% TP N°0 Numerical methods:

Dr. Rezzoug Imad

MATLAB Command window

```
x = 0:.1:1;
y = [x; exp(x)];
% Open the file with write permission
fid = fopen('exp.txt','w');
fprintf(fid, '%6.2f  %12.8f\n', y);
fclose(fid);
% View the contents of the file
type exp.txt
```

```
 0.00   1.00000000
 0.10   1.10517092
 0.20   1.22140276
 0.30   1.34985881
 0.40   1.49182470
 0.50   1.64872127
 0.60   1.82211880
 0.70   2.01375271
 0.80   2.22554093
 0.90   2.45960311
 1.00   2.71828183

>>
```

% TP N°1 Numerical methods:

Dr. Rezzoug Imad

% Ordinary Differential Equations

% Program for **Euler's Method**

```
clc;
clear all;
close all;

fun = input('\n Input Function = ','s');
f=inline(fun,'x','y');                    % Function Declaration
disp(sprintf(['\n     dy/dx = f(x,y) = ' fun]))

x0 = input('\n Enter initial value of x (X0) = ');
y0 = input('\n Enter initial value of y (Y0) = ');
xn = input('\n Enter Final value of x (Xn) = ');
n = input ('\n No. of Steps (n)= ');

format short g;

h=(xn-x0)/n;
disp(sprintf('     h = ( xn - x0 ) / n '))
disp(sprintf('       = ( %g - %g ) / %g ',xn,x0,n))
disp(sprintf('       = %g',h))
xa(1)=x0 ;
ya(1)=y0 ;

fprintf('\n  X \t\t Y \t\t f(x,y)');
fprintf('\n%.2f \t %.4f \t %.4f', xa(1),ya(1),f(xa(1),ya(1)));
for i = 1:n
   xa(i+1) = x0 + i*h;
   ya(i+1)=ya(i)+h*feval(f,xa(i),ya(i));
   fprintf('\n%.2f \t %.4f \t %.4f',xa(i+1),ya(i+1),f(xa(i+1),ya(i+1)));
end;

% To find Exact solution of dy/dx = f(x,y)
xspan = [x0 xn];
[x,y]=ode45(f,xspan,y0);

% Plotting the Exact and Approximate solution of the ODE.
hold on
xlabel('x');
ylabel('y');
title('Exact and Approximate Solution of the ODE by Euler Method');
plot(x,y,'--','LineWidth',2,'Color',[1 0 0]);
plot(xa,ya,'-','LineWidth',2,'Color',[0 0 0]);
legend('Exact','Approximation');
```

% TP N°2 Numerical methods:

Dr. Rezzoug Imad

% Ordinary Differential Equations

% Program for **Heun's Method**

```
clc;
clear all;
close all;

fun = input('\n Input Function = ','s');
f=inline(fun,'x','y');                    % Function Declaration
disp(sprintf(['\n     dy/dx = f(x,y) = ' fun]))

x0 = input('\n Enter initial value of x (X0) = ');
y0 = input('\n Enter initial value of y (Y0) = ');
xn = input('\n Enter Final value of x (Xn) = ');
n = input('\n Enter No. of steps (n) = ');

format short g;

h=(xn-x0)/n;
disp(sprintf('     h = ( xn - x0 ) / n '))
disp(sprintf('       = ( %g - %g ) / %g ',xn,x0,n))
disp(sprintf('       = %g',h))
xa(1)=x0 ;
ya(1)=y0 ;

fprintf('\n  X \t\t Y \t\t f(x,y)');
fprintf('\n%.2f \t %.4f \t %.4f', xa(1),ya(1),f(xa(1),ya(1)));
for i = 1:n
   xa(i+1) = x0 + i*h;
   k1=feval(f,xa(i),ya(i));
   k2=feval(f,xa(i+1),ya(i)+h*k1);
   ya(i+1)=ya(i)+h/2*(k1+k2);
   fprintf('\n%.2f \t %.4f \t %.4f',xa(i+1),ya(i+1),f(xa(i+1),ya(i+1)));
end;

% To find Exact solution of dy/dx = f(x,y)
xspan = [x0 xn];
[x,y]=ode45(f,xspan,y0);

% Plotting the Exact and Approximate solution of the ODE.
hold on
xlabel('x');
ylabel('y');
title('Exact and Approximate Solution of the ODE by Euler
Method');
plot(x,y,'--','LineWidth',2,'Color',[1 0 0]);
plot(xa,ya,'-','LineWidth',2,'Color',[0 0 0]);
legend('Exact','Approximation');
```

% TP N°3 Numerical methods:

Dr. Rezzoug Imad

% Ordinary Differential Equations

% Program for **Runge-Kutta 4th Order Method**

```
clc;
clear all;
close all;

fun = input('\n Input Function = ','s');
f=inline(fun,'x','y');                    % Function Declaration
disp(sprintf(['\n     dy/dx = f(x,y) = ' fun]))

x0 = input('\n Enter initial value of x (X0) = ');
y0 = input('\n Enter initial value of y (Y0) = ');
xn = input('\n Enter Final value of x (Xn) = ');
n = input('\n Enter No. of steps (n) = ');

format short g;

h=(xn-x0)/n;
disp(sprintf('     h = ( xn - x0 ) / n '))
disp(sprintf('       = ( %g - %g ) / %g ',xn,x0,n))
disp(sprintf('       = %g',h))
xa(1)=x0 ;
ya(1)=y0 ;

for i = 1:n
   xa(i+1) = x0 + i*h;
   k1=h*feval(f,xa(i),ya(i));
   k2=h*feval(f,xa(i)+(h/2),ya(i)+(k1/2));
   k3=h*feval(f,xa(i)+(h/2),ya(i)+(k2/2));
   k4=h*feval(f,xa(i)+h,ya(i)+k3);
   ya(i+1)=ya(i)+(1/6)*(k1+2*k2+2*k3+k4);
   fprintf('\n k1 = %.4f k2 = %.4f k3 = %.4f k4 = %.4f', k1,k2,k3,k4);
   fprintf('\t =>Y(%.2f) = %.5f',xa(i),ya(i));
end

% To find Exact solution of dy/dx = f(x,y)
xspan = [x0 xn];
[x,y]=ode45(f,xspan,y0);

% Plotting the Exact and Approximate solution of the ODE.
hold on
xlabel('x');
ylabel('y');
title('Exact and Approximate Solution of the ODE by Euler Method');
plot(x,y,'--','LineWidth',2,'Color',[1 0 0]);
plot(xa,ya,'-','LineWidth',2,'Color',[0 0 0]);
legend('Exact','Approximation');
```