2.1a)

In[539]:=

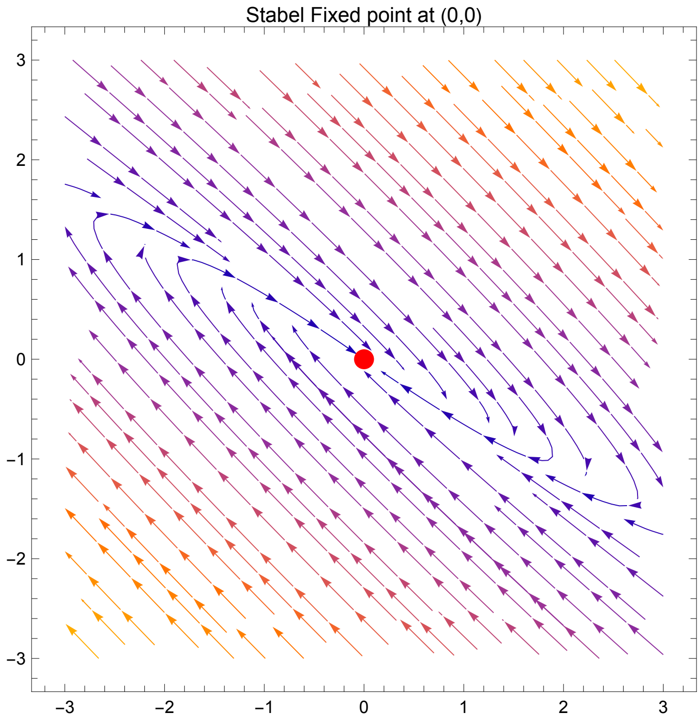
```
sigma = -1
stream = StreamPlot[{(sigma + 3) x + 4 y, (-9 / 4) x + (sigma - 3) y},
   {x, -3, 3}, {y, -3, 3}, PlotLabel → "Stabel Fixed point at (0,0)"];
fp = Graphics[{Red, PointSize[0.03], Point[{0, 0}]},
   Axes → True, AxesOrigin → {0, 0}];
Show[stream, fp]
f[x_, y_] := (2) x + 4 y
g[x_, y_] := (-9 / 4) x + (-4) y

j = D[{f[x, y], g[x, y]}, {{x, y}}];
Eigenvalues[j]
```

Out[539]=

-1

Out[542]=



Out[546]=

{-1, -1}

This is a stabel fixed point at (0,0) because eigenvalues real part negative

In[557]:=

```
sigma = 0
stream =
  StreamPlot[{(sigma + 3) x + 4 y, (-9 / 4) x + (sigma - 3) y}, {x, -3, 3}, {y, -3, 3},
   PlotLabel → "Line of fixed points along the eigen vector, only flow
      in one direction"];
f[x_, y_] := (3) x + 4 y
g[x_, y_] := (-9 / 4) x + (-3) y

j = D[{f[x, y], g[x, y]}, {{x, y}}];
Eigenvalues[j]
eVector = Eigenvectors[j];
eVector⟦1, 2⟧;
fp =
  Graphics[{Red, Thickness[0.01], Line[{{-3, -3 eVector⟦1, 2⟧ / eVector⟦1, 1⟧},
      {3, 3 eVector⟦1, 2⟧ / eVector⟦1, 1⟧}}]}];

Show[stream, fp]
```

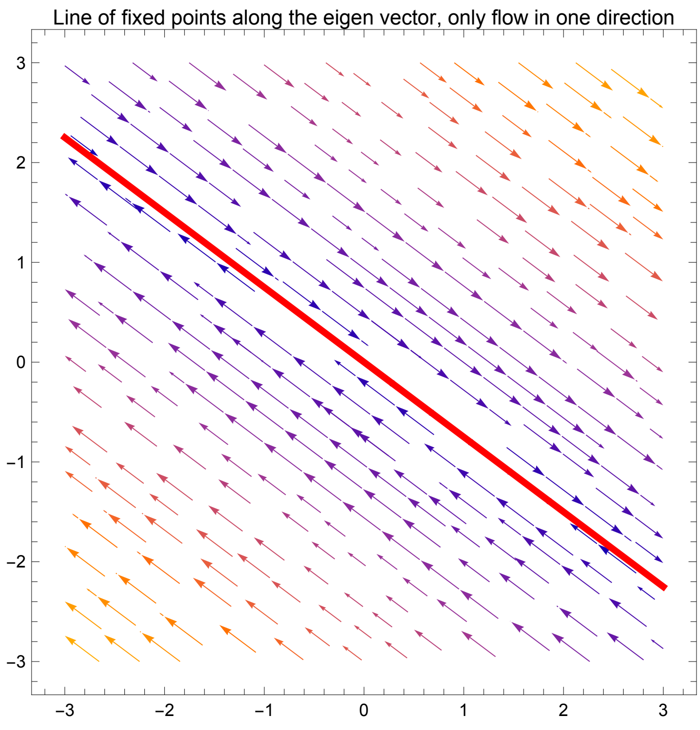
Out[557]=

0

Out[562]=

{0, 0}

Out[566]=



Line of fix points

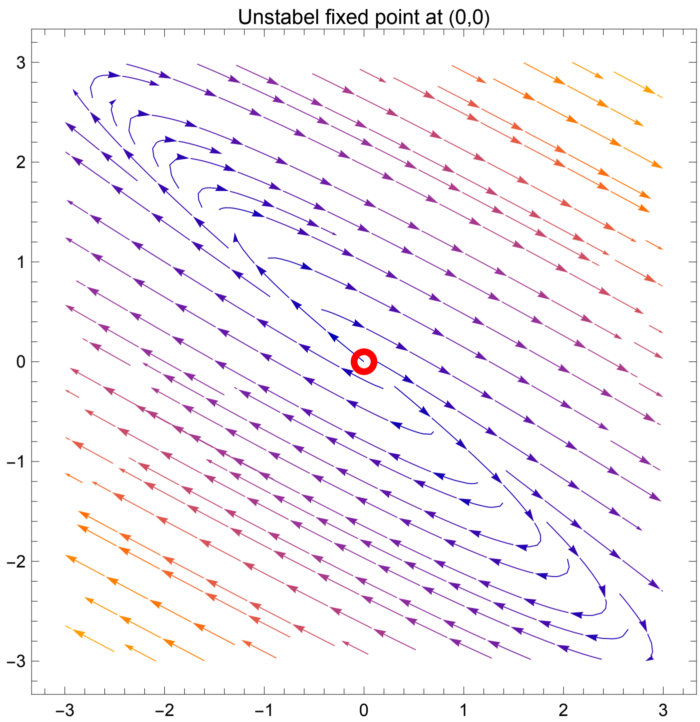
In[567]:=

```
sigma = 1
stream = StreamPlot[{(sigma + 3) x + 4 y, (-9 / 4) x + (sigma - 3) y},
   {x, -3, 3}, {y, -3, 3}, PlotLabel → "Unstabel fixed point at (0,0)"];
fp = Graphics[{Red, Thickness[0.01], Circle[{0, 0}, 0.1]}];
Show[stream, fp]
```

Out[567]=

```
1
```

Out[570]=



In[∘]:=

```
f[x_, y_] := (4) x + 4 y
g[x_, y_] := (-9 / 4) x + (-2) y

j = D[{f[x, y], g[x, y]}, {{x, y}}];
Eigenvalues[j]
```

Out[∘]=

```
{1, 1}
```

This is a unstable fixed point at (0,0) because eigenvalues real part positive

2.1 b)

```
matrix = {{σ + 3, 4}, {-9 / 4, σ - 3}}
```

In[ ]:=
```
matrix = {{σ + 3, 4}, {-9 / 4, σ - 3}};
```

2.1c)

In[ ]:=
```
vectors = Eigenvectors[{{3 + σ, 4}, {-9/4, -3 + σ}}]
```

Out[ ]=

$$\left\{\left\{-\frac{4}{3}, 1\right\}, \{0, 0\}\right\}$$

In[ ]:=
```
eigenVector = vectors[[1]]
```

Out[ ]=

$$\left\{-\frac{4}{3}, 1\right\}$$

In[ ]:=
```
magnitude = Sqrt[Total[eigenVector ^ 2]];
```

In[ ]:=
```
normalizedVector = -eigenVector / magnitude
```

Out[ ]=

$$\left\{\frac{4}{5}, -\frac{3}{5}\right\}$$

2.1 d)

In[ ]:=
```
Inverse[matrix]
```

Out[ ]=

$$\left\{\left\{\frac{-12 + 4\,\sigma}{4\,\sigma^2}, -\frac{4}{\sigma^2}\right\}, \left\{\frac{9}{4\,\sigma^2}, \frac{3 + \sigma}{\sigma^2}\right\}\right\}$$

12.1 e)

when sigma =0 inverse of A goes to inf therefor sigma =0 implies that invers of A dosent excist in this particular case (sigma =0)

2.1 f)

In[529]:=

```
matrixGeneral={{σ-cd,d^2},{-c^2,σ+cd}}
matrixSigmaMinus={{-1-cd,d^2},{-c^2,-1+cd}}
```

Out[529]=

$$\left\{\left\{-\mathrm{cd}+\sigma,\ d^2\right\},\ \left\{-c^2,\ \mathrm{cd}+\sigma\right\}\right\}$$

Out[530]=

$$\left\{\left\{-1-\mathrm{cd},\ d^2\right\},\ \left\{-c^2,\ -1+\mathrm{cd}\right\}\right\}$$

In[ ]:=

```
Eigensystem[matrixSigmaMinus]
```

Out[ ]=

$$\left\{\left\{-1-\sqrt{\mathrm{cd}^2-c^2\,d^2},\ -1+\sqrt{\mathrm{cd}^2-c^2\,d^2}\right\},\ \left\{\left\{-\frac{-\mathrm{cd}-\sqrt{\mathrm{cd}^2-c^2\,d^2}}{c^2},\ 1\right\},\ \left\{-\frac{-\mathrm{cd}+\sqrt{\mathrm{cd}^2-c^2\,d^2}}{c^2},\ 1\right\}\right\}\right\}$$

In[ ]:=

```
Eigenvalues[matrixSigmaMinus]
```

Out[ ]=

$$\left\{-1-\sqrt{\mathrm{cd}^2-c^2\,d^2},\ -1+\sqrt{\mathrm{cd}^2-c^2\,d^2}\right\}$$

In[ ]:=

```
Eigenvectors[matrixSigmaMinus]
```

Out[ ]=

$$\left\{\left\{-\frac{-\mathrm{cd}-\sqrt{\mathrm{cd}^2-c^2\,d^2}}{c^2},\ 1\right\},\ \left\{-\frac{-\mathrm{cd}+\sqrt{\mathrm{cd}^2-c^2\,d^2}}{c^2},\ 1\right\}\right\}$$

Eigenvalues should be the same as previous [sigma,sigma] (sigma=-1) therfore sqrt(cd^2-c^2d^2)=0 . Given this the eigenvector is [d/c,1].