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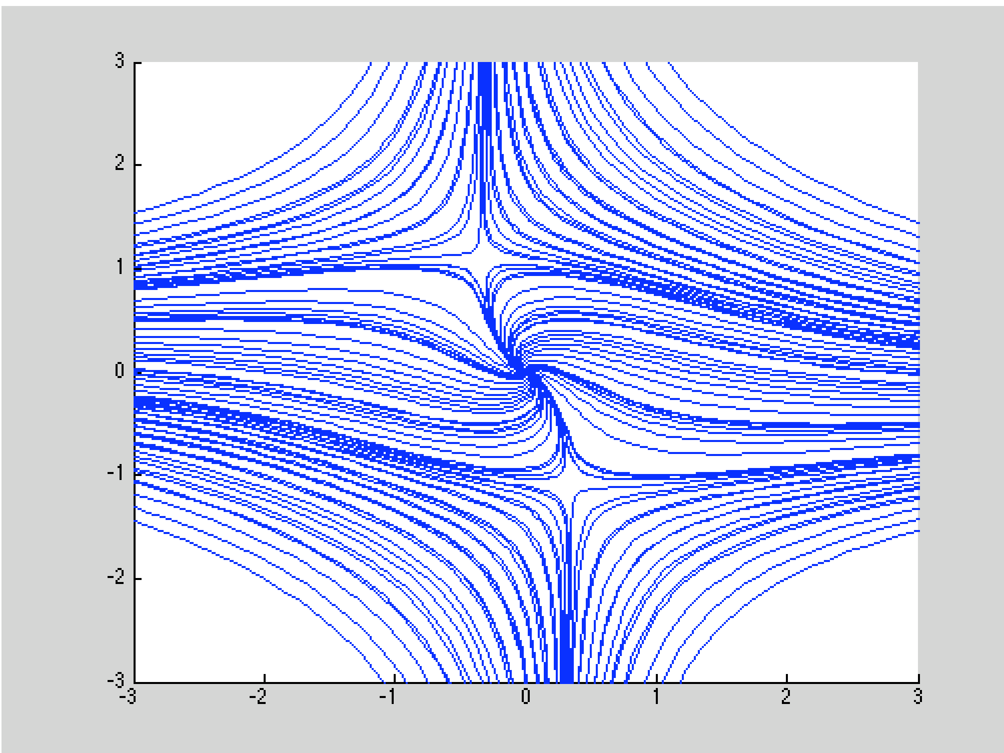
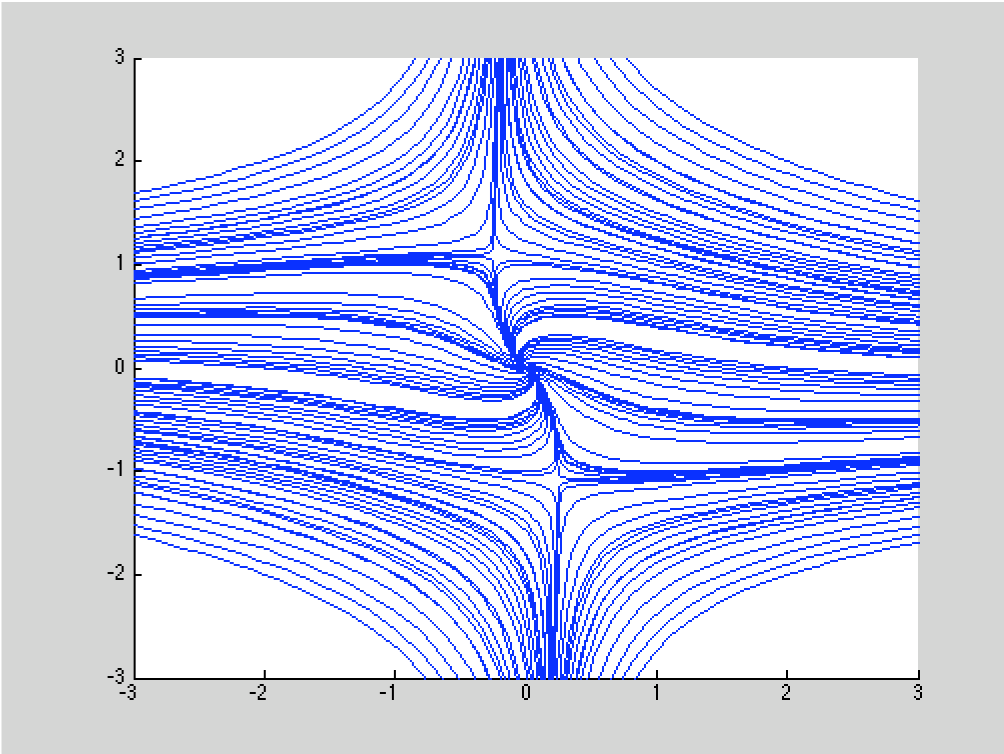
%Omar Sabir
% MATLAB extra credit project (section 9.3: problems 15 & 16)

warning off all
for w = 0:0.2:1
f = @(t, x) (1-w)*[-2*x(1)-x(2)-x(1)*(x(1)^2+x(2)^2); x(1)-x(2)+x(2)*(x(1)^2+x(2)^2)] +  w*[x(2)+x(1)*(1-x(1)^2-x(2)^2); -x(1)+x(2)*(1
figure; hold on
for a = -2:0.25:2
for b = -2:0.5:2
[t, xa] = ode45(f, [0 10], [a b]);
plot(xa(:,1), xa(:,2))
[t, xa] = ode45(f, [0 -5], [a b]);
plot(xa(:,1), xa(:,2))
end
end
axis([-3 3 -3 3])
end
```

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2
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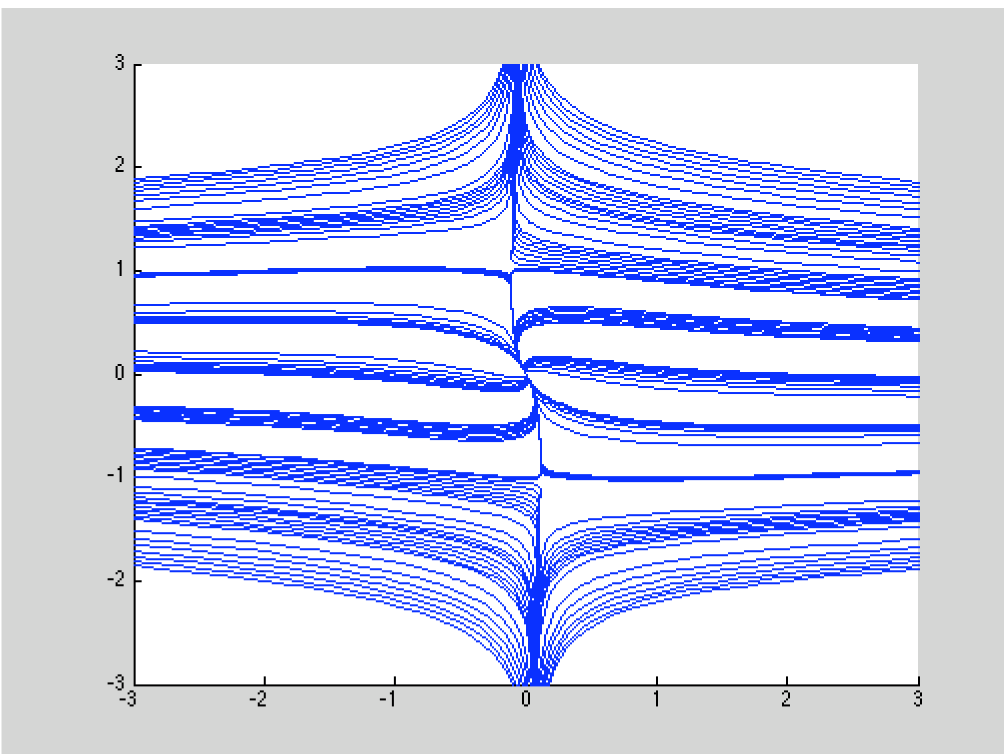
-2
-3
-3
-2
-1
0
1
2
3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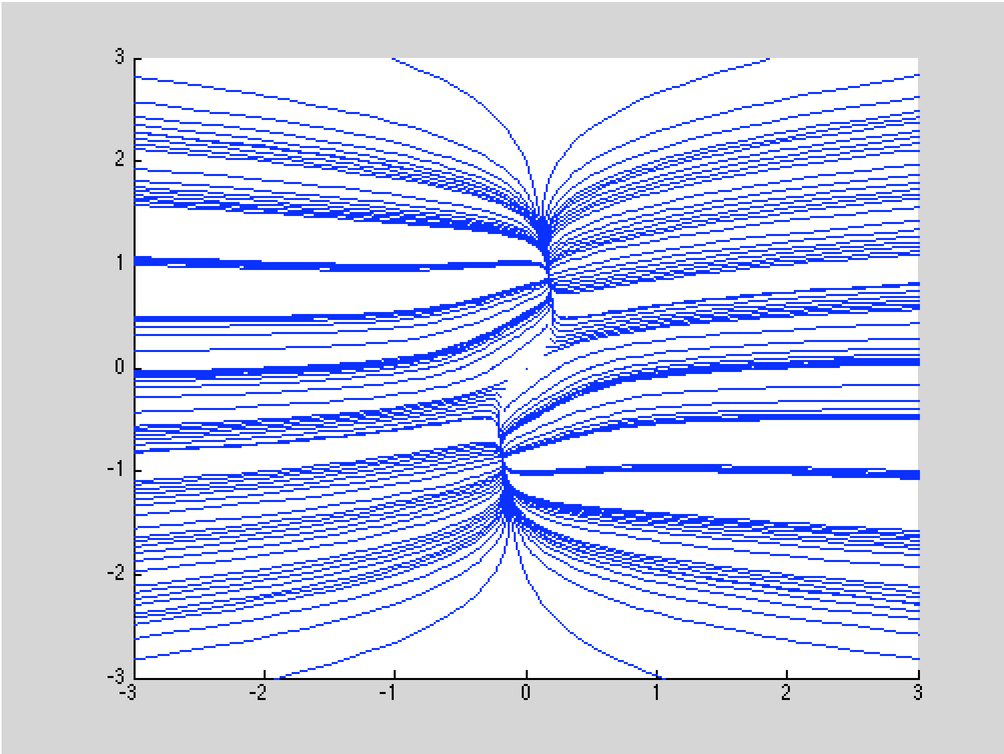

3
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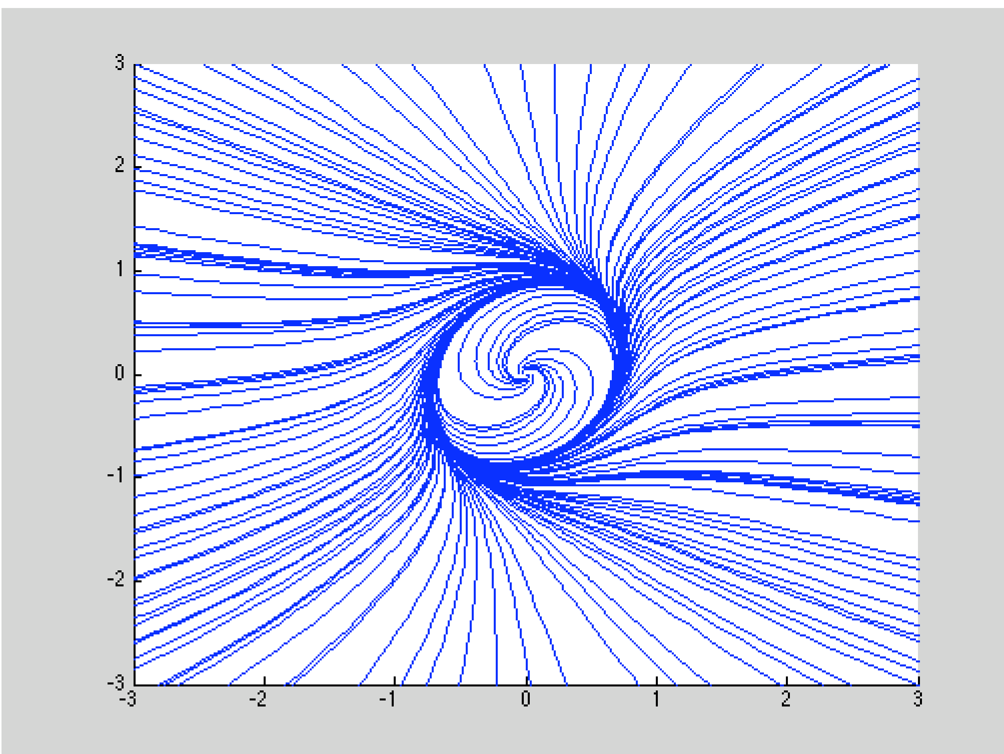

3
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-3
-2
-1
0
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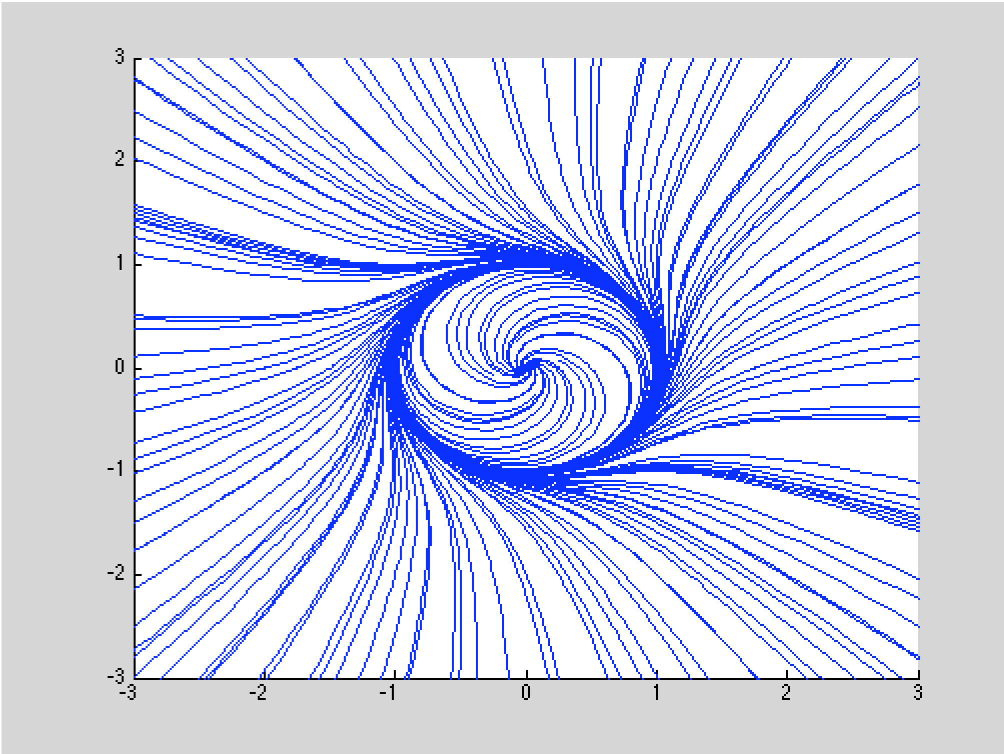
2
3



graphs 1(w=0), 2(w=0.2) & 3(w=0.4)

Starting with the first graph, there are three critical points: (0,0) , (-0.33076,1.0924), (0.33076,-1.0924) The two points (-0.33076,1.0924) & (0.33076,-1.0924) are saddles, and so they are both unstable. The point (0,0) is a counterclockwise spiral sink, and so it's attracting. Then, we can see that graph 2 and 3 are pretty much the same, but they are slightly different showing the transition to graph 4.

graph4 (w=0.6)

There are two critical points in this graph: (0.33076,1.0924) & (-0.33076,-1.0924) The three critical points from the previous graphs disappeared, and another two critical points appeared in this graph. They appear to be nodal sources in this graph where the trajectory in the x-direction is higher and more effective than the y-direction trajectory which shows that the eigenvalue for the vector in the x-direction is higher than the one for the y-direction.

graphs 5(w=0.8) & 6(w=1.0)

The two critical points from graph 4 diappeared, and one of the previous critical points appears again, and that point is (0,0). The eigenvalues are 1+i & 1-i , and so the points (0,0) is a spiral source, and so it's repelling and unstable.