Matlab Function ode45
Numerical Integration of Differential Equations
Rakinder Kalsi and Katherine Lloyd

The function:

\[ [T, Y, TE, YE, IE] = \text{ode45}(odefun, tspan, y0, options) \]

odefun – function handle to \( f(y) \) from differential equation \( \frac{dy}{dt} = f(y) \)
tspan – vector of interval of integration \([t_0, t_f]\).
y0 – initial conditions.
options – structure created by function \text{odeset}.

T – Time points the solution is returned for.
Y – Solution \( y(t) \).
TE – Time points at which events occur.
YE – Value of \( y(t) \) when events occur.
IE – Array index of events in \( Y \).

\text{odeset}

options = \text{odeset('name1',value1,'name2',value2,...)}

A list of options may be found on the \text{odeset} documentation.

\text{Events}

[\text{value,isterminal,direction}] = \text{events}(t,y)

value – expression which = 0 when the event occurs.
isterminal – takes value 1 (if integration stops at event) or 0 (if integration does not stop.
direction – Value determined by whether solution needs to be becoming more positive (1), more negative (-1) or either (0) for the event to be recorded.

\text{Links}

ode45 Documentation: http://www.mathworks.co.uk/help/matlab/ref/ode45.html

odeset Documentation: http://www.mathworks.co.uk/help/matlab/ref/odeset.html

General Differential Equation Solving Functions:
http://www.mathworks.co.uk/help/matlab/math/ordinary-differential-equations.html#f1-669698

Example Scripts and Functions:
http://www2.warwick.ac.uk/fac/sci/moac/people/students/2012/katherine_lloyd/presentations
The same equation may be passed using either using an anonymous function or a normal function. The two examples below integrate the same differential equation using ode45 but pass the function using the two methods.

Example using anonymous function:

```matlab
% Set up anonymous function. Part on right is f(y) from equation
dy_dt=f(y)
odefun=@(t,y) -t*y/sqrt(2-y^2);

% Set up time interval vector, initial conditions and options
tspan=[0,5];
y0=1;
options = odeset('Stats','on','OutputFcn',@odeplot);

% Run ode45. Returns solution Y and timepoints T
[T,Y] = ode45(odefun,tspan,y0,options);
```

Example using a normal function:

```matlab
function f()
    % set up time interval vector, initial conditions and options
tspan=[0,5];
y0=1;
    options = odeset('Stats','on','OutputFcn',@odeplot);
    % Run ode45
    [T,Y] = ode45(@g,tspan,y0,options);
end

function dy_dt=g(t,y)
    dy_dt= -t*y/sqrt(2-y^2);
end
```