TUTORIAL 8
MATH205 NUMERICAL ANALYSIS
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In this tutorial, you will develop solver of ordinary differential equations in MATLAB and practice using MATLAB to solve ODEs.

1. Implement in MATLAB the Eulers method for solving ODEs (page 560)! Consider the ODE

$$\frac{dy}{dt} = t^2 - 2y, \quad \text{with the initial condition} \quad y_0 = 1$$

Check whether the exact solution is $y(t) = \frac{1}{4}(2(t^2 - t) + 1 + 3e^{-2t})$

Use the MATLAB code to find the solution with *h*=0.2 for the first five points! Find the actual value and the relative error for each step.

i	t_i	$y_{i+1}=y_i + h\, f(t_i, y_i)$	Exact value $y(t_{i+1})$	Relative error
0	0.0	1	1	0
1	0.2			
2	0.4			
3	0.6			
…	…	…	…	…

Make the solution in Matlab for 40 points and then calculate the derivative of the solution using central (centered) difference method as well as Richardsson's differentiation. Plot the derivatives together with the function $t^2 - 2y$

2. System of ODEs is given (see book, section 22.6)

$$\frac{dy_1}{dt} = 1.2y_1 - 0.6y_1y_2, \quad \frac{dy_2}{dt} = -0.8y_2 + 0.3y_1y_2.$$

Initial conditions are $y_1(0) = 2, \quad y_2(0) = 1.$

Generate a function

```
function dydt = odefun(t,y)
dydt = [
    1.2*y(1)-0.6*y(1)*y(2);
    -0.8*y(2)+0.3*y(1)*y(2);
    ];
```

And solve the set of equations

```
tspan = [0 5];
y0 = [2 1];
[t,y] = ode45(@odefun,tspan,y0);
plot(t,y,'o');
legend('y_1','y_2');
```

Use the command `deval` to get a value of the solution at a specific time, e.g. at *t*=1.5!

3. Use the same system of ODEs, this case you have boundary values

   $$y_1(0) = 2, \quad y_1(5) = 2.$$

   Find the curve connecting the boundary values using the shooting method! What happens if $\frac{dy_1}{dt}(0) = 0.39$ and $\frac{dy_1}{dt}(0) = -4.99$?