Numerical integration of coupled ODEs

This example is based that given in the Mathworks web page https://www.mathworks.com/examples/matlab/mw/matlab-ex13677222-solve-nonstiff-odes. It uses the Matlab function `ODE45` to integrate a coupled pair of ordinary differential equations – the van der Pol equation with $\mu = 1$.

```
[t,y] = ode45(@vdp1,[0 20],[2; 0]);

% Plot of the solution
plot(t,y(:,1),'-o',t,y(:,2),'-o')
xlabel('Time t')
ylabel('Solution y')
legend('y_1','y_2')

print(gcf,'example_02_fig.png','-dpng');

dlmwrite ('example_02.txt',[t';y(:,1)';y(:,2)']','delimiter',' ','precision','% .8e');

function dydt = vdp1(t,y)
%VDP1  Evaluate the van der Pol ODEs for mu = 1
%
%   See also ODE113, ODE23, ODE45.

%   Jacek Kierzenka and Lawrence F. Shampine
%   Copyright 1984-2014 The MathWorks, Inc.

dydt = [y(2); (1-y(1)^2)*y(2)-y(1)];
end
```

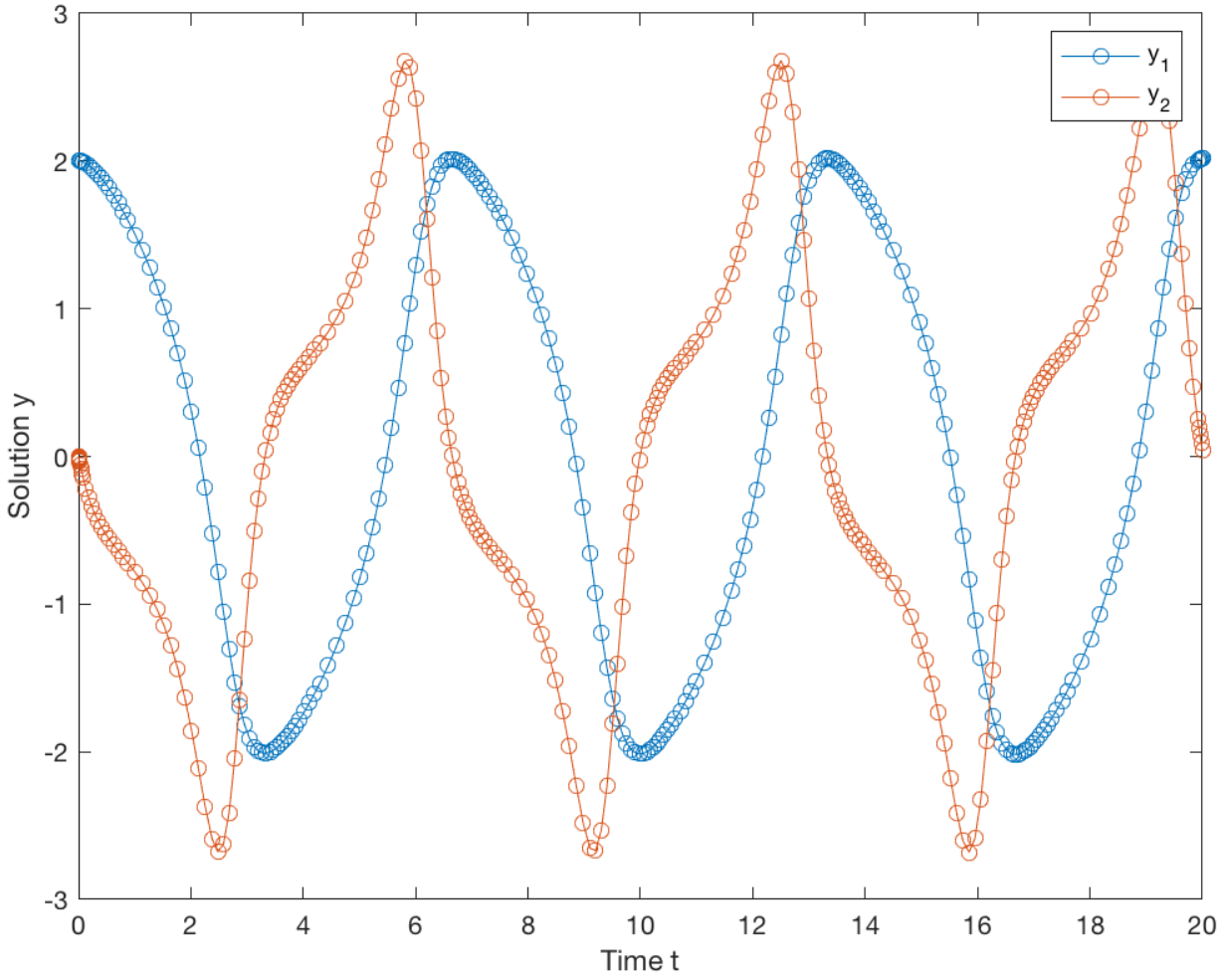

Figure 1: Solution of van der Pol equation ($\mu = 1$) using ODE45.

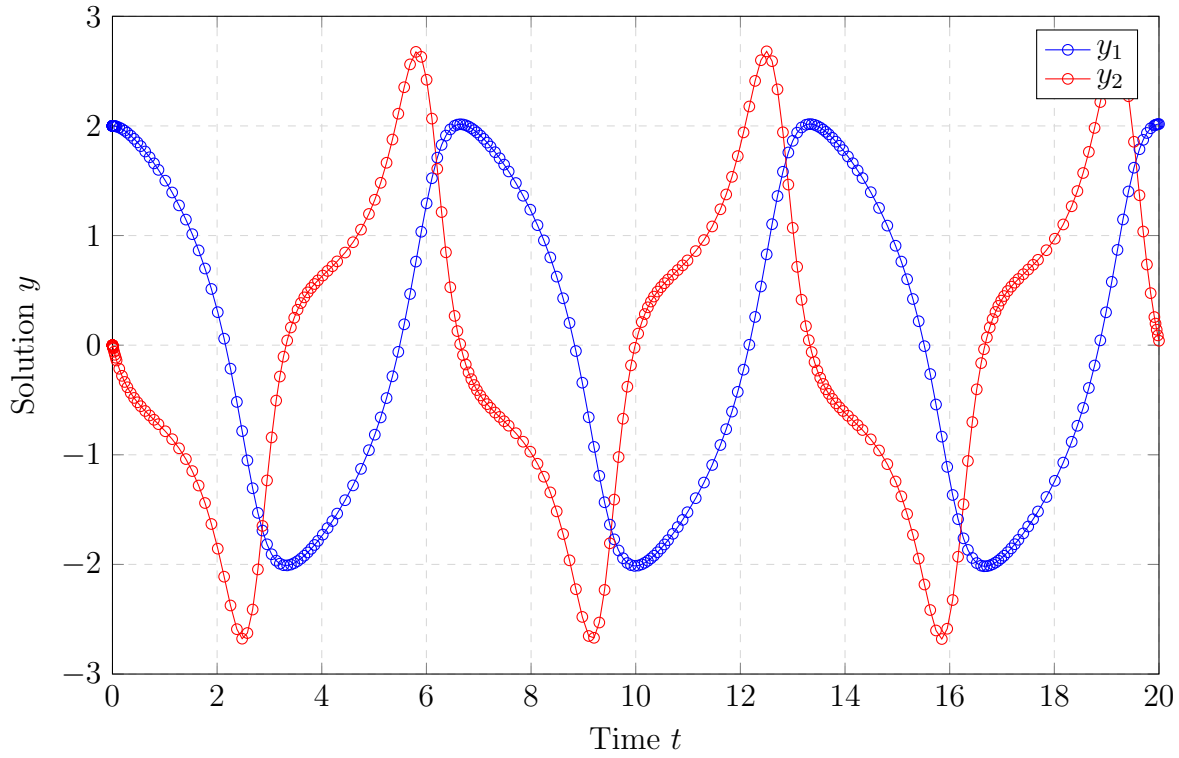

Figure 2: Solution of van der Pol equation ($\mu = 1$) using ODE45.

```
\begin{tikzpicture} % requires \usepackage{pgfplots}
   \begin{axis}
      [xmin= 0.0, xmax=20.0,
       ymin=-3.0, ymax=3.0,
       xlabel=$\text{Time }t$, ylabel=$\text{Solution }y$,
       grid=major, grid style={dashed,gray!30},
       legend entries = {$y_1$, $y_2$}]
       \addplot[blue, mark=o]   table [x index=0, y index=1]{example_02.txt};
       \addplot[red, mark=o]    table [x index=0, y index=2]{example_02.txt};
   \end{axis}
\end{tikzpicture}
\captionof{figure}{Solution of van der Pol equation ($\mu = 1$) using ODE45.} % requires \usepackage{caption}
```