Extra credit

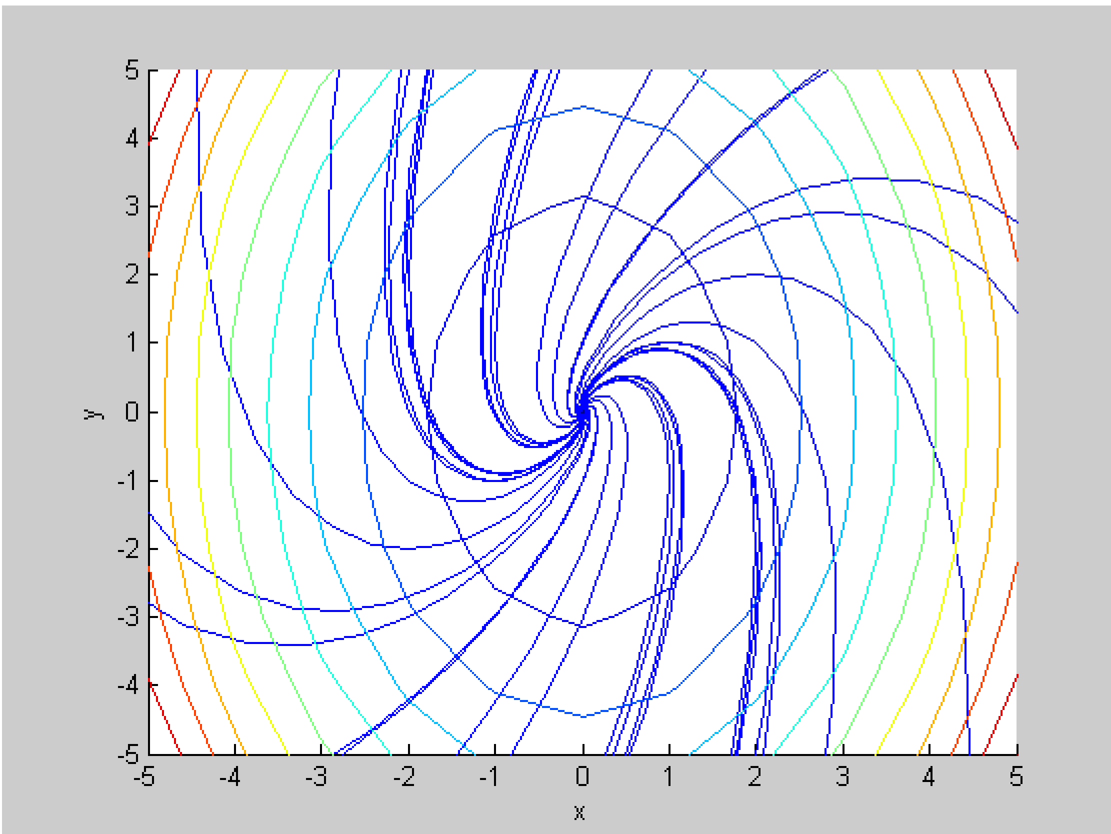
b)For the matrix A=

m+1-13m-1

% with m= [-2; 2]

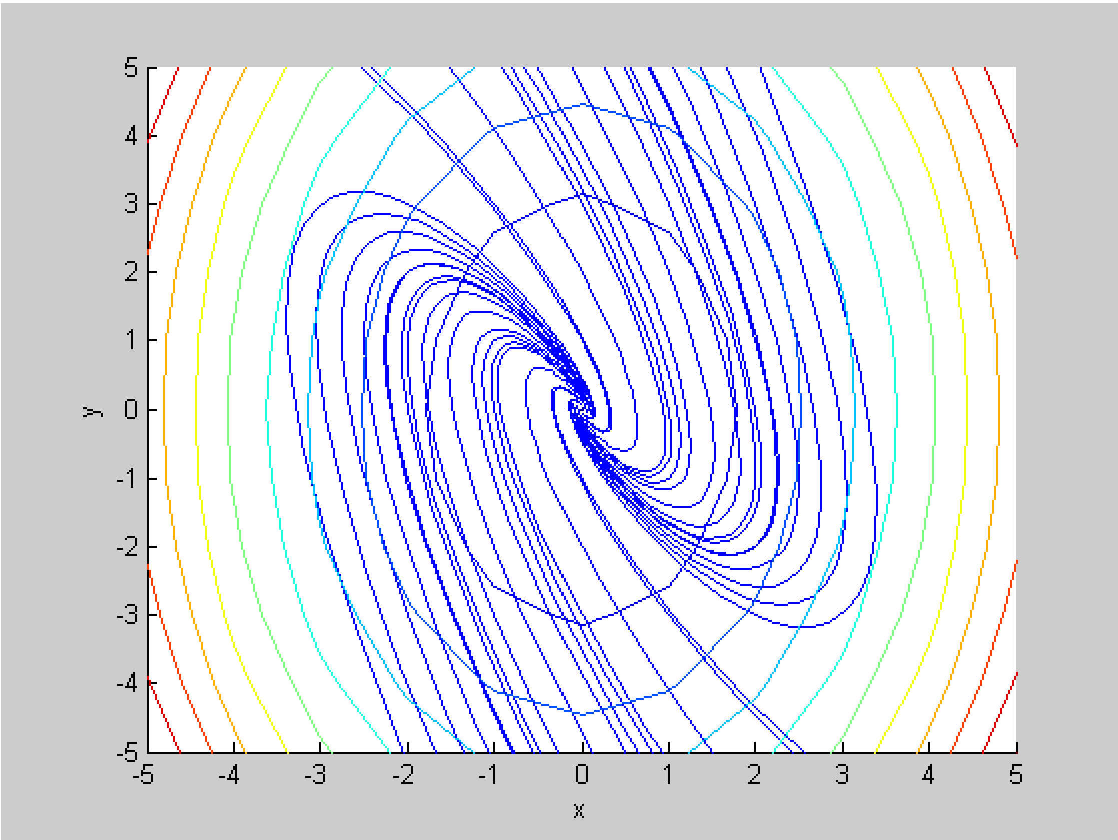
```
%We have: (delta)= (m)^2- det(A)

                %= (m)^2- [(m)^2-2]

                %= 2 or (delta)^(1/2)= 2^(1/2)

% Since (delta)>0, we can conclude that there are 2 simple real roots. And

% thus, the plot of it can either be: Nodal Sink if m < -2^(1/2); Nodal

% Source if m> 2^(1/2); Saddle if -2^(1/2)< m < 2^(1/2); Linear Sink if m=

% -2^(1/2), Linear Source if m= 2^(1/2)


% In other to illustrate these predictions, paticular values of m is chosen
that can satisfy the conditions of 5 casese above

% and also staying in the interval [-2;2]

%---------------------------------------------------------------------------

% A> m=-2

ivp='Dx= -1*x-y,Dy=3*x-3*y,x(0)=a,y(0)=b';

[x,y]=dsolve(ivp,'t');

xf=@(t,a,b)eval(vectorize(x));

yf=@(t,a,b)eval(vectorize(y));

figure;hold on

t= -3:0.1:3;

for a= -2:2

    for b=-3:3

        plot(xf(t,a,b),yf(t,a,b))

    end
```

```
end
[X,Y]=meshgrid(-5:5,-5:5);
contour(X, Y, 3*X.^2 - 2*X*Y + Y.^2)
hold off
axis ([-5 5 -5 5])
xlabel 'x'
ylabel 'y'
% the plot is stable Nodal Sink (attractive) lies inside the contour of the
% function: 3 x^2 - 2 x y + y^2
```



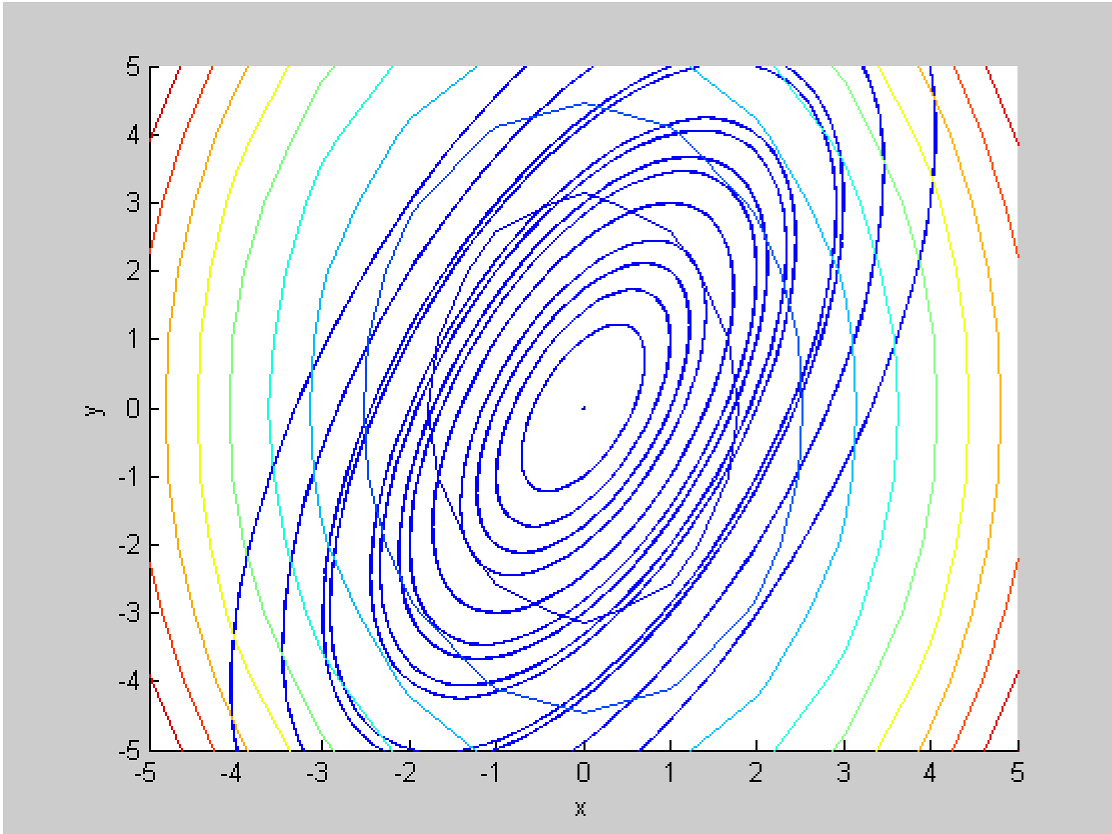

```
% B> m= -2^(1/2)
ivp='Dx= (-2^(1/2)+1)*x-y,Dy=3*x-(-2^(1/2)-1)*y,x(0)=a,y(0)=b';
[x,y]=dsolve(ivp,'t');
xf=@(t,a,b)eval(vectorize(x));
yf=@(t,a,b)eval(vectorize(y));
figure;hold on
```

```
t= -3:0.1:3;
for a= -2:2
    for b=-3:3
        plot(xf(t,a,b),yf(t,a,b))
    end
end
[X,Y]=meshgrid(-5:5,-5:5);
contour(X, Y, 3*X.^2 - 2*X*Y + Y.^2)
hold off
axis ([-5 5 -5 5])
xlabel 'x'
ylabel 'y'
% the matrix id Linear Sink (stable) lies inside the contour of the
% function: 3 x^2 - 2 x y + y^2
```



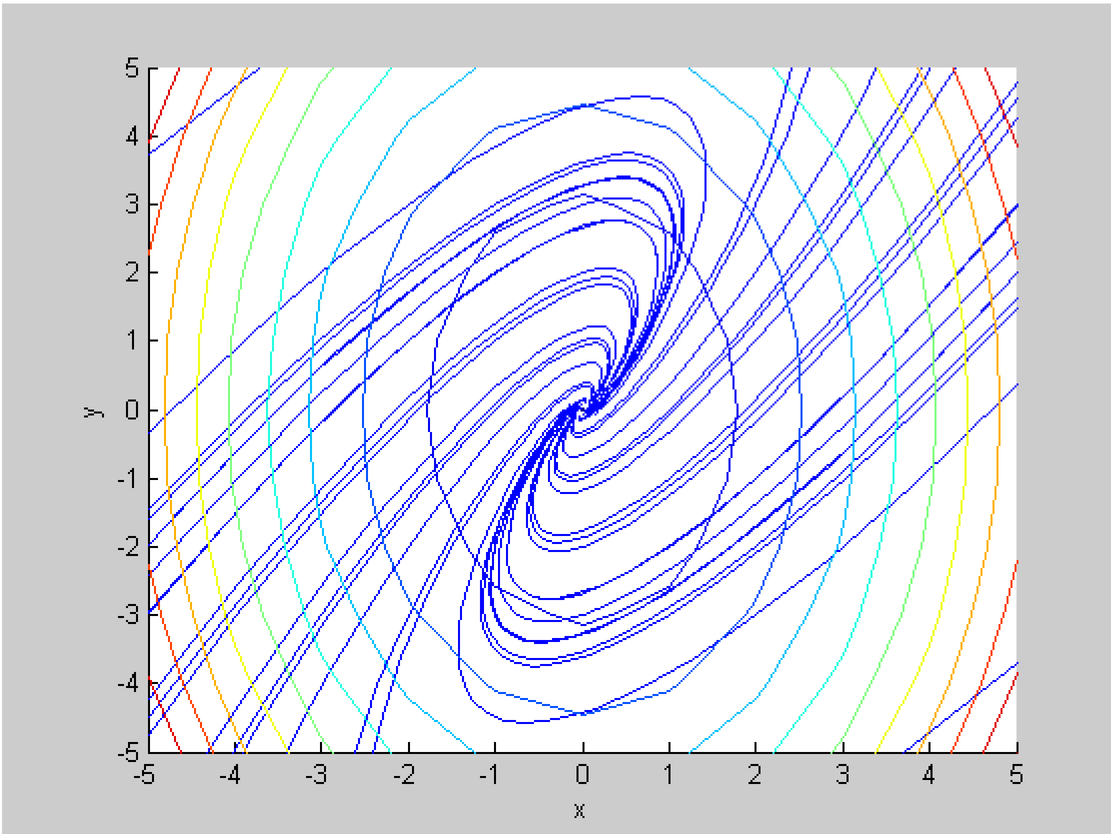

```
%C> m=0
```

```
ivp='Dx= x-y,Dy=3*x-y,x(0)=a,y(0)=b';
[x,y]=dsolve(ivp,'t');
xf=@(t,a,b)eval(vectorize(x));
yf=@(t,a,b)eval(vectorize(y));
figure;hold on
t= -3:0.1:3;
for a= -2:2
    for b=-3:3
        plot(xf(t,a,b),yf(t,a,b))
    end
end
[X,Y]=meshgrid(-5:5,-5:5);
contour(X, Y, 3*X.^2 - 2*X*Y + Y.^2)
hold off
axis ([-5 5 -5 5])
xlabel 'x'
ylabel 'y'
% the matrix id Saddle (unstable) lies inside the contour of the
% function: 3 x^2 - 2 x y + y^2
```



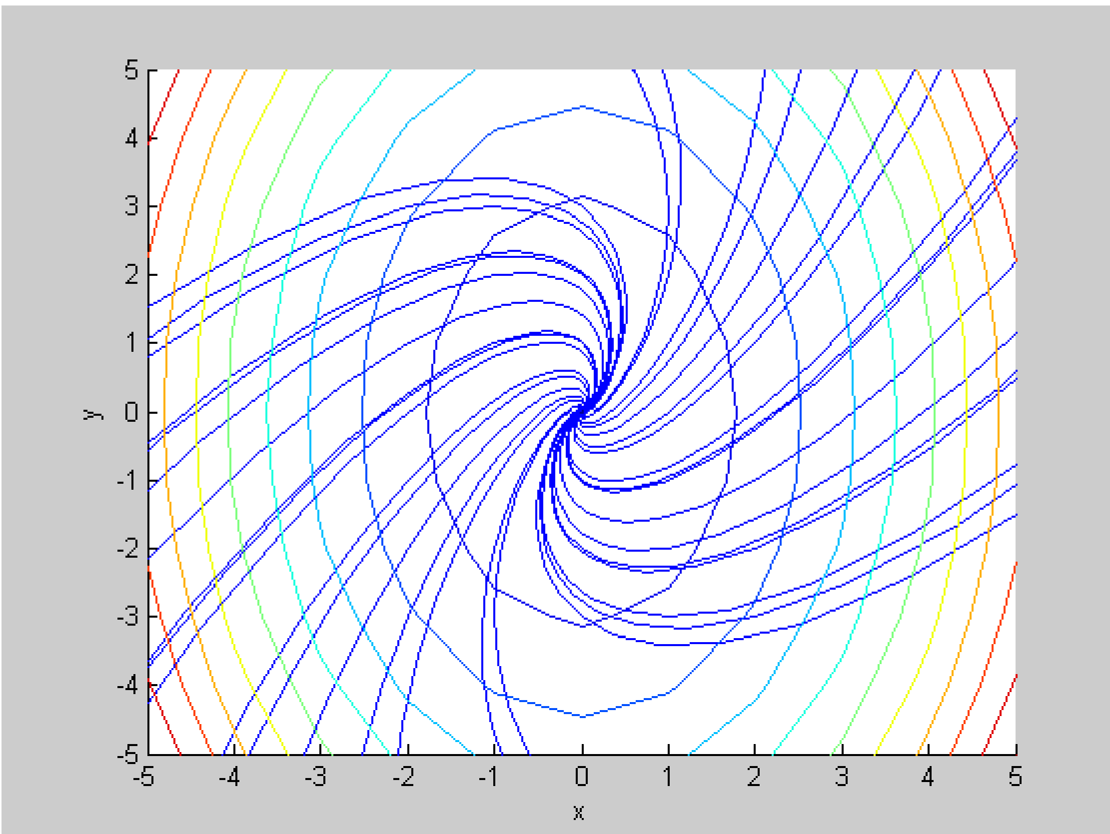

```
%D> m= 2^(1/2)

ivp='Dx= (2^(1/2)+1)*x-y,Dy=3*x-(2^(1/2)-1)*y,x(0)=a,y(0)=b';

[x,y]=dsolve(ivp,'t');

xf=@(t,a,b)eval(vectorize(x));

yf=@(t,a,b)eval(vectorize(y));

figure;hold on

t= -3:0.1:3;

for a= -2:2

    for b=-3:3

        plot(xf(t,a,b),yf(t,a,b))

    end

end

[X,Y]=meshgrid(-5:5,-5:5);

contour(X, Y, 3*X.^2 - 2*X*Y + Y.^2)

hold off

axis ([-5 5 -5 5])
```

```
xlabel 'x'
ylabel 'y'
% the matrix id Linear Source (unstable) lies inside the contour of the
% function: 3 x^2 - 2 x y + y^2
```




```
%E> m=2
ivp='Dx= 3*x-y,Dy=3*x+y,x(0)=a,y(0)=b';
[x,y]=dsolve(ivp,'t');
xf=@(t,a,b)eval(vectorize(x));
yf=@(t,a,b)eval(vectorize(y));
figure;hold on
t= -3:0.1:3;
for a= -2:2
    for b=-3:3
        plot(xf(t,a,b),yf(t,a,b))
    end
end
```

```
[X,Y]=meshgrid(-5:5,-5:5);

contour(X, Y, 3*X.^2 - 2*X*Y + Y.^2)

hold off

axis ([-5 5 -5 5])

xlabel 'x'

ylabel 'y'

% the matrix is the unstable Nodal Source (repelling) lies inside the contour
of the

% function: 3 x^2 - 2 x y + y^2
```



Conclusion:

At m= -2, the phase plane is Nodal Sink. As m increased to -2^(1/2), the phase plane angled to the left and became Linear Sink. As m increased to 0, it became Saddle. With m increased to 2^(1/2), the phase plane became Linear Source. Finally, as m increased to 2, it became Nodal Source