```
% Math 244: MATLAB Assignment 7
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% Date: December 2, 2024
clear;
clc;
```
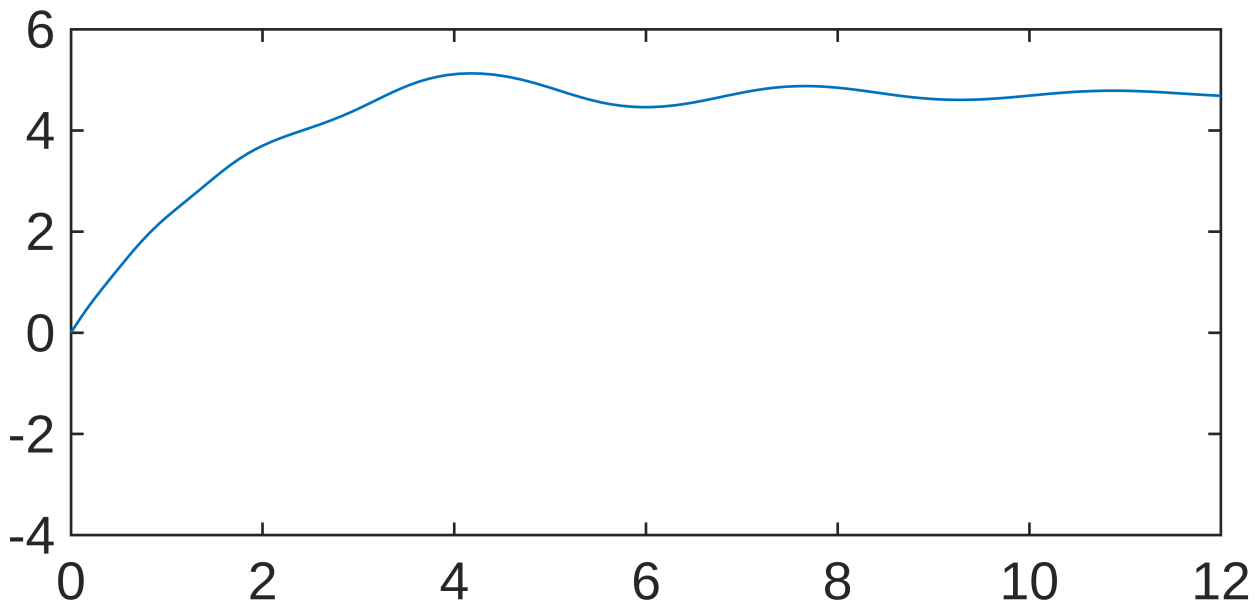
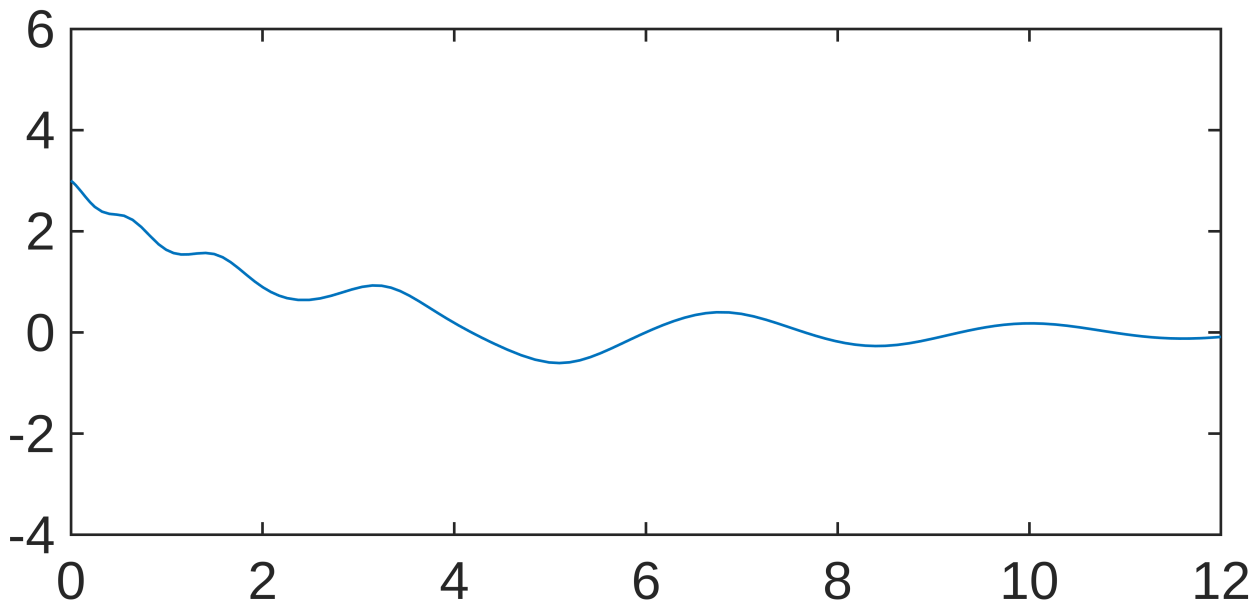

```
f = @(x,y) y;
g = @(x,y) -sin(4*x) - 0.5*y;
F = @(t, x) [f(x(1), x(2)); g(x(1), x(2))];

[t,x] = ode45(F, [0, 12], [0;3]);

xSol1 = x(:, 1);
ySol1 = x(:, 2);

figure();
set(gcf, 'Position', [100, 100, 800, 800]);
subplot(2,1,1)
plot(t, xSol1);
axis([0, 12, -4, 6]);

subplot(2, 1, 2)
plot(t, ySol1);
axis([0, 12, -4, 6]);
```

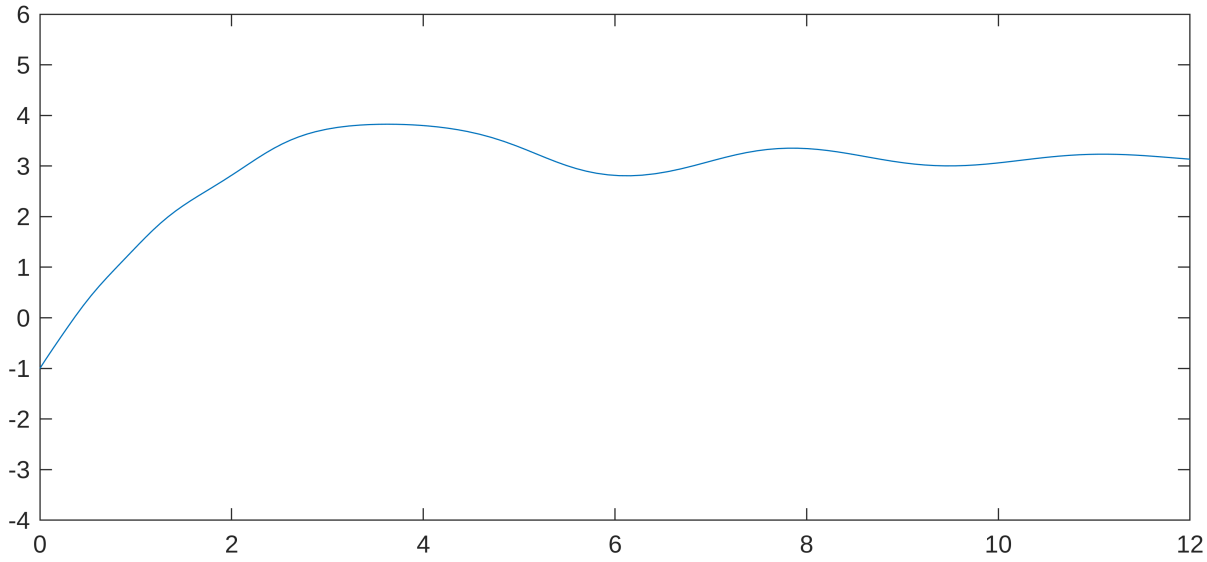


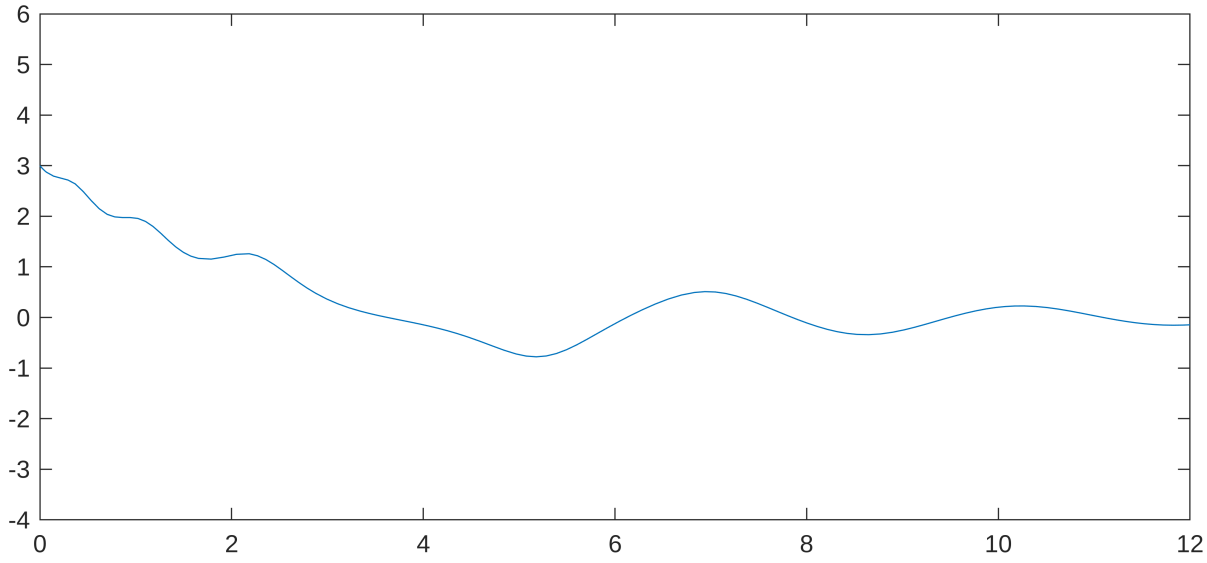



```
% x(t) goes to 4.6 as t goes to infinity;
% y(t) goes to -0.1 as t approaches infinity.
```

```
f = @(x,y) y;
g = @(x,y) -sin(4*x) - 0.5*y;
F = @(t, x) [f(x(1), x(2)); g(x(1), x(2))];
```

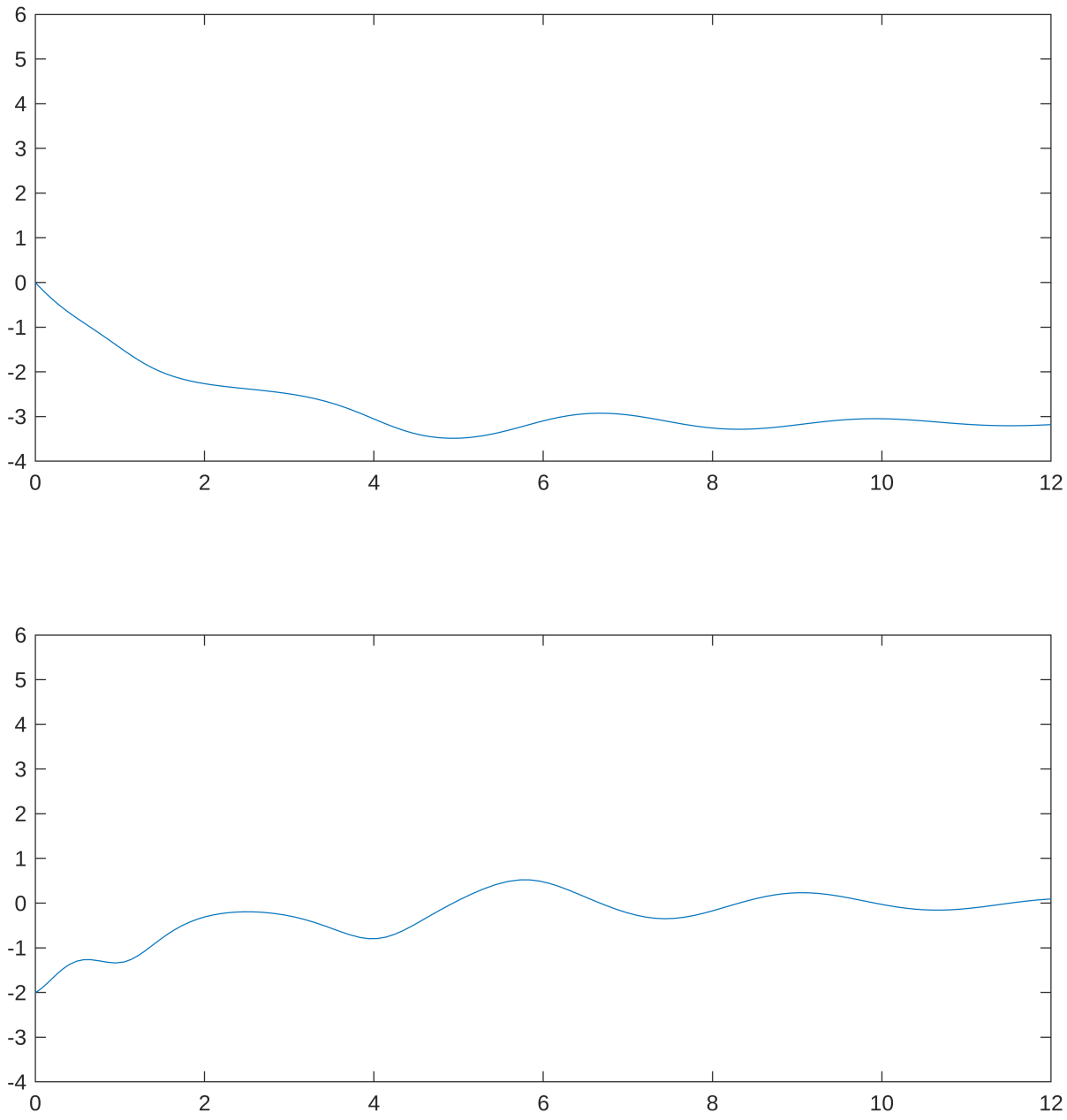
```
[t,x] = ode45(F, [0, 12], [-1;3]);

xSol2 = x(:, 1);
ySol2 = x(:, 2);

figure();
set(gcf, 'Position', [100, 100, 800, 800]);
subplot(2,1,1)
plot(t, xSol2);
axis([0, 12, -4, 6]);

subplot(2, 1, 2)
plot(t, ySol2);
axis([0, 12, -4, 6]);
```






```
[t,x] = ode45(F, [0, 12], [0;-2]);

xSol3 = x(:, 1);
ySol3 = x(:, 2);

figure();
set(gcf, 'Position', [100, 100, 800, 800]);
subplot(2,1,1)
```

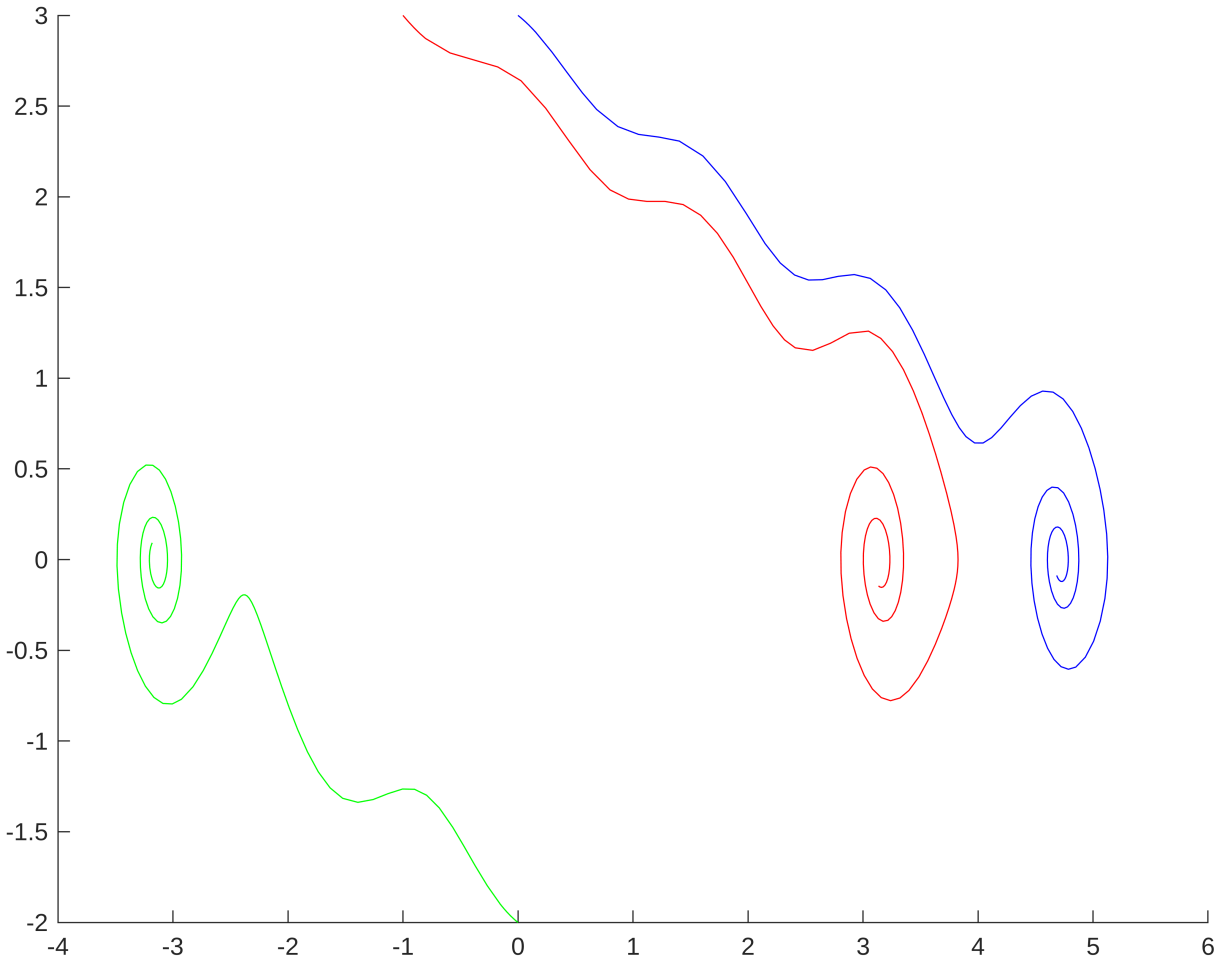
```
plot(t, xSol3);
axis([0, 12, -4, 6]);

subplot(2, 1, 2)
plot(t, ySol3);
axis([0, 12, -4, 6]);
```




```
% For (-1,3), y(t) approaches -0.15 and x(t) approaches 3.15.
```

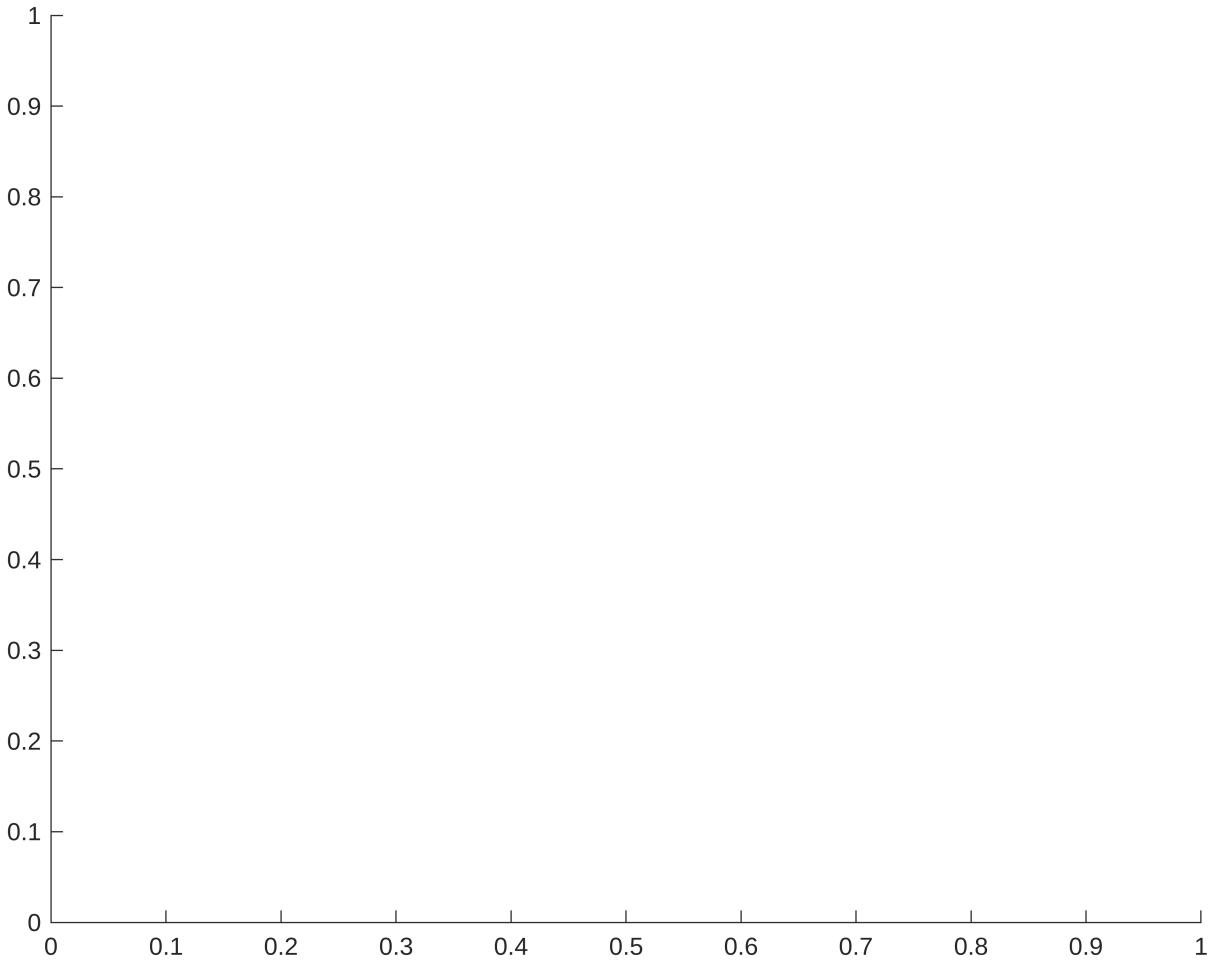
```
% For (0,-2), x(t) approaches -3.2 and y(t) approaches 0.
% Based on these, it seems like the solutions depend on both initial
% conditions and are not independent.
```

```
figure();
set(gcf, 'Position', [100, 100, 800, 600]);
hold on;
plot(xSol1, ySol1, 'b');
plot(xSol2, ySol2, 'r');
plot(xSol3, ySol3, 'g');
hold off;
```

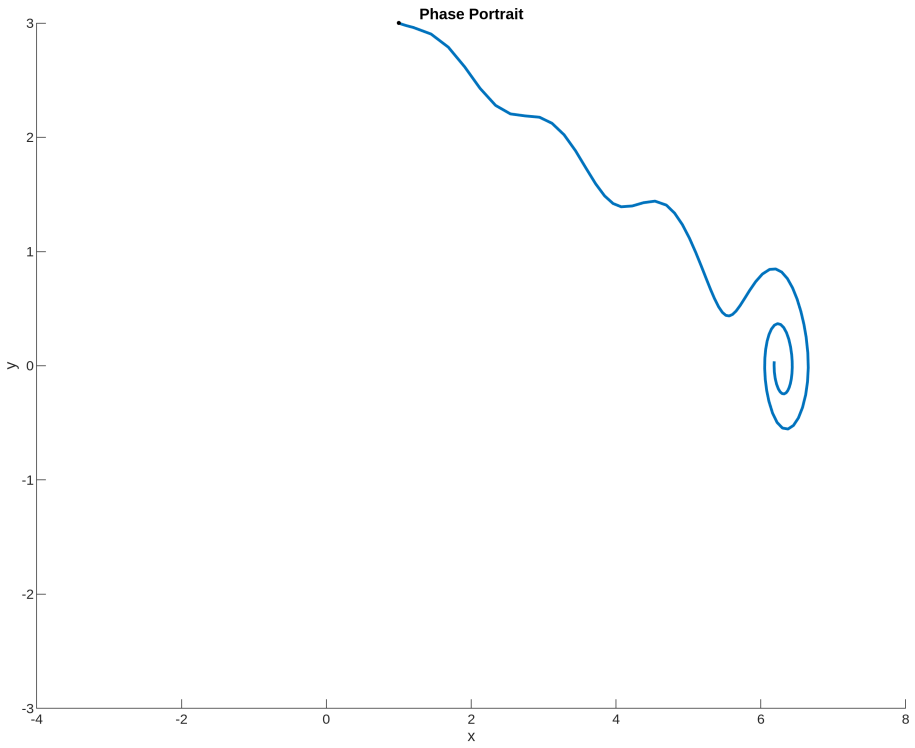



```
figure();
```

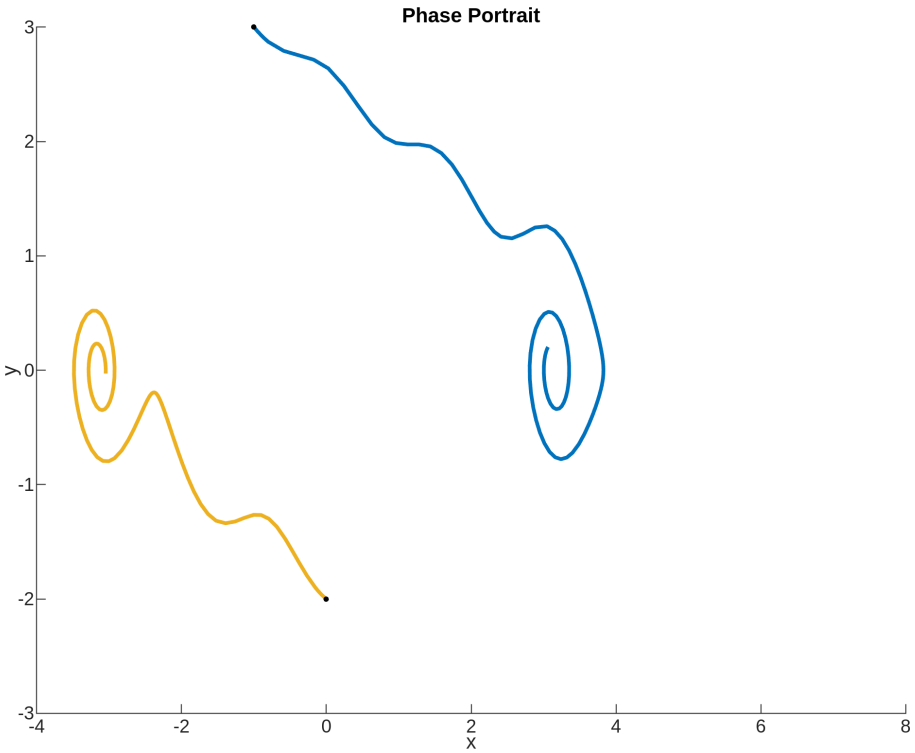
```
set(gcf, 'Position', [100, 100, 800, 600]);
hold on;
```



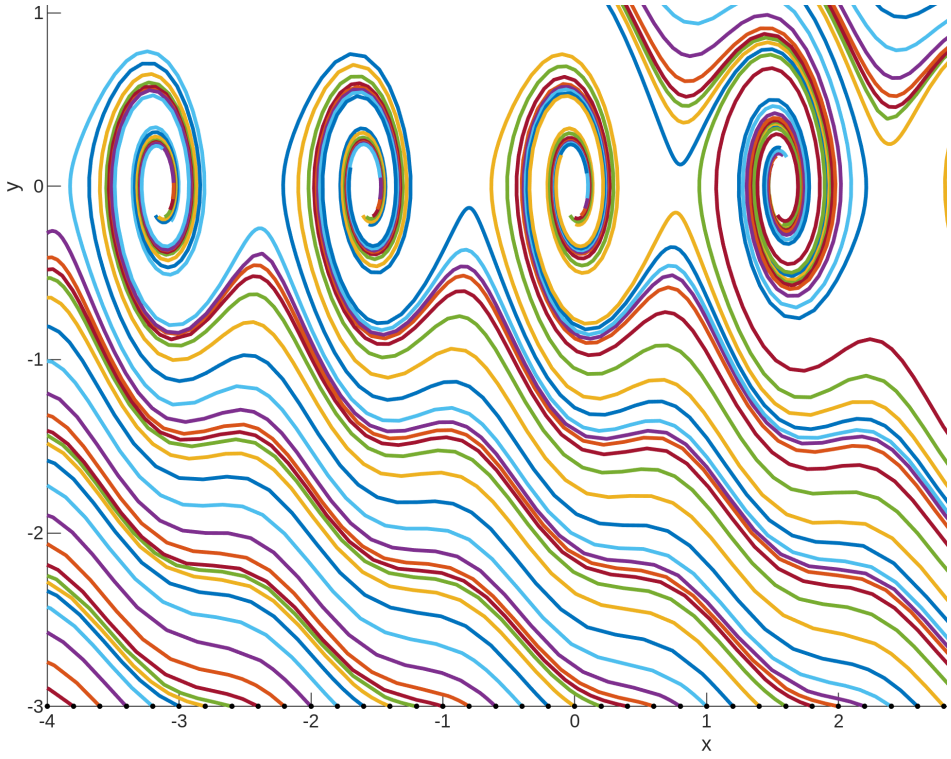

```
phasePortrait244(f, g, -4, 8, -3, 3, 0, 10, 1, 3);
```



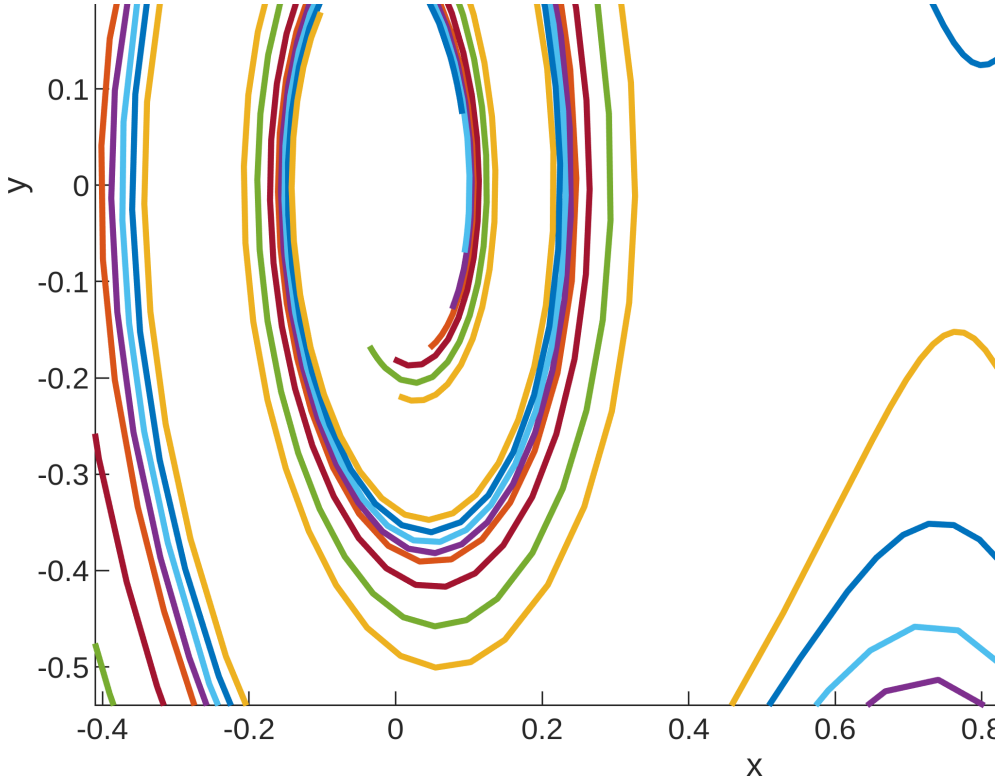

```
phasePortrait244(f, g, -4, 8, -3, 3, 0, 10, [-1,0], [3,-2]);
hold off;
```



```
figure();
set(gcf, 'Position', [100, 100, 800, 600]);
phasePortrait244(f, g, -4, 6, -3, 3, 0, 10, ...
    [-4:0.2:6, -4:0.2:6], [3*ones(1, 51), -3*ones(1, 51)]);
```

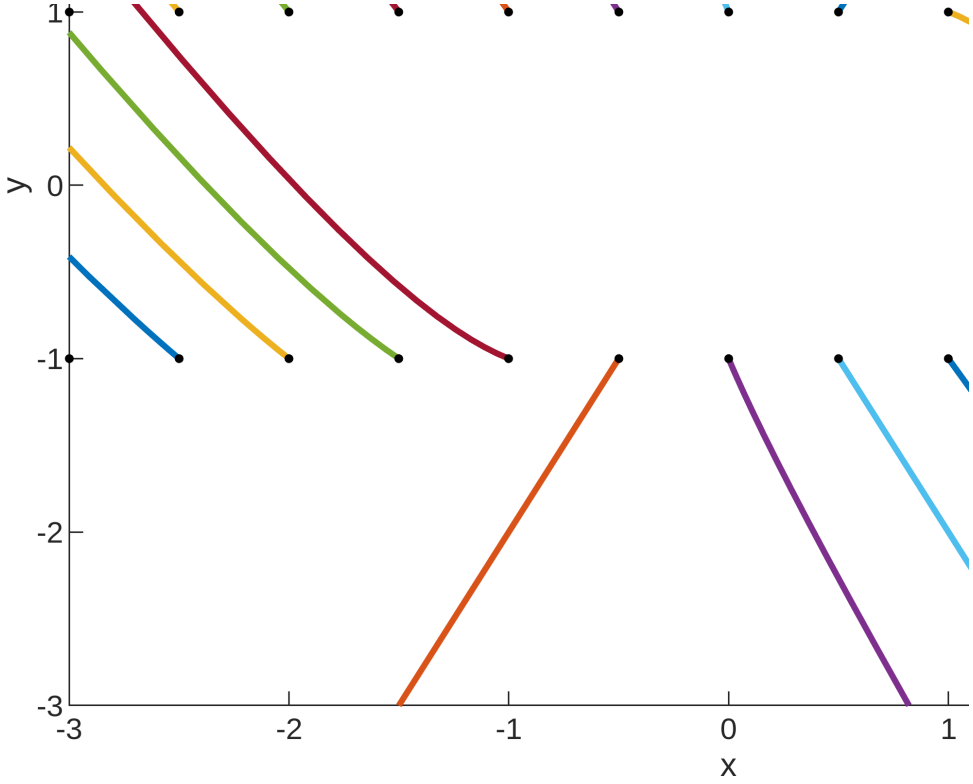



```
figure();
set(gcf, 'Position', [100, 100, 800, 600]);
phasePortrait244(f, g, -4, 6, -3, 3, 0, 10, [-4:0.2:6, -4:0.2:6], ...
    [3*ones(1, 51), -3*ones(1, 51)]);
xlim([-0.41 1.39])
ylim([-0.54 0.54])
```

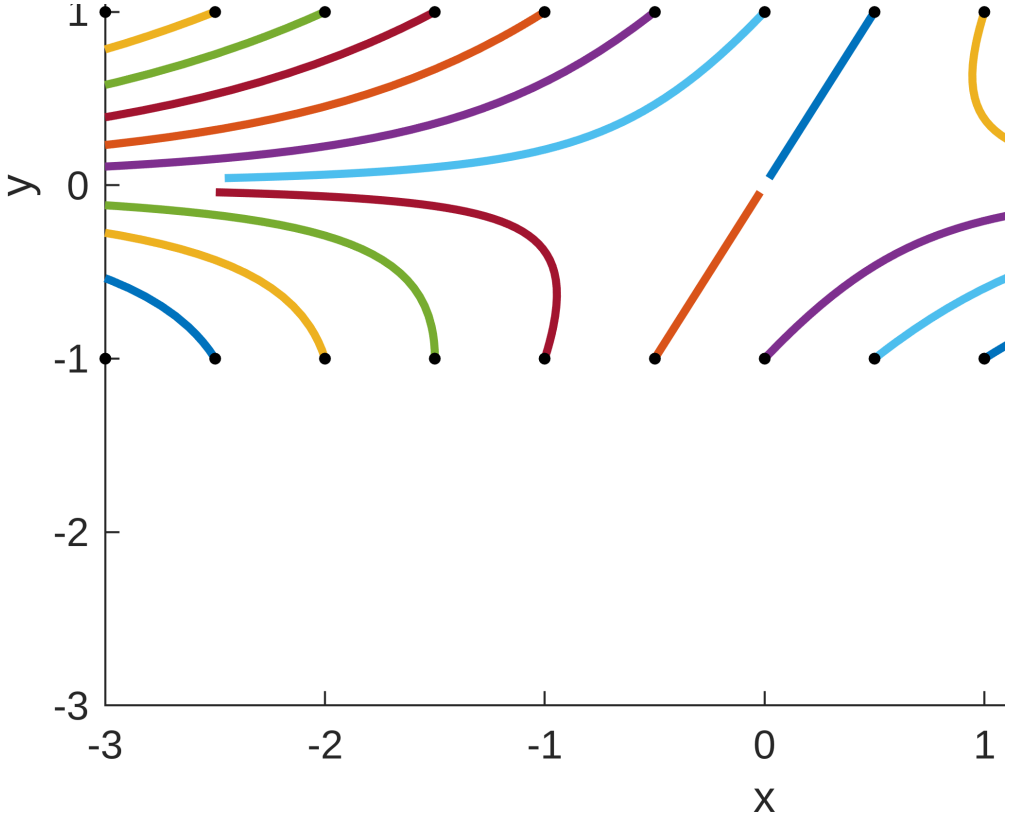



```
% After completing the lab, I went back and zoomed in (made another plot
% with smaller limits) on this phase portrait. This second plot really
% shows the different behavior at the points discussed in step 7. Namely,
% you can see, side by side, the converging behavior around (0,0) and the
% diverging behavior around (pi/4 , 0). I didn't really understand the
% point of step 7 until I came back and examined this plot closely as
% shown.
```

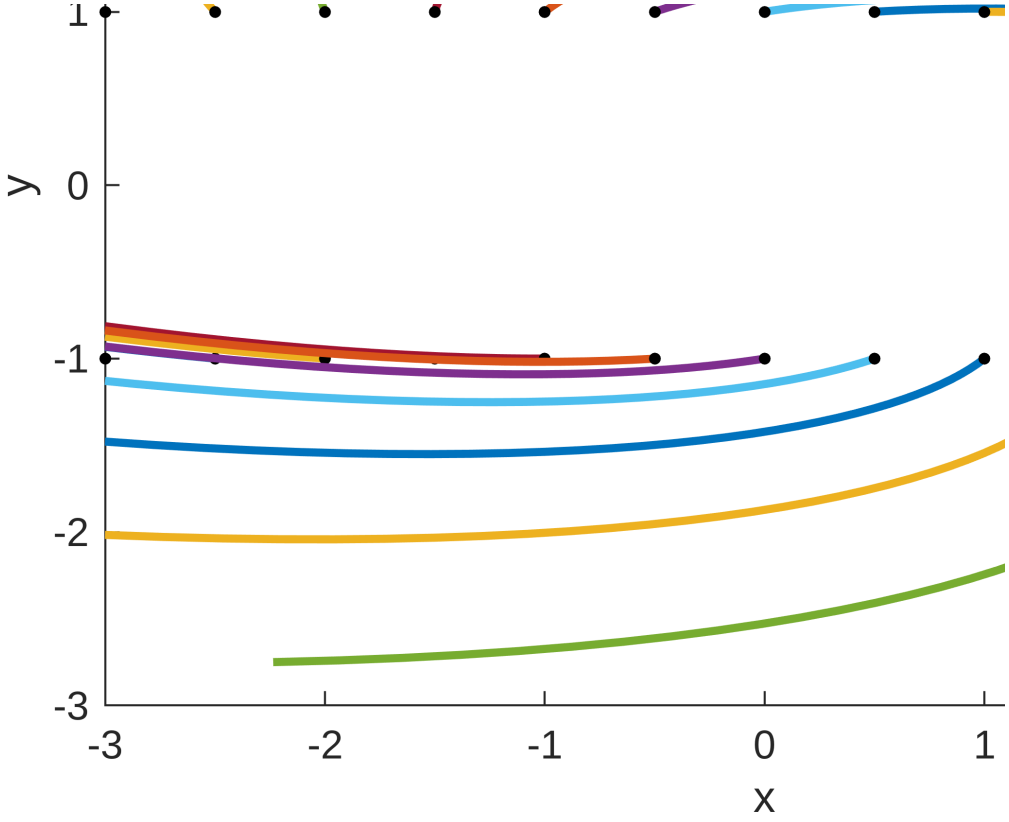
```
% (a)
f = @(x,y) 3*x - y;
g = @(x,y) -4*x + 3*y;
figure();
%set(gcf, 'Position', [100, 100, 800, 600]);
phasePortrait244(f, g, -3, 3, -3, 3, 0, 1.1, ...
    [-3:0.5:3, -3:0.5:3], [1*ones(1,13), -1*ones(1,13)]);
```



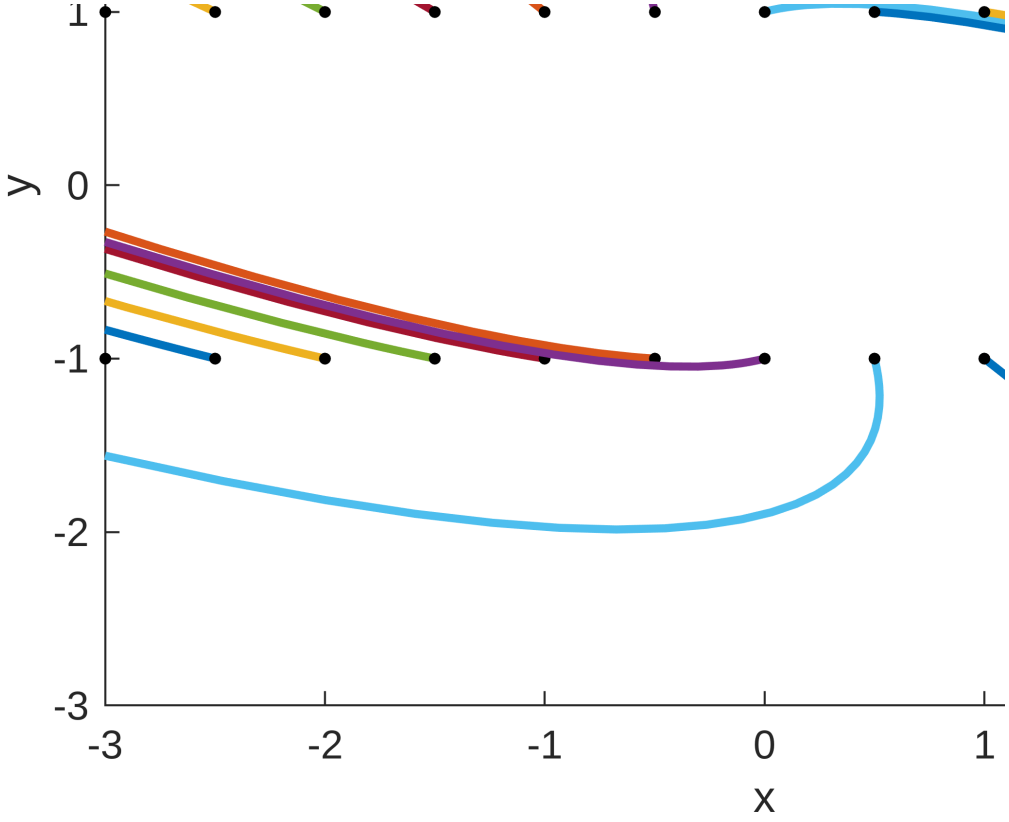

```
% (b)
f = @(x,y) 2*x - 3*y;
g = @(x,y) -4*y;
figure();
%set(gcf, 'Position', [100, 100, 800, 800]);
phasePortrait244(f, g, -3, 3, -3, 3, 0, 0.8, ...
    [-3:0.5:3, -3:0.5:3], [1*ones(1,13), -1*ones(1,13)]);
```



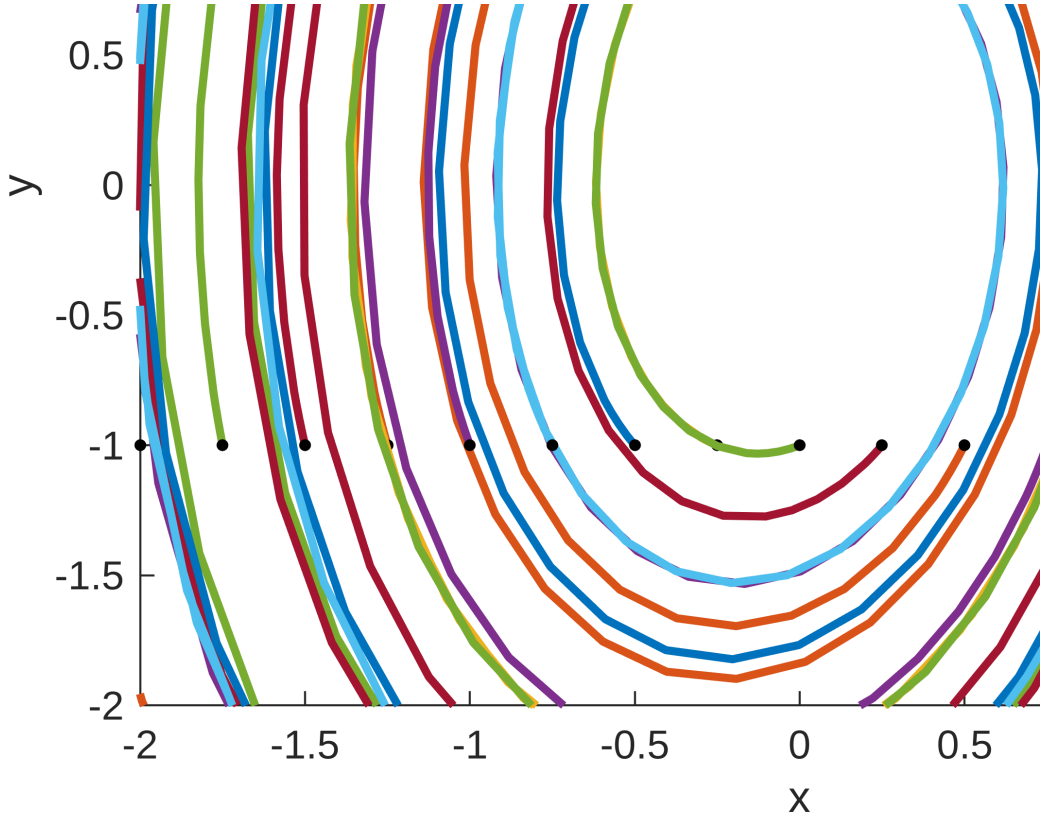

```
% (c)
f = @(x,y) 3*x + 5*y;
g = @(x,y) -x + y;
figure();
%set(gcf, 'Position', [100, 100, 800, 800]);
phasePortrait244(f, g, -3, 3, -3, 3, 0, 0.6, ...
    [-3:0.5:3, -3:0.5:3], [1*ones(1,13), -1*ones(1,13)]);
```



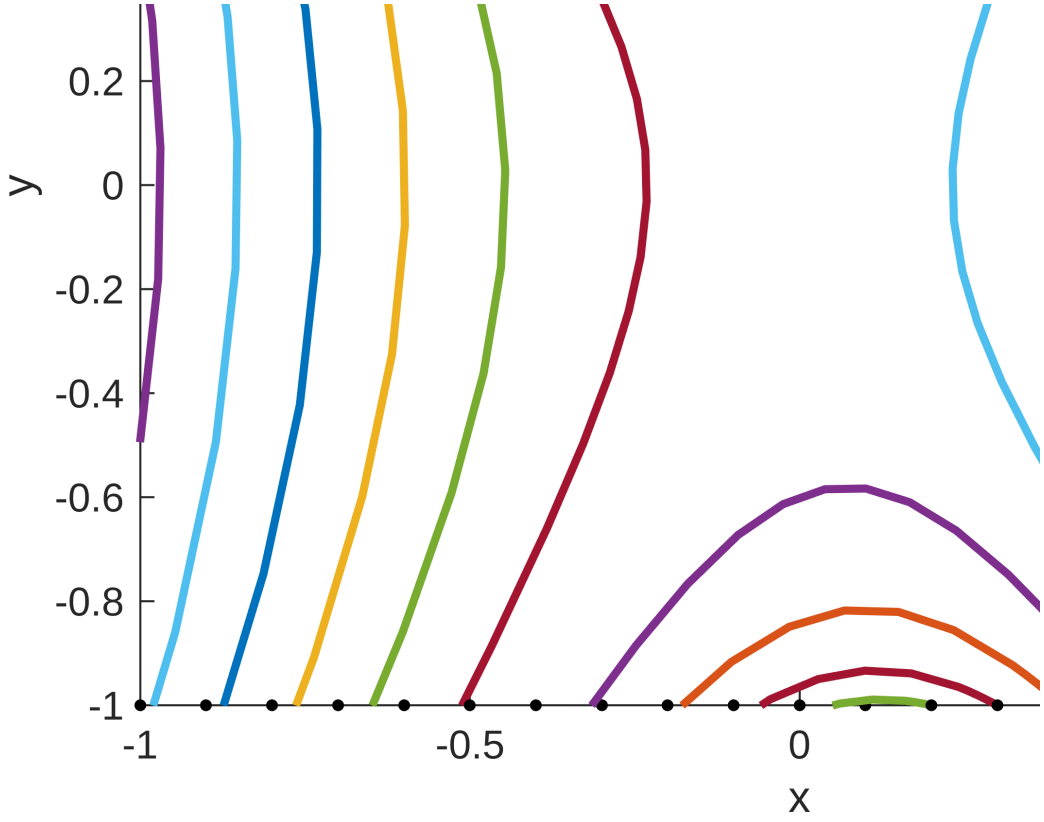

```
% (d)
f = @(x,y) 7*x + 3*y;
g = @(x,y) -3*x + y;
figure();
%set(gcf, 'Position', [100, 100, 800, 800]);
phasePortrait244(f, g, -3, 3, -3, 3, 0, 0.9, ...
    [-3:0.5:3, -3:0.5:3], [1*ones(1,13), -1*ones(1,13)]);
```




```
% (a) Point: (0,0)
f = @(x,y) y;
g = @(x,y) -4*x + 0.5*y;
figure();
set(gcf, 'Position', [100, 100, 800, 600]);
phasePortrait244(f, g, -2, 2, -2, 2, 0, 10, ...
    [-3:0.25:3, -3:0.25:3], [1*ones(1,25), -1*ones(1,25)]);
```




```
% (b) Point (, 0)
f = @(x,y) y;
g = @(x,y) 4*x + 0.5*y;
figure();
set(gcf, 'Position', [100, 100, 800, 600]);
phasePortrait244(f, g, -1, 1, -1, 1, 0, 10, ...
    [-3:0.1:3, -3:0.1:3], [1*ones(1,61), -1*ones(1,61)]);
```




```
% Comment:
% These portraits do indeed show the behavior around the critical points
% (0,0) and (pi/4 , 0). As discussed below the plot in step 5, one can
% see this behavior in the "fuller" plot, where this converging critical
% point transitions to a diverging critical point in a cycle of pi/4.
```