MAT 275 Euler Methods (Project 2)

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Problem 1. Initial Value Problem **1**

Problem 1. Initial Value Problem

Solution

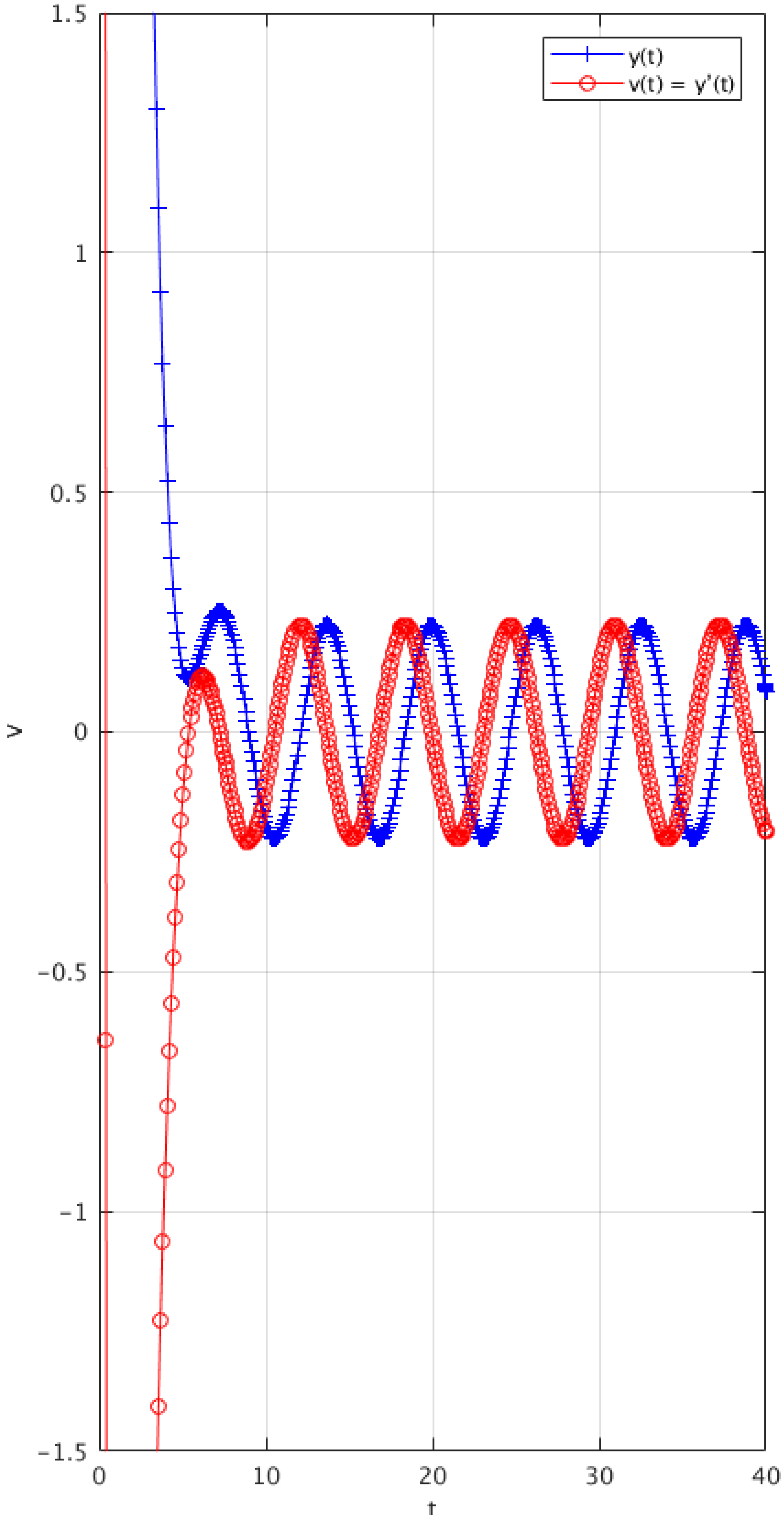
Part (a)

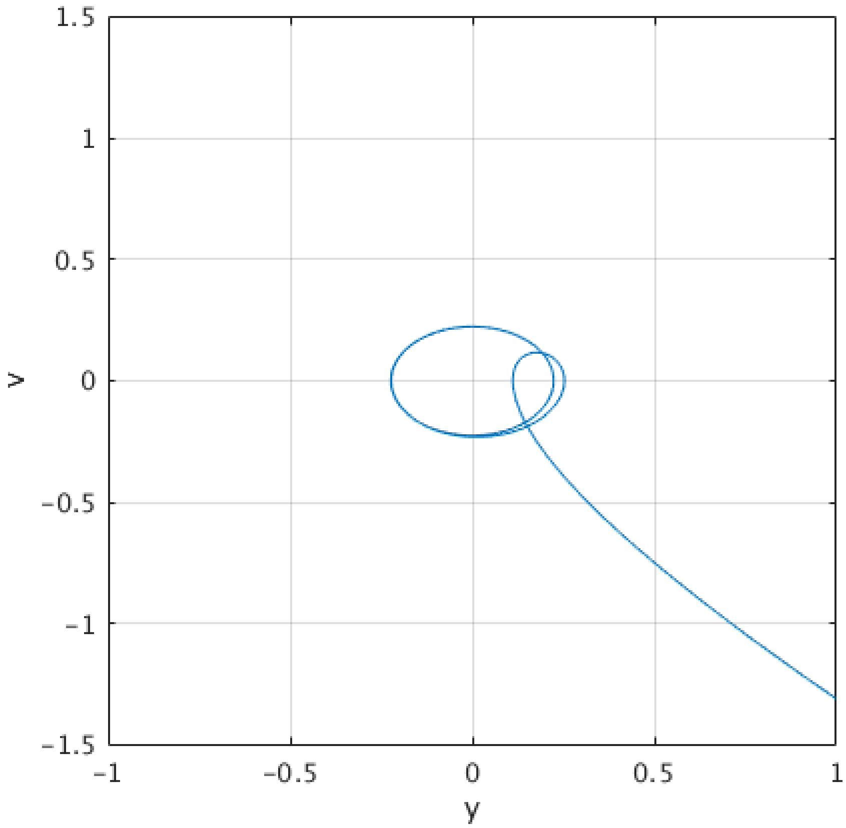
The following matlab code is used to solve exercise 1:

```
function LAB04ex1
t0 = 0; tf = 40; y0 = [10;60];
[t,Y] = ode45(@dYdt,[t0,tf],y0) %,[])%,a,b,c,d);
y = Y(:,1); v = Y(:,2);
figure(1);
plot(t, y, 'b-+'); ylabel('y'); legend('y(t)');
hold on
plot(t, v, 'ro-'); ylabel('v'); legend('v(t) = y''(t)');
hold off
xlabel('t');
ylim([-1.5, 1.5]);
grid on;
figure(2);
plot(y, v); axis square; xlabel('y'); ylabel('v'); % plot the phase plot
ylim([-1.5, 1.5]);
xlim([-1, 1]);
grid on;

function dYdt = f(t, Y) % f(t,Y,a,b,c,d)
y = Y(1); v = Y(2)
dYdt = [v; cos(t) - 4*v - 3*y];
```

The code simply integrates the equation and plots the resulting functions and their phase diagram. This shows two oscillating functions offset from one another, and a stable equilibrium which is reached after a certain amount of time. A legend and grid lines are shown. Each figure is intentionally given a full page so that detail can be shown.


y(t)
v(t) = y'(t)
1.5
1
0.5
0
-0.5
-1
-1.5
v
0
10
20
30
40
t


1.5
1
0.5
0
−0.5
−1
−1.5
−1
−0.5
0
0.5
1
v
y

Part (b)

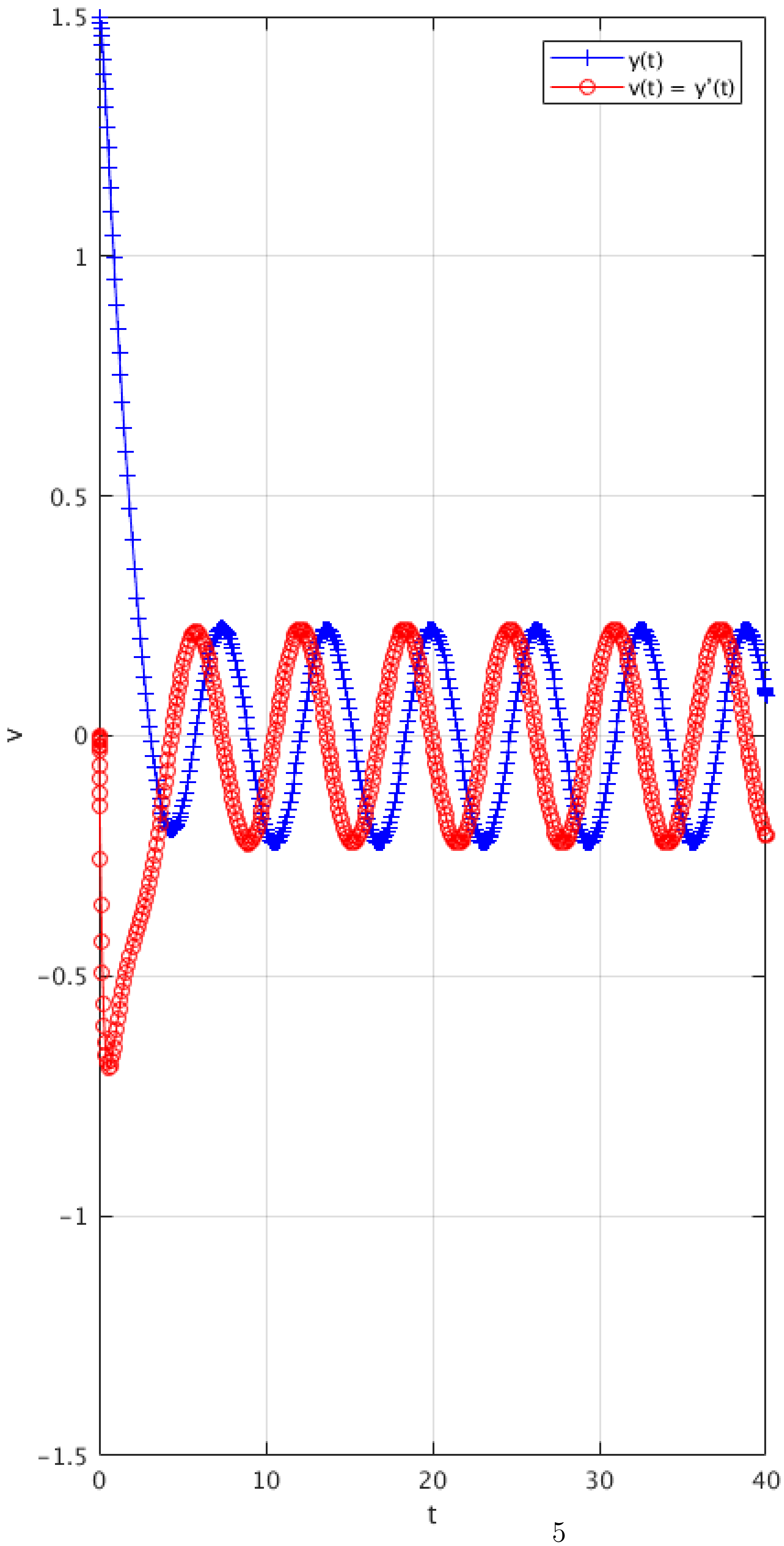
Approximately, the value of $t = 0$ makes y maximum, based on my graph and data. This is because y starts at sixty when t is 0, and then decreases from there until y reaches an oscillating section, which is discussed in the next part.

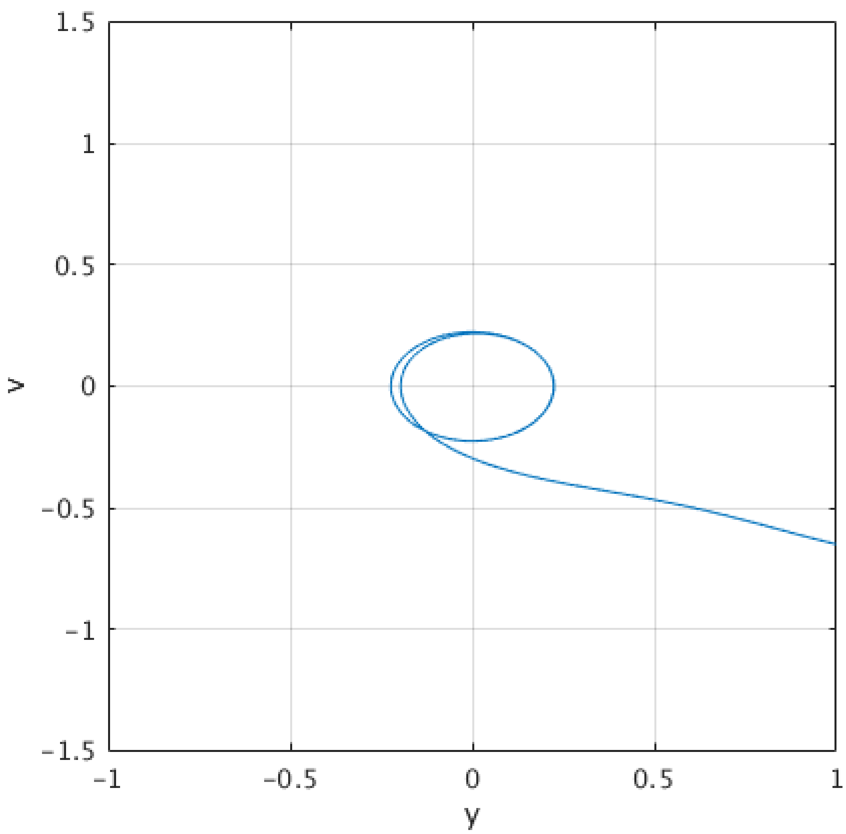
Part (c)

After an initial period, the equation for y appears to be oscillating between two values, which would make it *stable*.

Part (d)

When the initial starting location is changed to $(1.5, 5)$, the long-term stability of y is not affected. Despite the fact that the path starts in a new location, it is attracted into the same "orbit". This can also be seen in the phase diagram (next pages). However, this does affect the local maximum value of y, as it begins lower.


y(t)
v(t) = y'(t)
1.5
1
0.5
0
-0.5
-1
-1.5
y
0
10
20
30
40
t


1.5
1
0.5
0
-0.5
-1
-1.5
v
-1
-0.5
0
0.5
1
y