system 1

positive μ

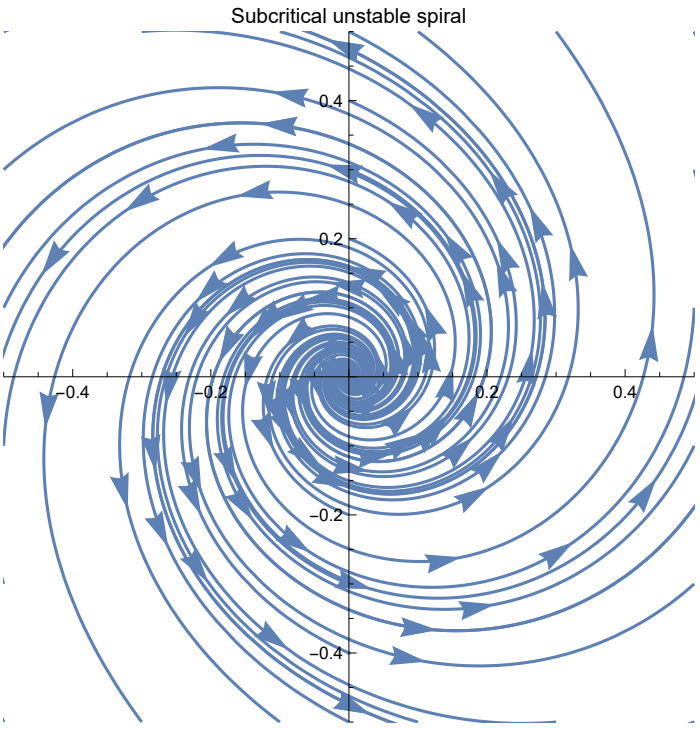
In[208]:=
```
Clear["Global`*"]
tEnd = -6;
tStart = 0;
xMin = -0.5;
xMax = 0.5;
yMin = -0.5;
yMax = 0.5;
systemSolver[x0_, y0_] =
  NDSolve[{x'[t] == μ * x[t] - 3 y[t] - x[t]^3, y'[t] == 3 x[t] + μ * y[t] + 2 y[t]^3,
     x[0] == x0, y[0] == y0} /. μ → 1, {x, y}, {t, tStart, tEnd}];

table1 = Table[{0, y}, {y, yMin, yMax, 0.1}];
table2 = Table[{xMin, y}, {y, yMin, yMax, 0.2}];
table3 = Table[{xMax, y}, {y, yMin, yMax, 0.2}];
table4 = Table[{x, yMin}, {x, xMin, xMax, 0.2}];
table5 = Table[{x, yMax}, {x, xMin, xMax, 0.2}];
initialCondition = Join[table1, table2, table3, table4, table5];

Show[Table[ParametricPlot[Evaluate[
     {x[t], y[t]} /. systemSolver[initialCondition[[i, 1]], initialCondition[[i, 2]]]],
    {t, tStart, tEnd}, PlotRange → {{xMin, xMax}, {yMin, yMax}}],
   {i, Length[initialCondition]}] /.
  Line[x_] :↦ {Arrowheads[{0., 0.04, 0.04, 0.04, 0.}], Arrow[x]},
 PlotLabel → "Subcritical unstable spiral"]
```

NDSolve: Initial condition x0 is not a number or a rectangular array of numbers.

Out[218]=



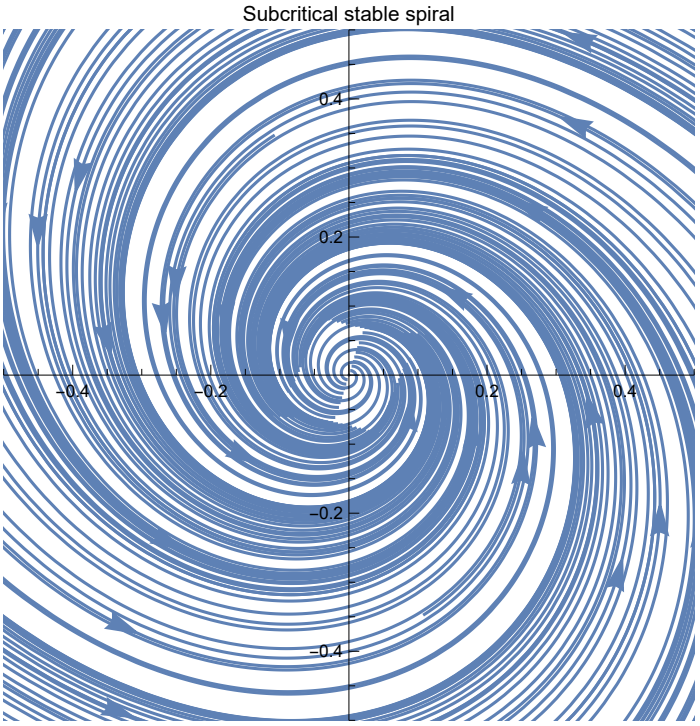
negative μ

In[ ]:=
```
Clear["Global`*"]
tEnd = -2;
tStart = 2;
xMin = -0.5;
xMax = 0.5;
yMin = -0.5;
yMax = 0.5;
systemSolver[x0_, y0_] =
  NDSolve[{x'[t] == μ * x[t] - 3 y[t] - x[t]^3, y'[t] == 3 x[t] + μ * y[t] + 2 y[t]^3,
     x[0] == x0, y[0] == y0} /. μ → -1, {x, y}, {t, tStart, tEnd}];

table1 = Table[{0, y}, {y, yMin, yMax, 0.05}];
table2 = Table[{xMin, y}, {y, yMin, yMax, 0.05}];
table3 = Table[{xMax, y}, {y, yMin, yMax, 0.05}];
table4 = Table[{x, yMin}, {x, xMin, xMax, 0.05}];
table5 = Table[{x, yMax}, {x, xMin, xMax, 0.05}];
initialCondition = Join[table1, table2, table3, table4, table5];

Show[Table[ParametricPlot[Evaluate[
     {x[t], y[t]} /. systemSolver[initialCondition[[i, 1]], initialCondition[[i, 2]]]],
    {t, tStart, tEnd}, PlotRange → {{xMin, xMax}, {yMin, yMax}}],
   {i, Length[initialCondition]}] /.
  Line[x_] :→ {Arrowheads[{0., 0.04, 0.04, 0.04, 0.}], Arrow[x]},
 PlotLabel → "Subcritical stable spiral"]
```

Out[ ]=




```
(*We se that the above plot is stable since all the arrows moves towards the center*)
```

system 2

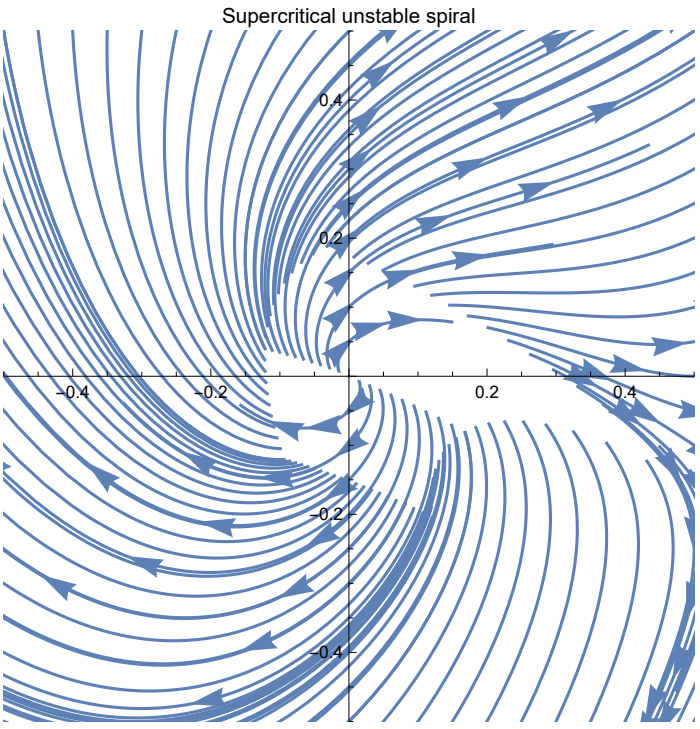
Positive μ

In[ ]:=
```
Clear["Global`*"]
tEnd = -1.2;
tStart = 1.2;
xMin = -0.5;
xMax = 0.5;
yMin = -0.5;
yMax = 0.5;
systemSolver[x0_, y0_] =
  NDSolve[{x'[t] == μ * x[t] + y[t] - x[t]^2, y'[t] == -x[t] + μ * y[t] + 2 x[t]^2,
     x[0] == x0, y[0] == y0} /. μ → 1, {x, y}, {t, tStart, tEnd}];
table1 = Table[{0, y}, {y, yMin, yMax, 0.05}];
table2 = Table[{xMin, y}, {y, yMin, yMax, 0.05}];
table3 = Table[{xMax, y}, {y, yMin, yMax, 0.05}];
table4 = Table[{x, yMin}, {x, xMin, xMax, 0.05}];
table5 = Table[{x, yMax}, {x, xMin, xMax, 0.05}];
initialCondition = Join[table1, table2, table3, table4, table5];

Show[Table[ParametricPlot[Evaluate[
     {x[t], y[t]} /. systemSolver[initialCondition[[i, 1]], initialCondition[[i, 2]]]],
    {t, tStart, tEnd}, PlotRange → {{xMin, xMax}, {yMin, yMax}}],
   {i, Length[initialCondition]}] /.
  Line[x_] :→ {Arrowheads[{0., 0.04, 0.04, 0.04, 0.}], Arrow[x]},
 PlotLabel → "Supercritical unstable spiral"]
```

NDSolve: Initial condition x0 is not a number or a rectangular array of numbers.

Out[ ]=



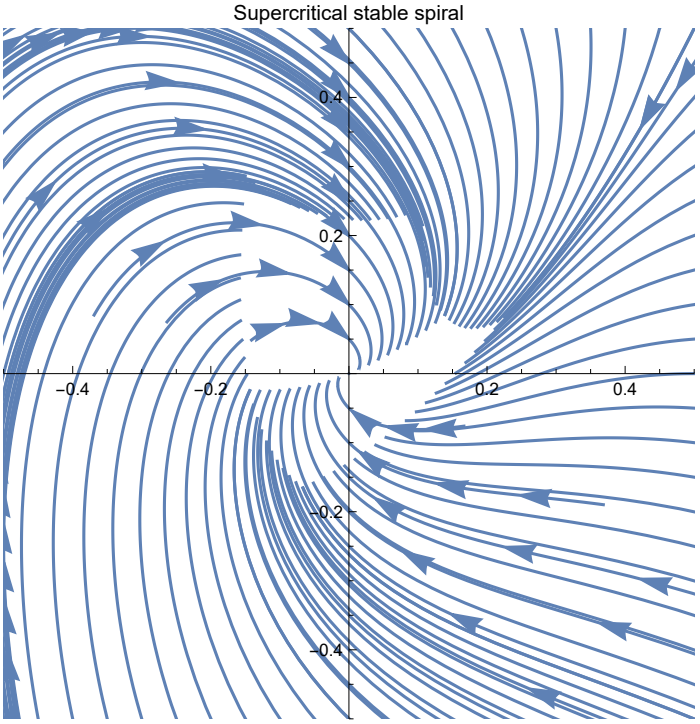
```
(*We see that the above plot is unstable since the arrows moves away from the center*)
```

negative μ

In[ ]:=
```
Clear["Global`*"]
tEnd = -1.2;
tStart = 1.2;
xMin = -0.5;
xMax = 0.5;
yMin = -0.5;
yMax = 0.5;
systemSolver[x0_, y0_] =
  NDSolve[{x'[t] == μ * x[t] + y[t] - x[t]^2, y'[t] == -x[t] + μ * y[t] + 2 x[t]^2,
     x[0] == x0, y[0] == y0} /. μ → -1, {x, y}, {t, tStart, tEnd}];
table1 = Table[{0, y}, {y, yMin, yMax, 0.05}];
table2 = Table[{xMin, y}, {y, yMin, yMax, 0.05}];
table3 = Table[{xMax, y}, {y, yMin, yMax, 0.05}];
table4 = Table[{x, yMin}, {x, xMin, xMax, 0.05}];
table5 = Table[{x, yMax}, {x, xMin, xMax, 0.05}];
initialCondition = Join[table1, table2, table3, table4, table5];

Show[Table[ParametricPlot[Evaluate[
     {x[t], y[t]} /. systemSolver[initialCondition[[i, 1]], initialCondition[[i, 2]]]],
    {t, tStart, tEnd}, PlotRange → {{xMin, xMax}, {yMin, yMax}}],
   {i, Length[initialCondition]}] /.
  Line[x_] :↦ {Arrowheads[{0., 0.04, 0.04, 0.04, 0.}], Arrow[x]},
 PlotLabel → "Supercritical stable spiral"]
```

Out[ ]=



```
(*We se that its stable since the arrows moves towards the center*)
(*In conlusion, the plots agrees with my answers in task c). I got that a1>
 0 which means that all plots for system 1 should be
  subcritical which the plots show. And I got that a2<
 0 which means that all the plots for system 2 should be supercritical*)
```