Exercise 3.1

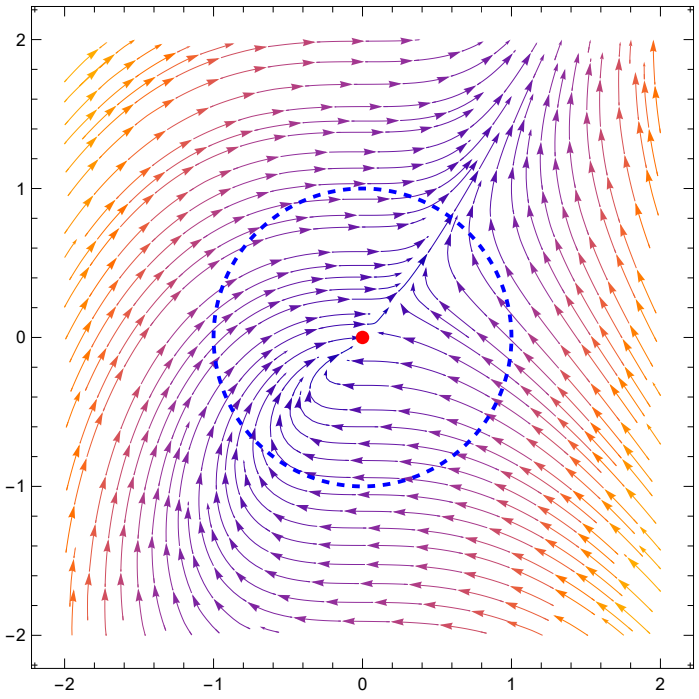
In[285]:=

```
xdot[x_, y_] := y - x
ydot[x_, y_] := x^2

fp = {{0, 0}};

s = StreamPlot[{xdot[x, y], ydot[x, y]},
    {x, -2, 2}, {y, -2, 2}, StreamStyle → Darker[Blue],
    StreamPoints → Fine, Epilog → {Red, PointSize[Large], Point[fp]}];
c = ParametricPlot[{Cos[t], Sin[t]},
    {t, 0, 2 Pi}, PlotStyle → {Dashed, Blue, Thick}];
Show[s, c]
```

Out[290]=



Index = 0.

Task b)

In[291]:=
```
ClearAll["Global`*"]

x[r_, theta_] := r * Cos[θ]
y[r_, theta_] := r * Sin[θ]

xDot = D[x[r[t], θ[t]], t]
yDot = D[y[r[t], θ[t]], t]
```

Out[294]=
```
Cos[θ] r'[t]
```

Out[295]=
```
Sin[θ] r'[t]
```

In[296]:=
```
(*
xDotSubst= Cos[θ]*(a*r+O[r^2]);
yDotSubst= Sin[θ]*(a*r+O[r^2]);
*)

(*For small r, O(r^2) is negligeble, and thus:*)
xDotFinal = Cos[θ] * a * r
xDotFinal = Sin[θ] * a * r

(*Which is just:*)
xDotCartesian[x_] = a * x
yDotCartesian[y_] = a * y
```

Out[296]=
```
a r Cos[θ]
```

Out[297]=
```
a r Sin[θ]
```

Out[298]=
```
a x
```

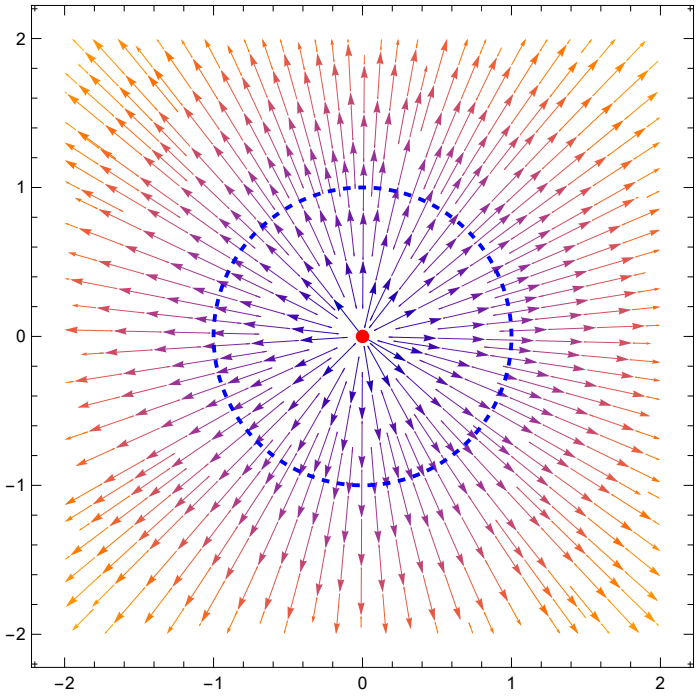
Out[299]=
```
a y
```

In[300]:=
```
ClearAll["Global`*"]
(*Choose a ≠ 0 and make streamplot, moreover we have an fp in {{0,0}}*)
a = 1
xdot[x_, y_] := a * x
ydot[x_, y_] := a * y
fp = {{0, 0}};
s = StreamPlot[{xdot[x, y], ydot[x, y]},
    {x, -2, 2}, {y, -2, 2}, StreamStyle → Darker[Blue],
    StreamPoints → Fine, Epilog → {Red, PointSize[Large], Point[fp]}];

c = ParametricPlot[{Cos[t], Sin[t]},
    {t, 0, 2 Pi}, PlotStyle → {Dashed, Blue, Thick}];
Show[s, c]
```

Out[301]=
```
1
```

Out[307]=



Index +1.

task c)

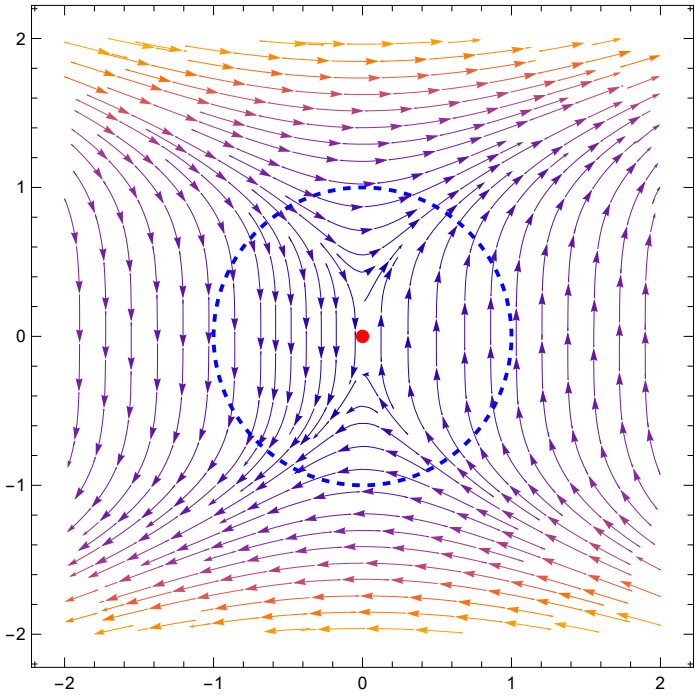
In[308]:=

```
ClearAll["Global`*"]
xdot[x_, y_] := y^3
ydot[x_, y_] := x

fp = {{0, 0}};
s = StreamPlot[{xdot[x, y], ydot[x, y]},
    {x, -2, 2}, {y, -2, 2}, StreamStyle → Darker[Blue],
    StreamPoints → Fine, Epilog → {Red, PointSize[Large], Point[fp]}];

c = ParametricPlot[{Cos[t], Sin[t]},
    {t, 0, 2 Pi}, PlotStyle → {Dashed, Blue, Thick}];
Show[s, c]
```

Out[314]=



Index = -1

Task d)

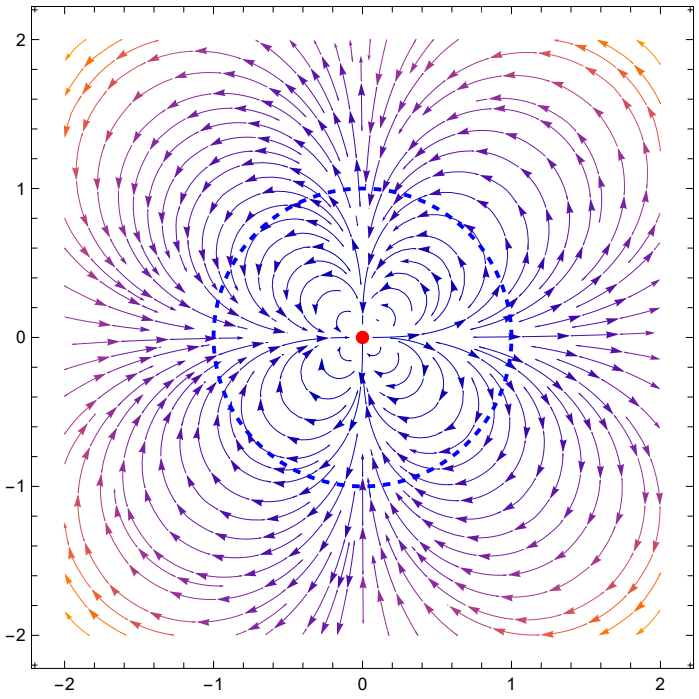
In[315]:=

```
(*n ≠ 0 integer, choose try different values and examine plot.*)
ClearAll["Global`*"]
n = 3;
xdot[x_, y_, n_] := (x^2 + y^2) ^ (Abs[n] / 2) * Cos[n * ArcTan[y / x]]
ydot[x_, y_, n_] := (x^2 + y^2) ^ (Abs[n] / 2) * Sin[n * ArcTan[y / x]]

fp = {{0, 0}};
s = StreamPlot[{xdot[x, y, n], ydot[x, y, n]},
   {x, -2, 2}, {y, -2, 2}, StreamStyle → Darker[Blue],
   StreamPoints → Fine, Epilog → {Red, PointSize[Large], Point[fp]}];

c = ParametricPlot[{Cos[t], Sin[t]},
   {t, 0, 2 Pi}, PlotStyle → {Dashed, Blue, Thick}];
Show[s, c]
```

Out[322]=



After trying multiple values of n, the index seem to be the same as n, i.e when n = 1, index=1, etc. Thus index = n.