In[158]:=

```
Clear["Global`*"]
r = 0.1;
x = r * Cos[t];
y = r * Sin[t];
Index[p_, q_] := 1/(2 π) Integrate[(p D[q, t] - q D[p, t])/(p^2 + q^2), {t, 0, 2 π}];
a = 3;
```

Problem 1

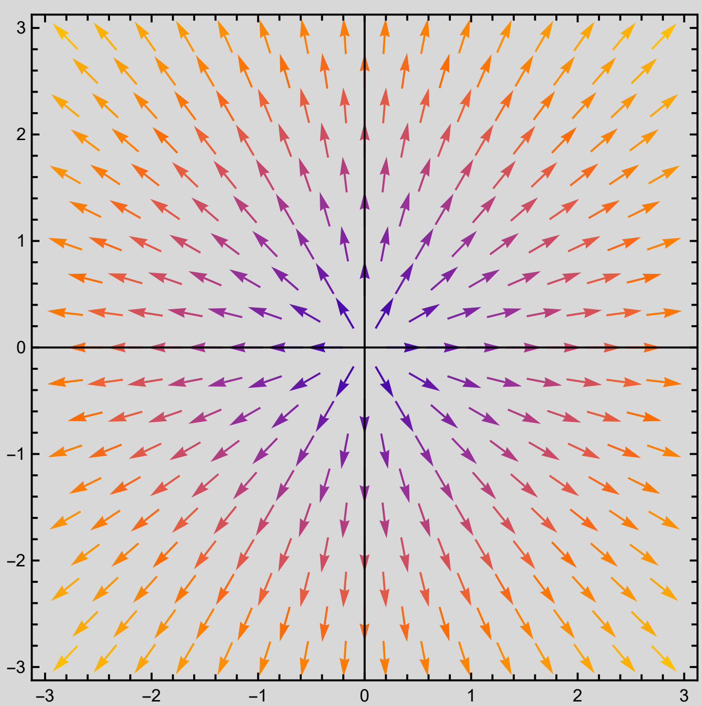
In[164]:=

```
(* f(x,y) = (x,y) *)
p1 = x;
q1 = y;
Index[p1, q1]
VectorPlot[{x, y}, {x, -a, a}, {y, -a, a}, Axes → True]
```

Out[166]=

```
1
```

Out[167]=



Having an index of 1 indicates that f(x,y) is stable, unstable, node, or a focus. Further analysis shows that the origin is an unstable equilibrium.

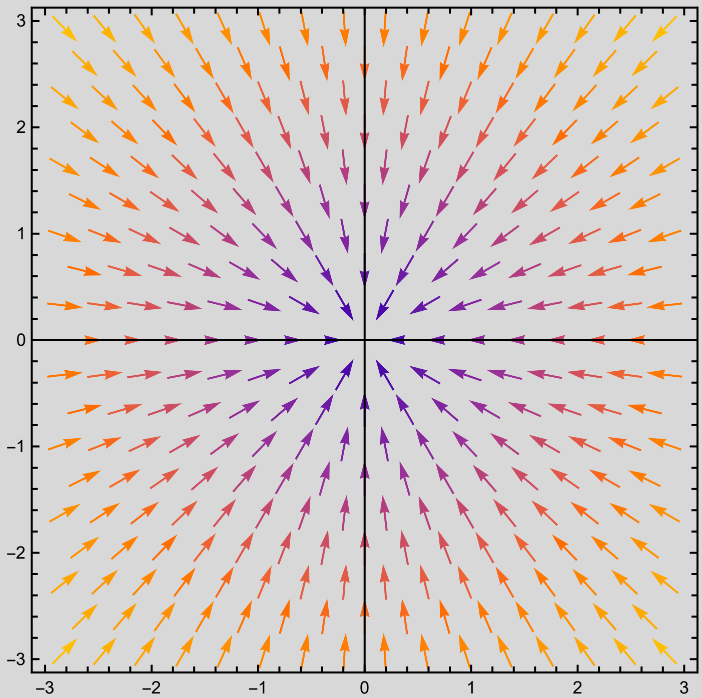
Problem 2

In[168]:=

```
(* f(x,y) = (-x,-y) *)
p2 = -x;
q2 = -y;
Index[p2, q2]
VectorPlot[{-x, -y}, {x, -a, a}, {y, -a, a}, Axes → True]
```

Out[170]= 1

Out[171]=



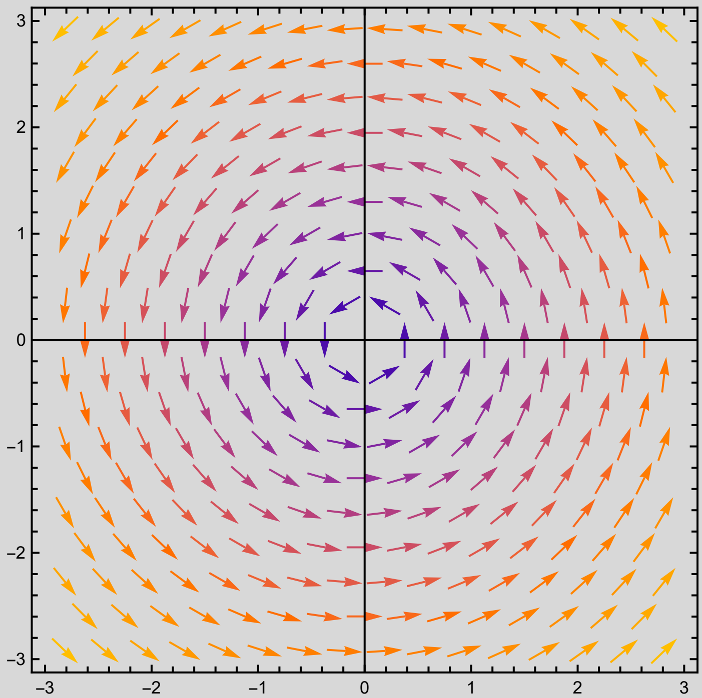
Having an index of 1 indicates that f(x,y) is stable, unstable, node, or a focus. Further analysis shows that the origin is a stable equilibrium.

Problem 3

In[172]:=
```
(* f(x,y) = (-y,x) *)
p3 = -y;
q3 = x;
Index[p3, q3]
VectorPlot[{-y, x}, {x, -a, a}, {y, -a, a}, Axes → True]
```

Out[174]= 1

Out[175]=



Having an index of 1 indicates that f(x,y) is stable, unstable, node, or a focus. Further analysis shows that the origin is a center.

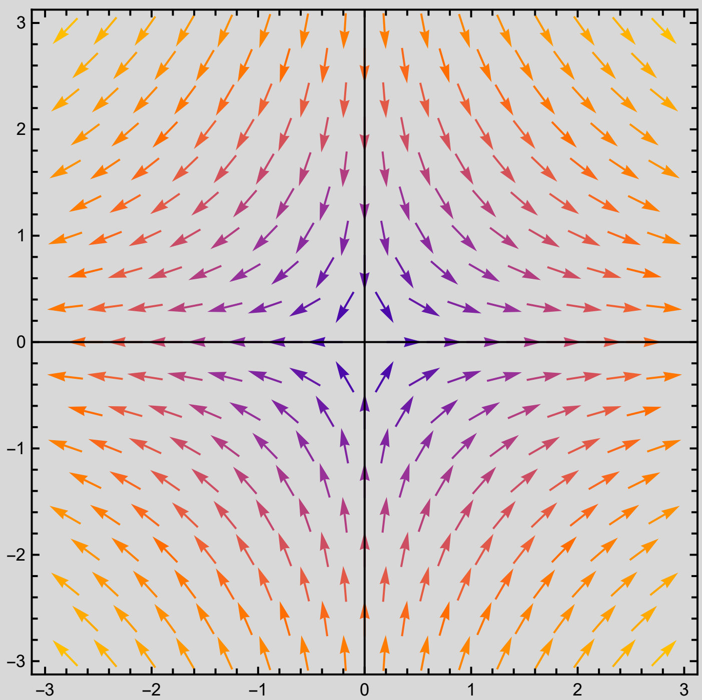
Problem 4

In[176]:=

```
(* f(x,y) = (x,-y) *)
p4 = x;
q4 = -y;
Index[p4, q4]
VectorPlot[{x, -y}, {x, -a, a}, {y, -a, a}, Axes → True]
```

Out[178]= -1.

Out[179]=



Having an index of -1 indicates that f(x,y) is a saddle. Further analysis shows that the origin is in fact a saddle.