Jessica Ernst

Extra Credit: p. 525 3, 5

Number 3

First Time alpha=1 Critical Points

```
clear all
close all
syms x y
sys1=x*(1.5-.5*x-y);
sys2=y*(2-y-1.125*x);
[xc, yc]=solve(sys1, sys2, x, y);
disp('Critical Points:'); disp([xc, yc])
%
A=jacobian([sys1 sys2], [x y]);
evals=eig(A);
disp('Eigenvalues at (0, 0):')
disp(double(subs(evals, {x, y}, {0, 0})))
disp('Eigenvalues at (0, 2):');
disp(double(subs(evals, {x, y}, {0, 2})))
disp('Eigenvalues at (3, 0):');
disp(double(subs(evals, {x, y}, {3, 0})))
disp('Eigenvalues at (4/5, 11/10):');
disp(double(subs(evals, {x, y}, {4/5, 11/10})))
%
[X,Y]=meshgrid(-1:0.1:3, -1:0.3:3);
U=X.*(1.5-.5.*X-Y);
V=Y.*(2-Y-1.125.*X);
L=sqrt((U/3).^2+(V/4.5).^2);
quiver(X, Y, U./L, V./L, .4);
```

```
axis tight
xlabel x
ylabel y
title 'vector field for problem 3'
%
warning off all
f=@(t, x)[x(1)*(1.5-.5*x(1)-x(2)); x(2)*(2-x(2)-1.125*x(1))];
figure; hold on
for a=[1 2]
for b=.1:.1:.9
[t, xa]=ode45(f, [0 20], [a*b a*2.5*(1-b)]);
plot(xa(:,1), xa(:,2))
[t, xa]=ode45(f, [0 -5], [a*b a*2.5*(1-b)]);
plot(xa(:,1), xa(:,2))
end
end
axis([-1 3 -1 3])
xlabel x
ylabel y
title 'Trajectories for Problem 3'
% Combined Portrait and Vector Field
hold on
quiver(X, Y, U./L, V./L, 0.4)
axis([-1 3 -1 3])
title 'Vector Field and Trajectories for Problem 3'
```

Critical Points:

[0, 0]

[0, 2]

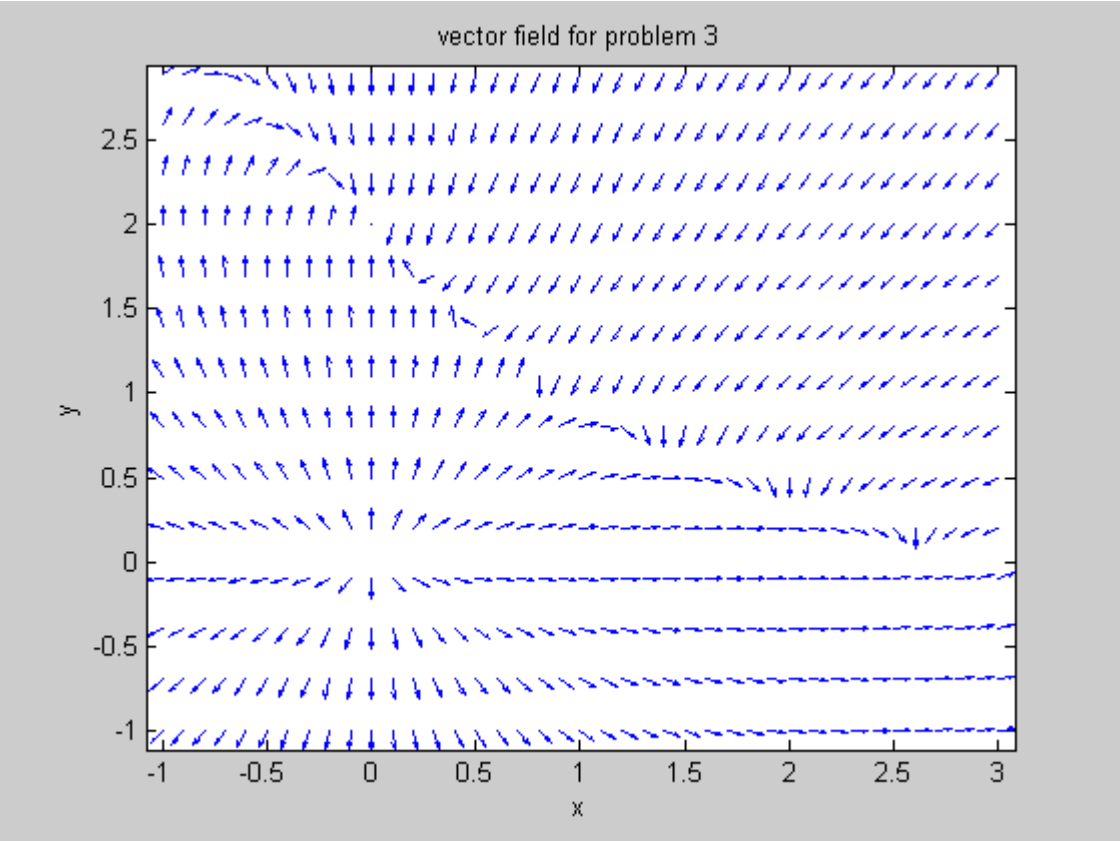
[3, 0]

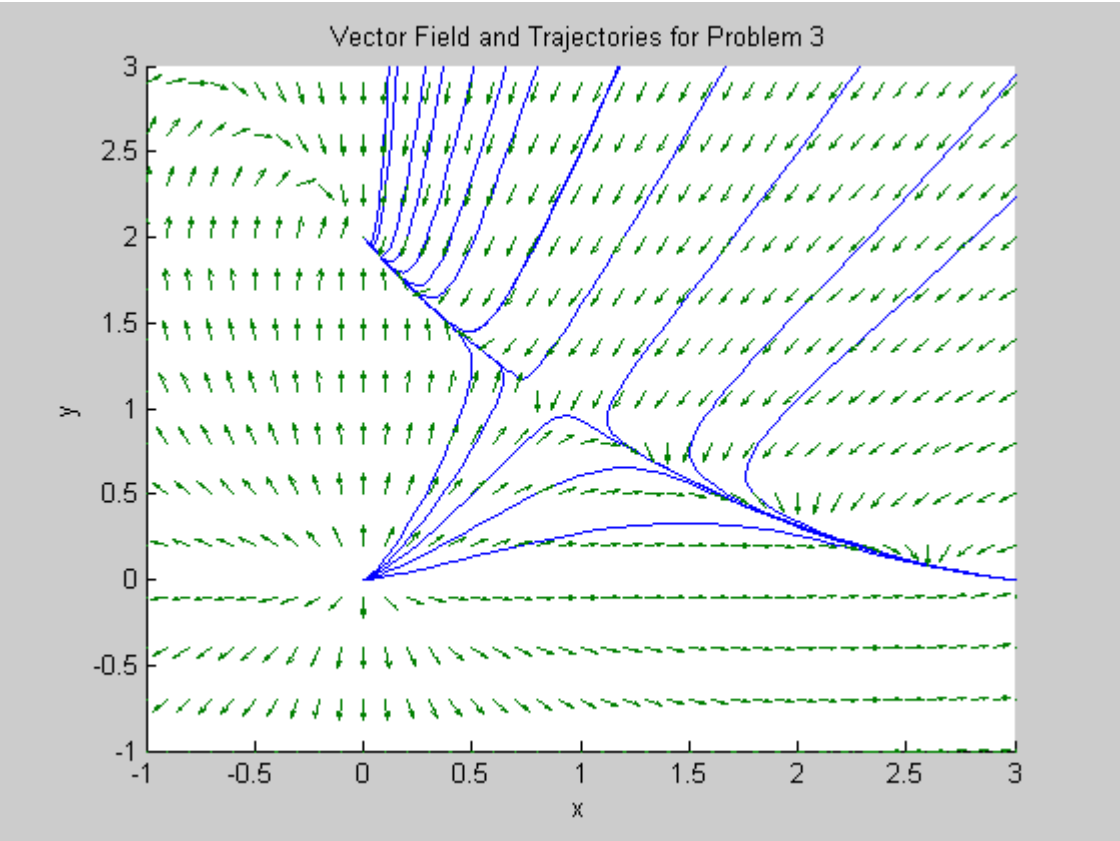
[4/5, 11/10]

Eigenvalues at (0, 0):

1.5000

```
    2.0000

Eigenvalues at (0, 2):
   -2.0000
   -0.5000

Eigenvalues at (3, 0):
   -1.5000
   -1.3750

Eigenvalues at (4/5, 11/10):
   -1.8048
    0.3048
```





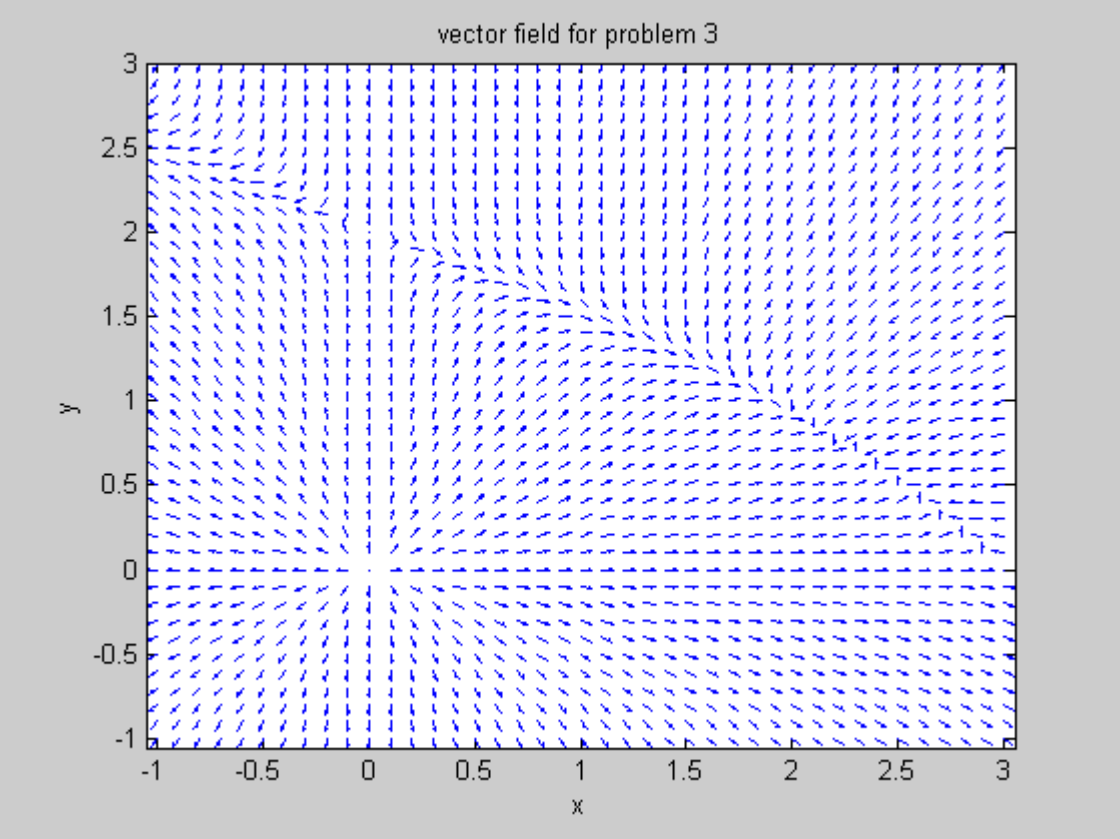
Second Time Alpha=.5 Critical Points

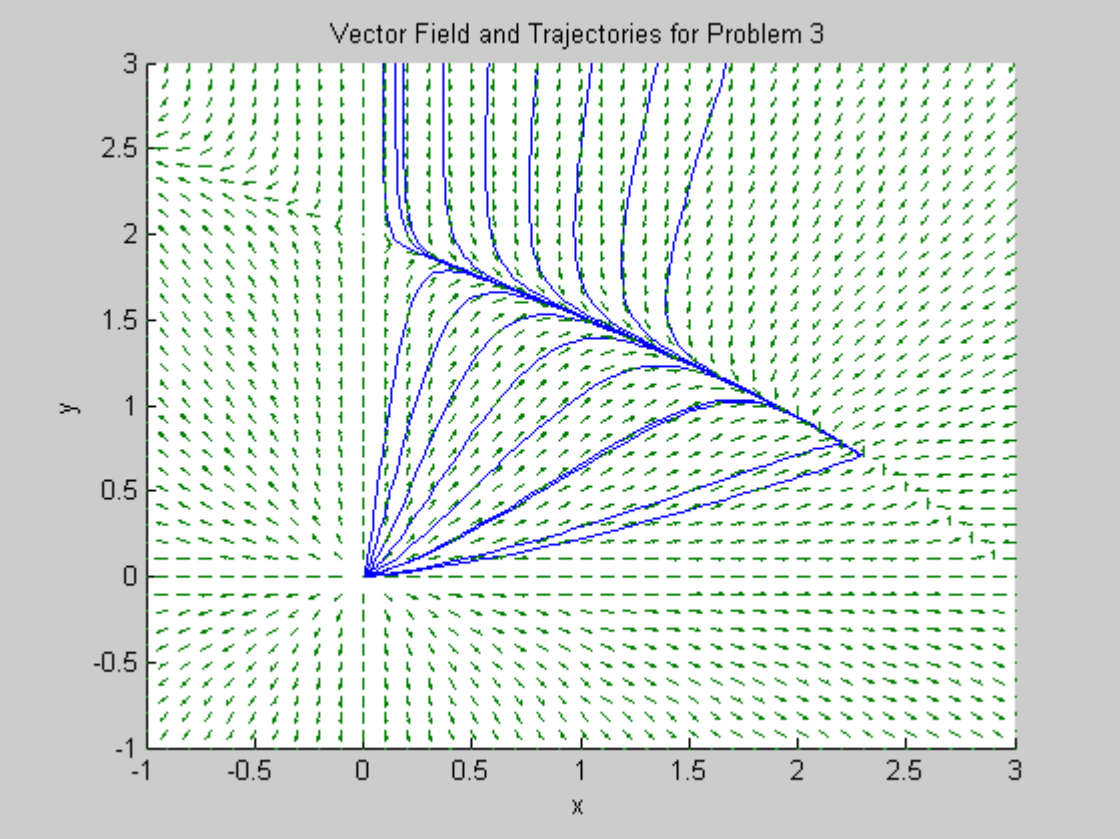
```
clear all
close all
syms x y
sys1=x*(1.5-.5*x-.5*y);
sys2=y*(2-y-.5625*x);
[xc, yc]=solve(sys1, sys2, x, y);
disp('Critical Points:'); disp([xc, yc])
%
A=jacobian([sys1 sys2], [x y]);
evals=eig(A);
disp('Eigenvalues at (0, 0):')
```

```
disp(double(subs(evals, {x, y}, {0, 0})))
disp('Eigenvalues at (0, 2):');
disp(double(subs(evals, {x, y}, {0, 2})))
disp('Eigenvalues at (3, 0):');
disp(double(subs(evals, {x, y}, {3, 0})))
disp('Eigenvalues at (16/7, 5/7):');
disp(double(subs(evals, {x, y}, {16/7, 5/7})))
%
[X,Y]=meshgrid(-1:0.1:3, -1:0.1:3);
U=X.*(1.5-.5.*X-.5.*Y);
V=Y.*(2-Y-.5625.*X);
L=sqrt((U/3).^2+(V/3).^2);
quiver(X, Y, U./L, V./L, .4);
axis tight
xlabel x
ylabel y
title 'vector field for problem 3'
%
warning off all
f=@(t, x)[x(1)*(1.5-.5*x(1)-.5*x(2)); x(2)*(2-x(2)-.5625*x(1))];
figure; hold on
for a=[1 2]
for b=.1:.1:.9
[t, xa]=ode45(f, [0 20], [a*b a*2.5*(1-b)]);
plot(xa(:,1), xa(:,2))
[t, xa]=ode45(f, [0 -5], [a*b a*2.5*(1-b)]);
plot(xa(:,1), xa(:,2))
end
end
axis([-1 3 -1 3])
xlabel x
ylabel y
title 'Trajectories for Problem 3'
% Combined Portrait and Vector Field
```

```
      hold on
      quiver(X, Y, U./L, V./L, 0.4)
      axis([-1 3 -1 3])
      title 'Vector Field and Trajectories for Problem 3'
```

```
Critical Points:
[    0,   0]
[    0,   2]
[    3,   0]
[ 16/7, 5/7]

Eigenvalues at (0, 0):
    1.5000
    2.0000

Eigenvalues at (0, 2):
   -2.0000
    0.5000

Eigenvalues at (3, 0):
   -1.5000
    0.3125

Eigenvalues at (16/7, 5/7):
   -1.6393
   -0.2179
```


vector field for problem 3
3
2.5
2
1.5
1
0.5
0
-0.5
-1
y
-1
-0.5
0
0.5
1
1.5
2
2.5
3
x



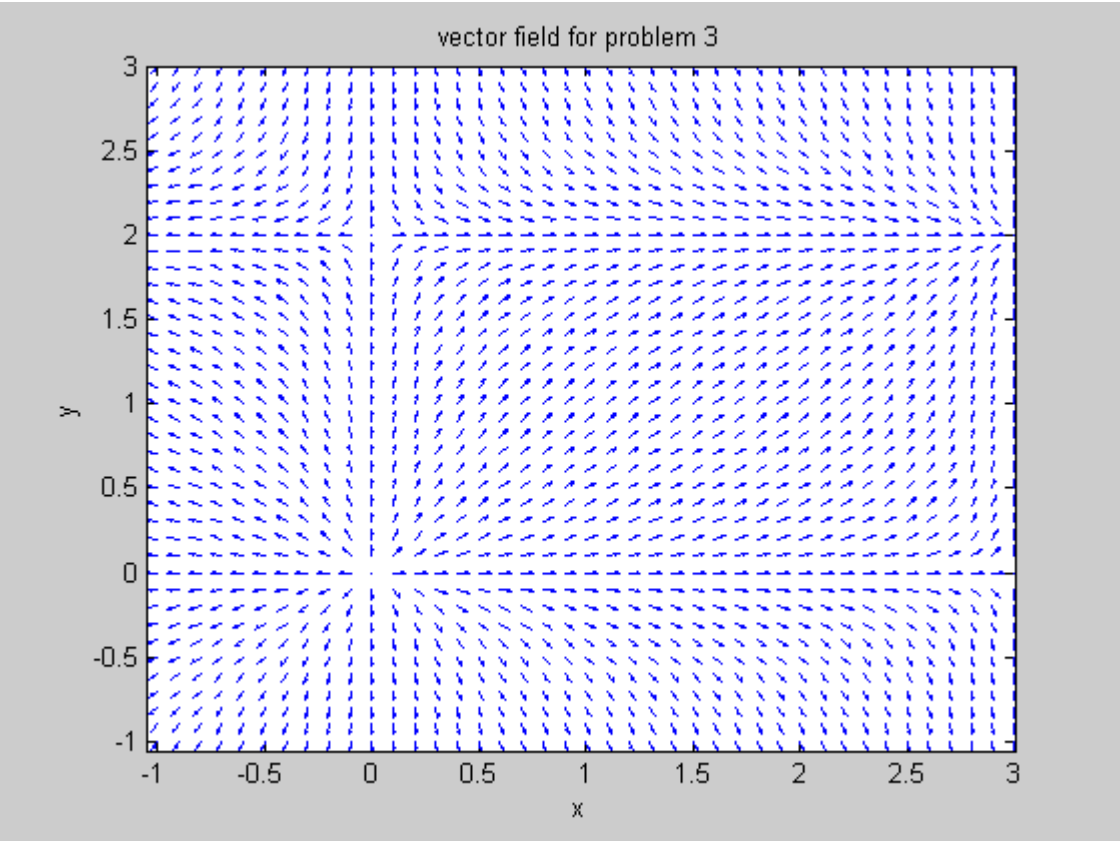
Third Time alpha=0 Critical Points

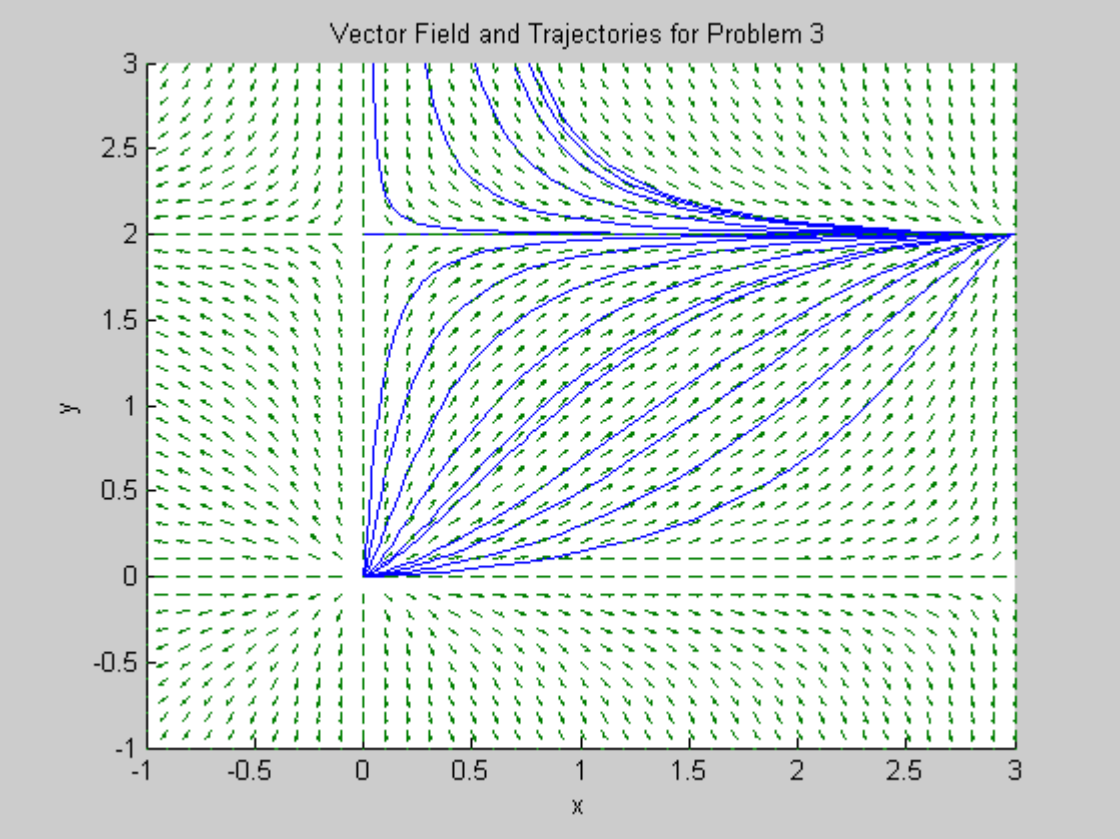
```
clear all
close all
syms x y
sys1=x*(1.5-.5*x);
sys2=y*(2-y);
[xc, yc]=solve(sys1, sys2, x, y);
disp('Critical Points:'); disp([xc, yc])
%
A=jacobian([sys1 sys2], [x y]);
evals=eig(A);
disp('Eigenvalues at (0, 0):')
disp(double(subs(evals, {x, y}, {0, 0})))
disp('Eigenvalues at (0, 2):');
```

```
disp(double(subs(evals, {x, y}, {0, 2})))
disp('Eigenvalues at (3, 0):');
disp(double(subs(evals, {x, y}, {3, 0})))
disp('Eigenvalues at (3, 2):');
disp(double(subs(evals, {x, y}, {3, 2})))
%
[X,Y]=meshgrid(-1:0.1:3, -1:0.1:3);
U=X.*(1.5-.5.*X);
V=Y.*(2-Y);
L=sqrt((U/3).^2+(V/3).^2);
quiver(X, Y, U./L, V./L, .4);
axis tight
xlabel x
ylabel y
title 'vector field for problem 3'
%
warning off all
f=@(t, x)[x(1)*(1.5-.5*x(1)); x(2)*(2-x(2))];
figure; hold on
for a=[1 2]
for b=.1:.1:.9
[t, xa]=ode45(f, [0 20], [a*b a*2.5*(1-b)]);
plot(xa(:,1), xa(:,2))
[t, xa]=ode45(f, [0 -5], [a*b a*2.5*(1-b)]);
plot(xa(:,1), xa(:,2))
end
end
axis([-1 3 -1 3])
xlabel x
ylabel y
title 'Trajectories for Problem 3'
% Combined Portrait and Vector Field
hold on
quiver(X, Y, U./L, V./L, 0.4)
```

```
axis([-1 3 -1 3])
title 'Vector Field and Trajectories for Problem 3'
% When you change the coefficient of the last term from -1 to -.5 the graph
% don't change very much. However the set of equations act differently
% because in the first attempt of the phase portrait the vector field
% splits and goes opposite directions but in the second attempt they all go
% to the right.  Then in the third attempt because of the third critical
% point being (3, 2) the vector field curves instead of being in straight
% lines because they have to hit all of the critical points.
```

```
Critical Points:
[ 0, 0]
[ 0, 2]
[ 3, 0]
[ 3, 2]

Eigenvalues at (0, 0):
    1.5000
    2.0000

Eigenvalues at (0, 2):
    1.5000
   -2.0000

Eigenvalues at (3, 0):
   -1.5000
    2.0000

Eigenvalues at (3, 2):
   -1.5000
   -2.0000
```


vector field for problem 3
3
2.5
2
1.5
1
0.5
0
-0.5
-1
y
-1
-0.5
0
0.5
1
1.5
2
2.5
3
x



Number 5

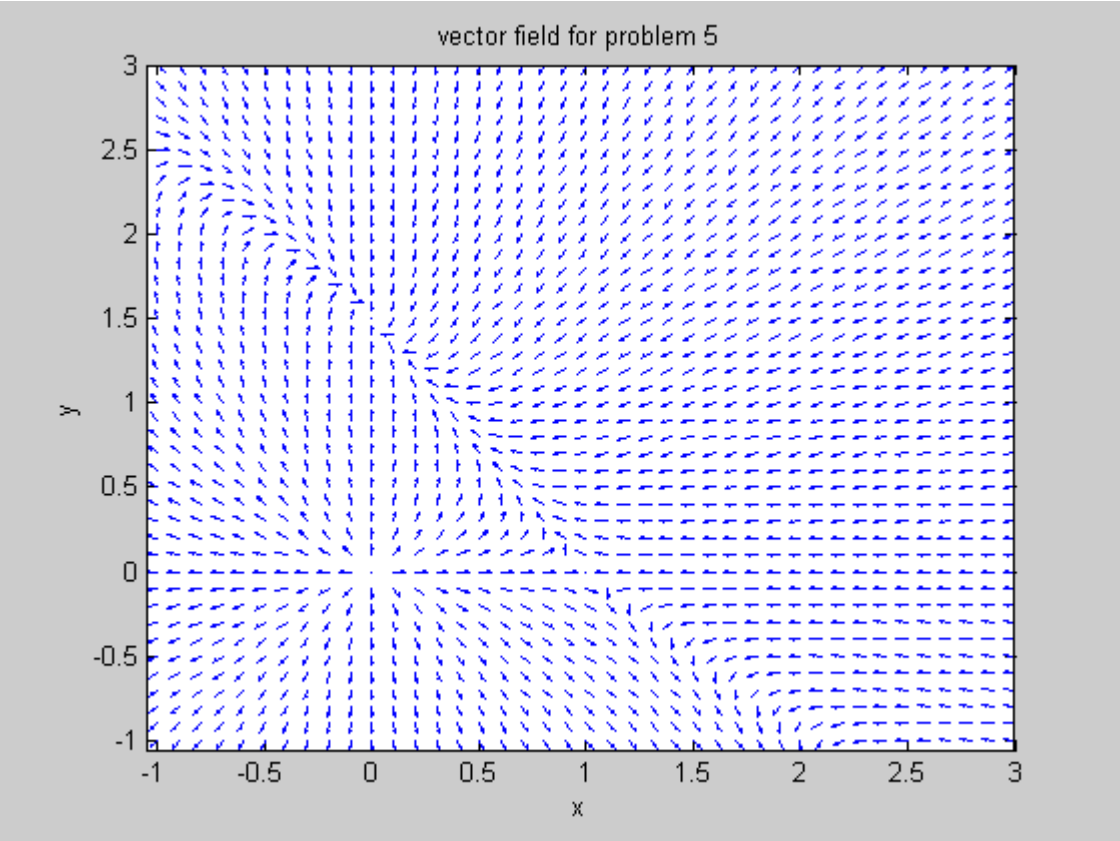
First Time alpha=1 Critical Points

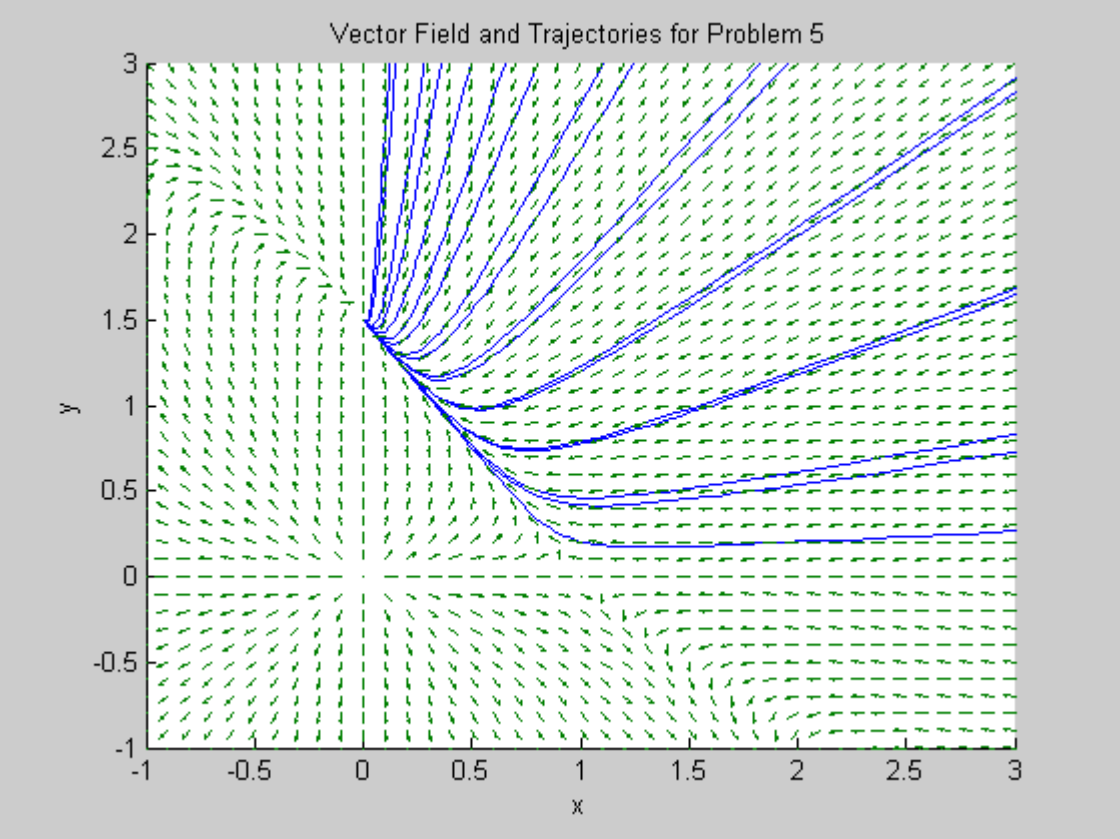
```
clear all
close all
syms x y
sys1=x*(1-x-y);
sys2=y*(1.5-y-x);
[xc, yc]=solve(sys1, sys2, x, y);
disp('Critical Points:'); disp([xc, yc])
%
A=jacobian([sys1 sys2], [x y]);
evals=eig(A);
disp('Eigenvalues at (0, 0):')
disp(double(subs(evals, {x, y}, {0, 0})))
```

```
disp('Eigenvalues at (1, 0):');
disp(double(subs(evals, {x, y}, {0, 2})))
disp('Eigenvalues at (0, 3/2):');
disp(double(subs(evals, {x, y}, {3, 0})))
%
[X,Y]=meshgrid(-1:0.1:3, -1:0.1:3);
U=X.*(1-X-Y);
V=Y.*(1.5-Y-X);
L=sqrt((U/3).^2+(V/3).^2);
quiver(X, Y, U./L, V./L, .4);
axis tight
xlabel x
ylabel y
title 'vector field for problem 5'
%
warning off all
f=@(t, x)[x(1)*(1-x(1)-x(2)); x(2)*(1.5-x(2)-x(1))];
figure; hold on
for a=[1 2]
for b=.1:.1:.9
[t, xa]=ode45(f, [0 20], [a*b a*2.5*(1-b)]);
plot(xa(:,1), xa(:,2))
[t, xa]=ode45(f, [0 -5], [a*b a*2.5*(1-b)]);
plot(xa(:,1), xa(:,2))
end
end
axis([-1 3 -1 3])
xlabel x
ylabel y
title 'Trajectories for Problem 5'
% Combined Portrait and Vector Field
hold on
quiver(X, Y, U./L, V./L, 0.4)
axis([-1 3 -1 3])
```

```
      title 'Vector Field and Trajectories for Problem 5'
```

```
Critical Points:
[ 0,   0]
[ 1,   0]
[ 0, 3/2]

Eigenvalues at (0, 0):
    1.0000
    1.5000

Eigenvalues at (1, 0):
   -2.5000
   -1.0000

Eigenvalues at (0, 3/2):
   -5.0000
   -1.5000
```


vector field for problem 5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
y
-1
-0.5
0
0.5
1
1.5
2
2.5
3
x



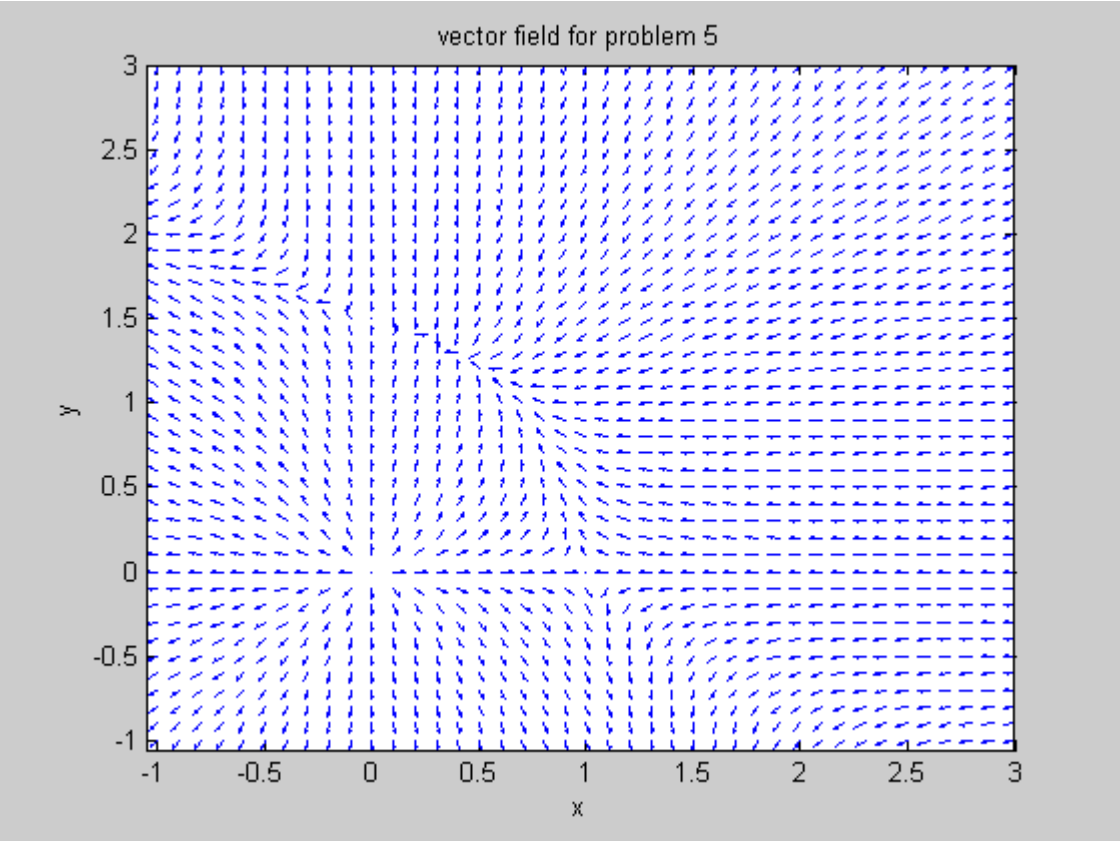
Second Attempt alpha=.5 Critical Points

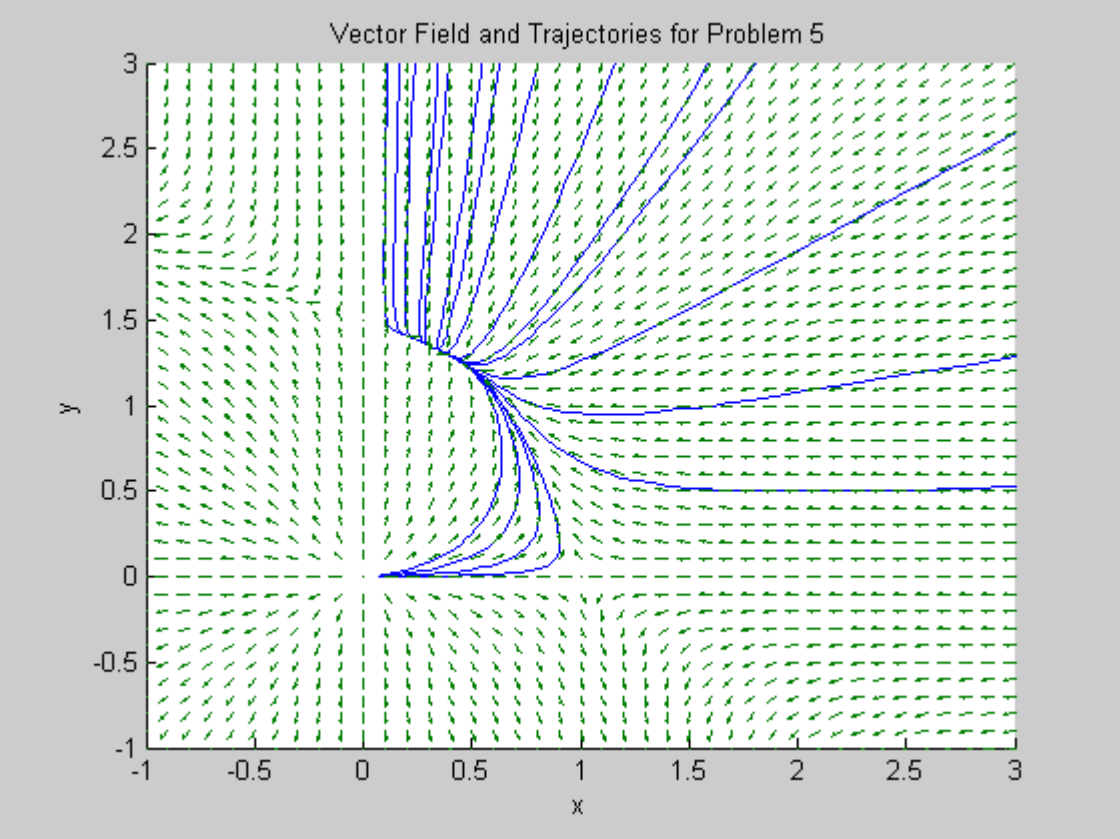
```
clear all
close all
syms x y
sys1=x*(1-x-.5*y);
sys2=y*(1.5-y-.5*x);
[xc, yc]=solve(sys1, sys2, x, y);
disp('Critical Points:'); disp([xc, yc])
%
A=jacobian([sys1 sys2], [x y]);
evals=eig(A);
disp('Eigenvalues at (0, 0):')
disp(double(subs(evals, {x, y}, {0, 0})))
disp('Eigenvalues at (1, 0):');
```

```
disp(double(subs(evals, {x, y}, {0, 2})))
disp('Eigenvalues at (0, 3/2):');
disp(double(subs(evals, {x, y}, {3, 0})))
disp('Eigenvalues at (1/3, 4/3):');
disp(double(subs(evals, {x, y}, {1/3, 4/3})))
%
[X,Y]=meshgrid(-1:0.1:3, -1:0.1:3);
U=X.*(1-X-.5.*Y);
V=Y.*(1.5-Y-.5.*X);
L=sqrt((U/3).^2+(V/3).^2);
quiver(X, Y, U./L, V./L, .4);
axis tight
xlabel x
ylabel y
title 'vector field for problem 5'
%
warning off all
f=@(t, x)[x(1)*(1-x(1)-.5*x(2)); x(2)*(1.5-x(2)-.5*x(1))];
figure; hold on
for a=[1 2]
for b=.1:.1:.9
[t, xa]=ode45(f, [0 20], [a*b a*2.5*(1-b)]);
plot(xa(:,1), xa(:,2))
[t, xa]=ode45(f, [0 -5], [a*b a*2.5*(1-b)]);
plot(xa(:,1), xa(:,2))
end
end
axis([-1 3 -1 3])
xlabel x
ylabel y
title 'Trajectories for Problem 5'
% Combined Portrait and Vector Field
hold on
quiver(X, Y, U./L, V./L, 0.4)
```

```
      axis([-1 3 -1 3])
      title 'Vector Field and Trajectories for Problem 5'
```

```
Critical Points:
[   0,   0]
[   1,   0]
[   0, 3/2]
[ 1/3, 4/3]

Eigenvalues at (0, 0):
    1.0000
    1.5000

Eigenvalues at (1, 0):
   -2.5000
         0

Eigenvalues at (0, 3/2):
    -5
     0

Eigenvalues at (1/3, 4/3):
   -1.4343
   -0.2324
```


vector field for problem 5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
y
-1
-0.5
0
0.5
1
1.5
2
2.5
3
x



Third Attempt alpha=0 Critical Points

```
clear all
close all
syms x y
sys1=x*(1-x);
sys2=y*(1.5-y);
[xc, yc]=solve(sys1, sys2, x, y);
disp('Critical Points:'); disp([xc, yc])
%
A=jacobian([sys1 sys2], [x y]);
evals=eig(A);
disp('Eigenvalues at (0, 0):')
disp(double(subs(evals, {x, y}, {0, 0})))
disp('Eigenvalues at (1, 0):');
```

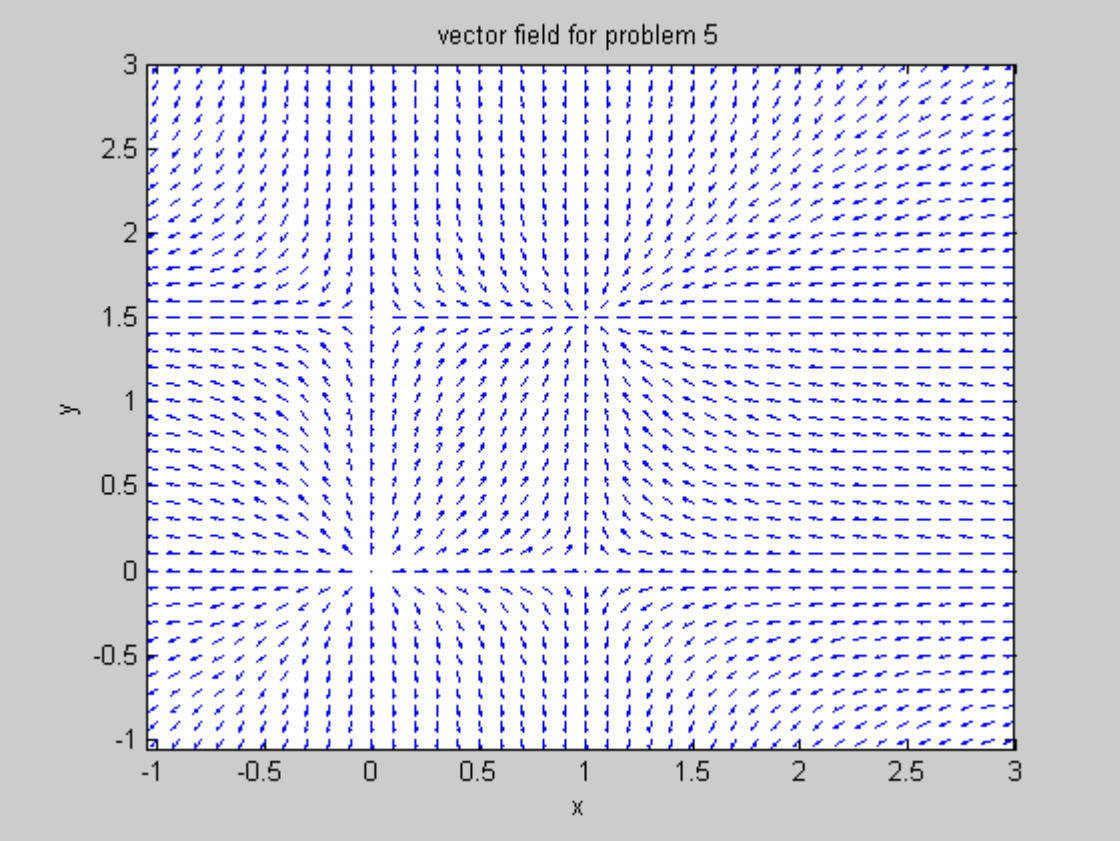
```
disp(double(subs(evals, {x, y}, {0, 2})))
disp('Eigenvalues at (0, 3/2):');
disp(double(subs(evals, {x, y}, {3, 0})))
disp('Eigenvalues at (1, 3/2):');
disp(double(subs(evals, {x, y}, {1, 3/2})))
%
[X,Y]=meshgrid(-1:0.1:3, -1:0.1:3);
U=X.*(1-X);
V=Y.*(1.5-Y);
L=sqrt((U/3).^2+(V/3).^2);
quiver(X, Y, U./L, V./L, .4);
axis tight
xlabel x
ylabel y
title 'vector field for problem 5'
%
warning off all
f=@(t, x)[x(1)*(1-x(1)); x(2)*(1.5-x(2))];
figure; hold on
for a=[1 2]
for b=.1:.1:.9
[t, xa]=ode45(f, [0 20], [a*b a*2.5*(1-b)]);
plot(xa(:,1), xa(:,2))
[t, xa]=ode45(f, [0 -5], [a*b a*2.5*(1-b)]);
plot(xa(:,1), xa(:,2))
end
end
axis([-1 3 -1 3])
xlabel x
ylabel y
title 'Trajectories for Problem 5'
% Combined Portrait and Vector Field
hold on
quiver(X, Y, U./L, V./L, 0.4)
```

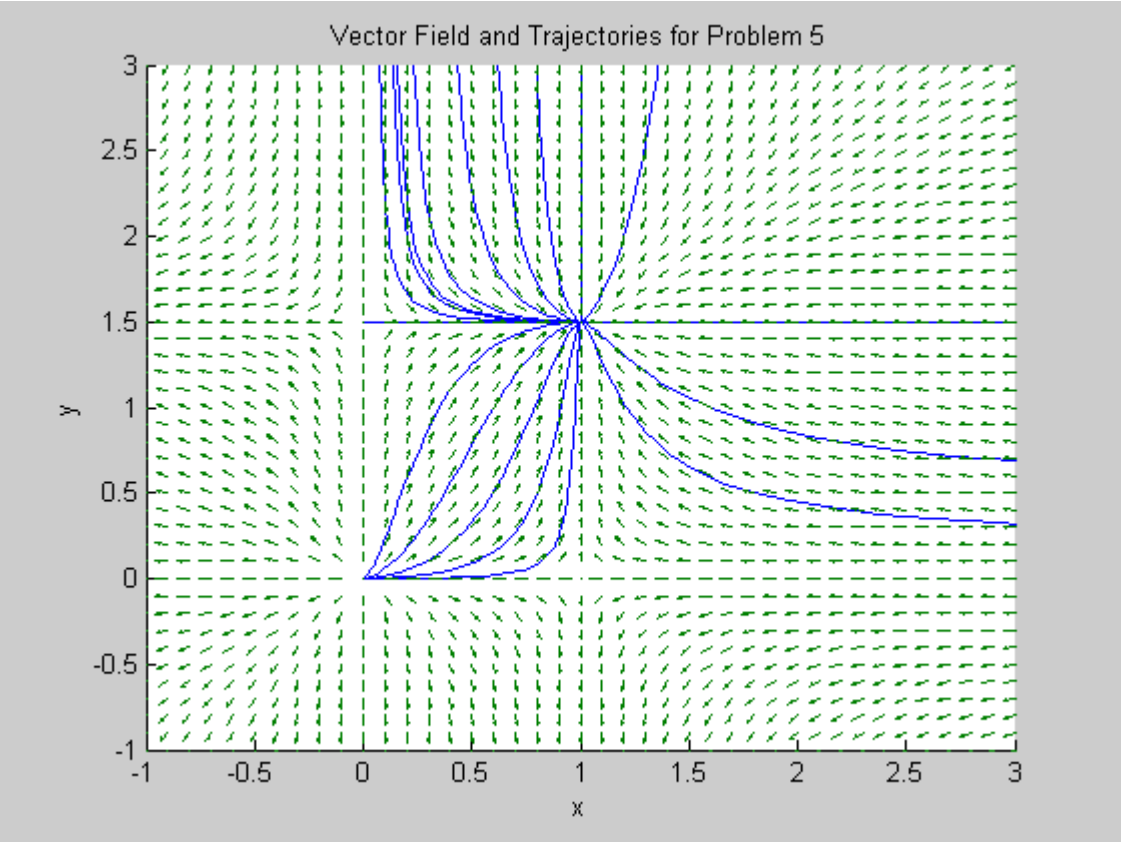
```
axis([-1 3 -1 3])
title 'Vector Field and Trajectories for Problem 5'
% In the first graph it is what one would expect from the kind of equation
% that this is but in the second one there is a critical point added which
% adds an intirely new group of vector fields to the graph. This is because
% the field has to act with all of the critical points. Then in the third
% graph almost everything is completely differnt the top vector fields that
% usually point right are now straight up and down and there are two more
% parts to the graph than in the first one. This is because there are not
% only one but two different critical points from the first one whereas int
% he second attempt it was only an addition of a critical point. These
% critical points tell you how and where the graphs are going to behave and
% by changing just one variable in both equations it can greatly influence
% the outcome.
```

```
Critical Points:
[ 0,   0]
[ 1,   0]
[ 0, 3/2]
[ 1, 3/2]

Eigenvalues at (0, 0):
    1.0000
    1.5000

Eigenvalues at (1, 0):
    1.0000
   -2.5000

Eigenvalues at (0, 3/2):
   -5.0000
    1.5000

Eigenvalues at (1, 3/2):
```

-1.0000

-1.5000


vector field for problem 5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
y
-1
-0.5
0
0.5
1
1.5
2
2.5
3
x


Vector Field and Trajectories for Problem 5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
y
-1
-0.5
0
0.5
1
1.5
2
2.5
3
x