, 0.010261907959959142`,
 -0.1699104914232195`, 0.1596487662797147`, -0.011202603406568179`,
 -0.1483498403176881`, 0.15955221253061486`, -0.029768219990785442`,
 -0.12698884358595283`, 0.15675267050477737`, -0.0454852927906848`,
 -0.10616608647617659`, 0.15163569983355613`, -0.05844634598453442`,
 -0.0861684126922002 4`, 0.14458149197099557`, -0.0687791711511906 9`,
```

```
-0.06723218852942292`, 0.1359571474302794`, -0.07736822320919594`,
-0.047665039339575735`, 0.12495610288181112`, -0.0831527318380753`,
-0.029831780447979184`, 0.11288872099530216`, -0.08640298497473718`,
-0.013861553242872204`, 0.10015706796887598`, -0.08740426635612168`,
0.000173501368196861`, 0.0871195172909849`, -0.0864488135660466`,
0.01225159333282117`, 0.07408958146472285`, -0.083828777186426`,
0.022394558907191855`, 0.06133607108113704`, -0.0798301815087604`,
0.030661235330914607`, 0.04908418174281877`, -0.07472786260105453`,
0.0371410483124271`, 0.03751728352807681`, -0.0680462175628085`,
0.04240426587264544`, 0.025589451195284045`, -0.06064562040019792`,
0.0457688755761132`, 0.014839576419171809`, -0.05282672016902199`,
0.047440496052988376`, 0.005361657052767074`, -0.04485467568077455`,
0.047636498708554624`, -0.002796862653938019`, -0.036957813052424265`,
0.046578700225701056`, -0.009629300062872818`, -0.029327425396382934`,
0.0444870380899699`, -0.01516381671013827`, -0.022118546867482908`,
0.04157423710782299`, -0.019457493748990095`, -0.015451536896955703`,
0.038041459148022934`, -0.022590537084671358`, -0.009414311940401848`,
0.034074902398287`, -0.024660729448806273`, -0.004065070155150285`,
0.02984330079205711`, -0.025778241707366093`, 0.000564636181797098`,
0.025496254767521483`, -0.026060890747542986`, 0.00419636533141765`,
0.021488455353178747`, -0.02568480820489731`, 0.007215031240050161`,
0.01757976646828511`, -0.02479473495716611`, 0.009641728327164211`,
0.013842407230924276`, -0.023483986442459838`, 0.01150761628845532`,
0.010334461279059558`, -0.021841824293366396`, 0.01285178968497512`,
0.007100616149705896`, -0.01995205273319839`, 0.013719276224577893`,
0.004173094485297442`, -0.01789194088844245`, 0.014159190863655425`,
0.0015727283555625052`, -0.01573144652084019`, 0.014223125210712012`,
-0.0006886686757724033`, -0.013533977285015257`, 0.013963819812384199`,
-0.0026110567552639894`, -0.011352309446686708`, 0.013433284139794346`,
-0.004200528568033388`, -0.009232351649918896`, 0.012682069772517946`,
-0.005469655043150205`, -0.007212074781522754`, 0.011758363001251585`,
-0.006436280061643962`, -0.005321811922619444`, 0.010707259592898`,
-0.007122371557928522`, -0.0035846833177064002`, 0.009570211607058097`,
-0.0075529461805004024`, -0.00201711916260043`, 0.008384795461777537`,
-0.007755067532095995`, -0.0006296294670192623`, 0.007183979039108`,
-0.007757043066591537`, 0.0005731260627550461`, 0.006525547961600232`,
-0.007682886835737917`, 0.0011573852080769952`, 0.005875493075264081`,
-0.007561309457221403`, 0.0016858501605269156`]], List[Automatic]]
```

In[20]:= **ListPlot[{sol⟦1, 2, 3, 1⟧, sol⟦1, 2, 4, 3, sol⟦1, 2, 4, 2, ;; -2⟧ + 1⟧}^{T}]**

Out[20]=

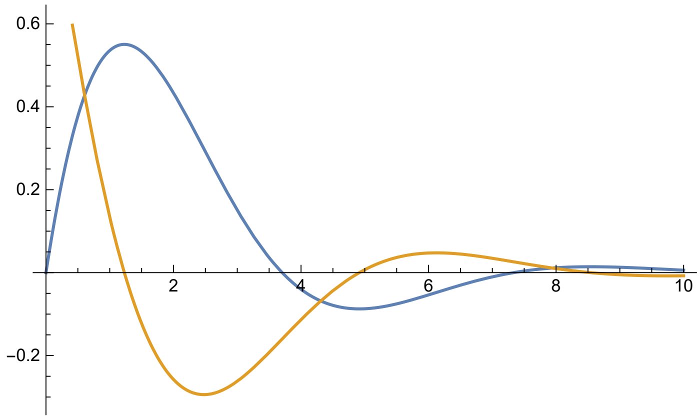


Задачи

3.1

In[21]:=
```
sol1 = NDSolve[{
    x''[t] == -x'[t] - Sin[x[t]],
    x'[0] == 1, x[0] == 0
   }, x, {t, 0, 10}];
Plot[{x[t], x'[t]} /. sol1 // Evaluate, {t, 0, 10}]
```

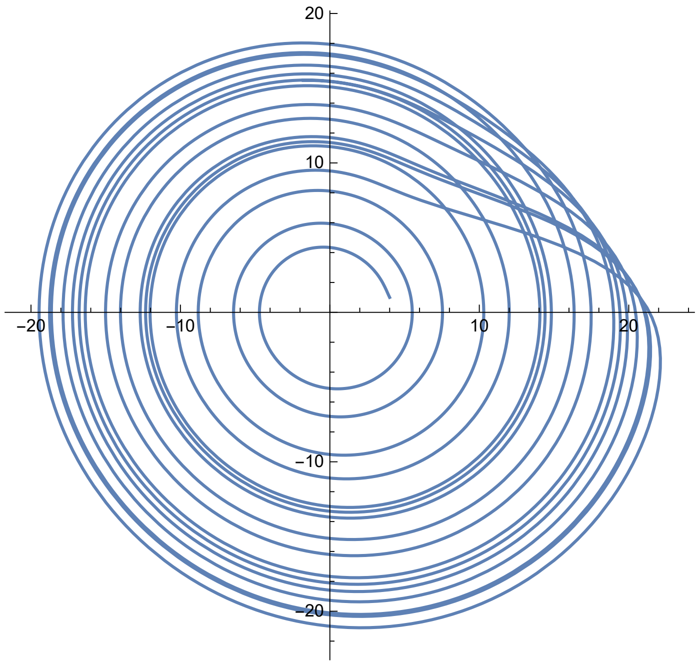
Out[22]=



3.2

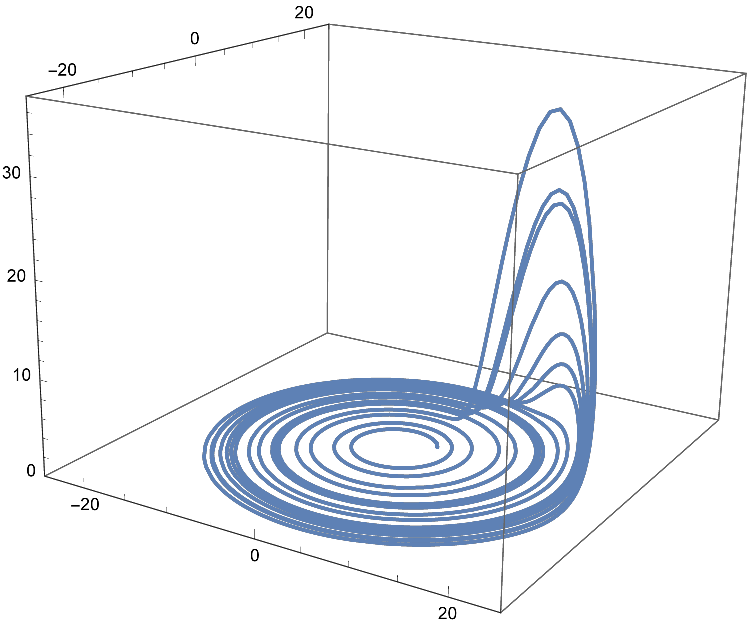
In[23]:=
```
a = b = .2; c = 5.7;
a = b = .1; c = 14;

sol2 = NDSolve[{
    x'[t] == -y[t] - z[t],
    y'[t] == x[t] + a y[t],
    z'[t] == b + z[t] (x[t] - c),
    x[0] == 4, y[0] == 1, z[0] == 1
   },
   {x, y, z}, {t, 0, 100}];
ParametricPlot[{x[t], y[t]} /. sol2, {t, 0, 100}]
```

Out[26]=



In[27]:=
```
ParametricPlot3D[{x[t], y[t], z[t]} /. sol2,
  {t, 0, 100}, PlotRange → 25 {{-1, 1}, {-1, 1}, {0, 1.5}}]
```

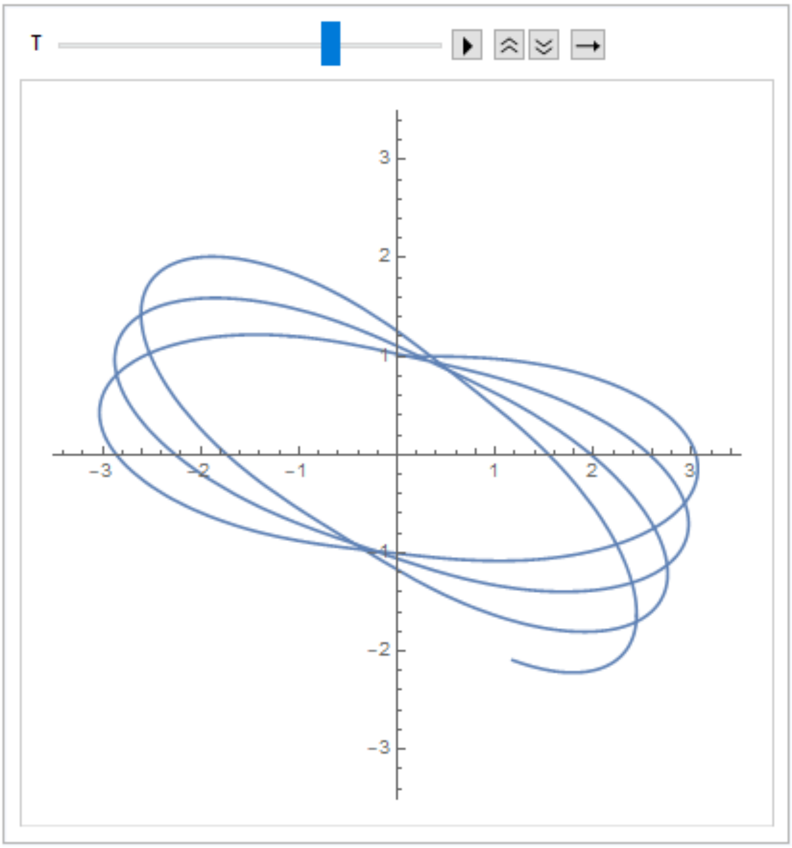
Out[27]=



3.3

In[28]:=
```
F[r_] := -1/r + 1/r^2;
sol3 = NDSolve[{x''[t] == F[r] * x[t]/r, x[0] == 0, x'[0] == 1, y''[t] == F[r] * y[t]/r,
     y[0] == 1, y'[0] == 0} /. {r → Sqrt[x[t]^2 + y[t]^2]}, {x, y}, {t, 0, 100}];
```

In[30]:=
```
Pic[T_] :=
   ParametricPlot[{x[t], y[t]} /. sol3, {t, 0, T}, PlotRange → 3.5 {{-1, 1}, {-1, 1}}];
Animate[Pic[T], {T, 0.1, 100}]
```


T
3
2
1
-3
-2
-1
1
2
3
-1
-2
-3