Handout no.11

Name	Ahmad, Faizan, Asad
Reg. No	2019-EE-373, 381, 383
Marks/Grade	

EXPERIMENT NO. 11

Perform Numerical solution of non-linear equations in power system stability by Euler's Method

Objective:

At the end of this lab session students will be able

- To accurately select the parameters in Euler's method to solve the non-linear equations.

Introduction:

Power system stability is an essential aspect of the operation of modern power grids. The dynamic behavior of power systems can be modelled using non-linear equations, which describe the interactions between different components of the system. However, finding analytical solutions for non-linear equations can be challenging, if not impossible, in many cases. As a result, numerical methods have become a popular approach for obtaining approximate solutions to these equations.

Euler's method is a well-known numerical technique for solving non-linear equations. It is a first-order method that uses the slope of the tangent line at the current point to estimate the value at the next point. Although it is a simple method, it can provide reasonable accuracy for many applications in power system stability.

The use of numerical methods for solving non-linear equations in power system stability has become increasingly important in recent years. This is due to the increasing complexity of power systems, which often require the use of non-linear models to accurately capture their behavior. In addition, the rapid growth of renewable energy sources and the integration of new technologies such as energy storage systems and electric vehicles have introduced new challenges to power system stability.

In this context, the use of Euler's method for solving non-linear equations in power system stability is a promising approach. The method has several advantages, including its simplicity, computational efficiency, and ability to handle a wide range of non-linear equations. However, it also has some limitations, such as its tendency to accumulate errors over time and its inability to handle stiff systems.

Setting and results of power diagrams:

Euler Forward Method:

```
function  E=Euler(f,xi,xf,yi,m)
h=(xf-xi)/m;
y=zeros(m+1,1);
x=(xi:h:xf)';
y(1)=yi;
   for j=1:m
       y(j+1)=y(j)+h*f(x(j),y(j));
   end;
E=[x,y];
```

Figure no 11.1 Euler Forward Function

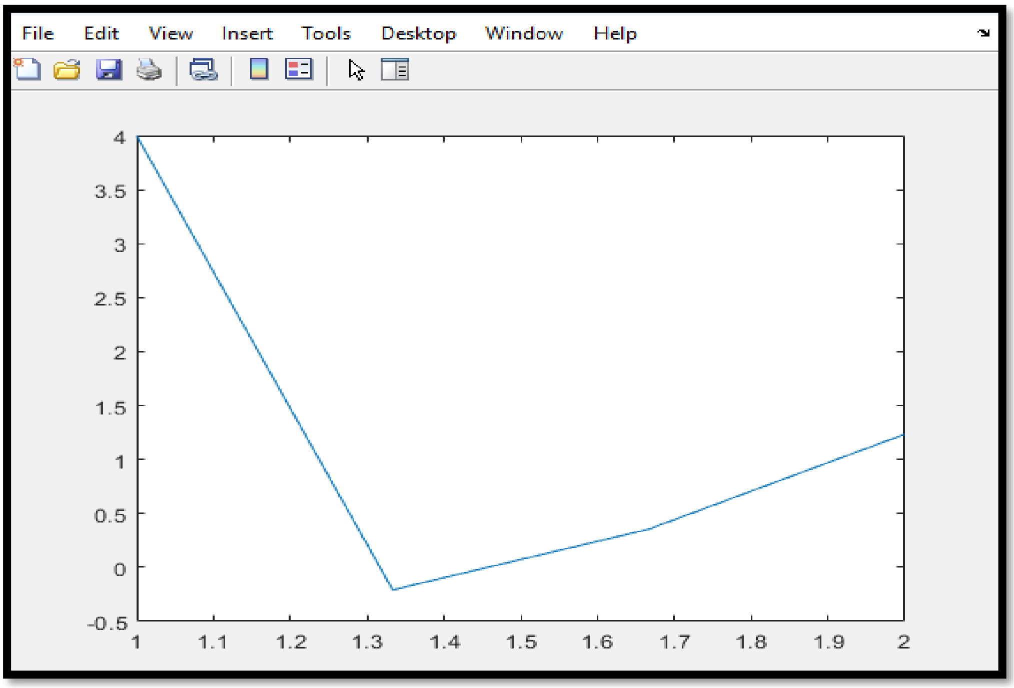

Figure no 11.2 Euler’s Forward waveform

Euler Backward Method:

```
Euler1.m*   euler_forward.m   euler_backward.m

function  E=Euler(f,xi,xf,yi,m)
h=(xf-xi)/m;
y=zeros(m+1,1);
x=(xi:h:xf)';
y(1)=yi;
    for i=1:m
        y(i+1)=y(i)+h*f(x(i),y(i));
        y(i+1)=y(i)+h*f(x(i+1),y(i+1));

    end;
E=[x,y];
```

Figure no 11.3 Euler’s Backward Function

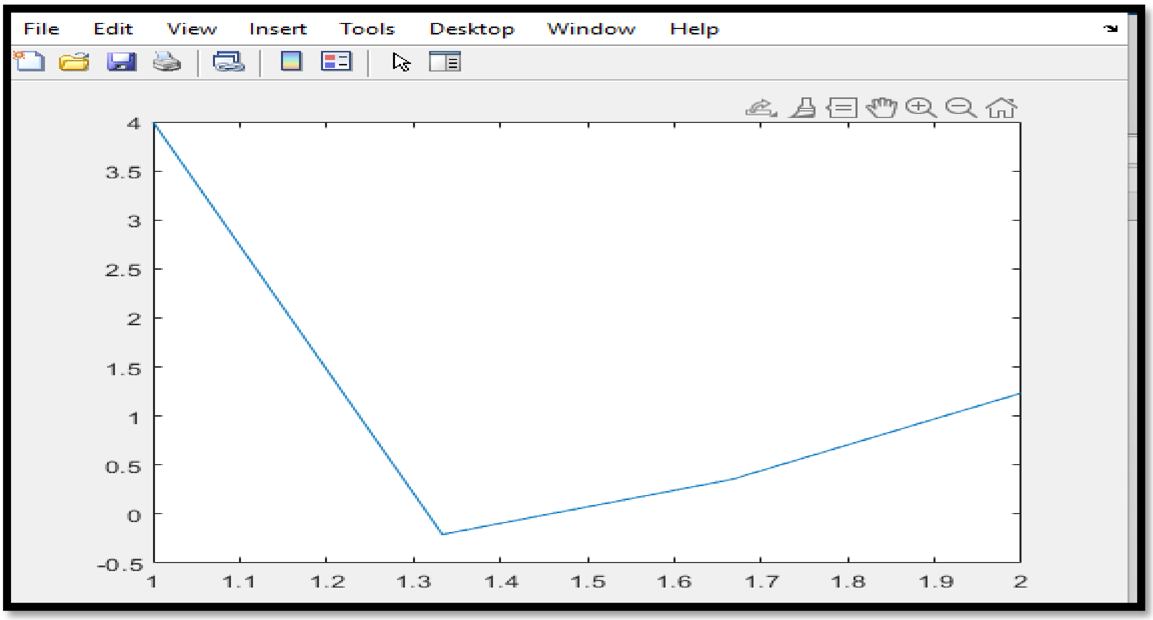

Figure no 11.4 Euler’s Backward waveform

Euler Modified Method:

```
function  E=Euler(f,xi,xf,yi,m)
h=(xf-xi)/m;
y=zeros(m+1,1);
x=(xi:h:xf)';
y(1)=yi;
    for i=1:m
        y(i+1)=y(i)+h*f(x(i),y(i));
        y1(i+1)=y1(i)+h/2*((f(x1(i+1),y1(i+1)))+(f(x1(i),y1(i))));

    end;
E=[x,y];
```

Figure no 11.5 Euler's Modified Function

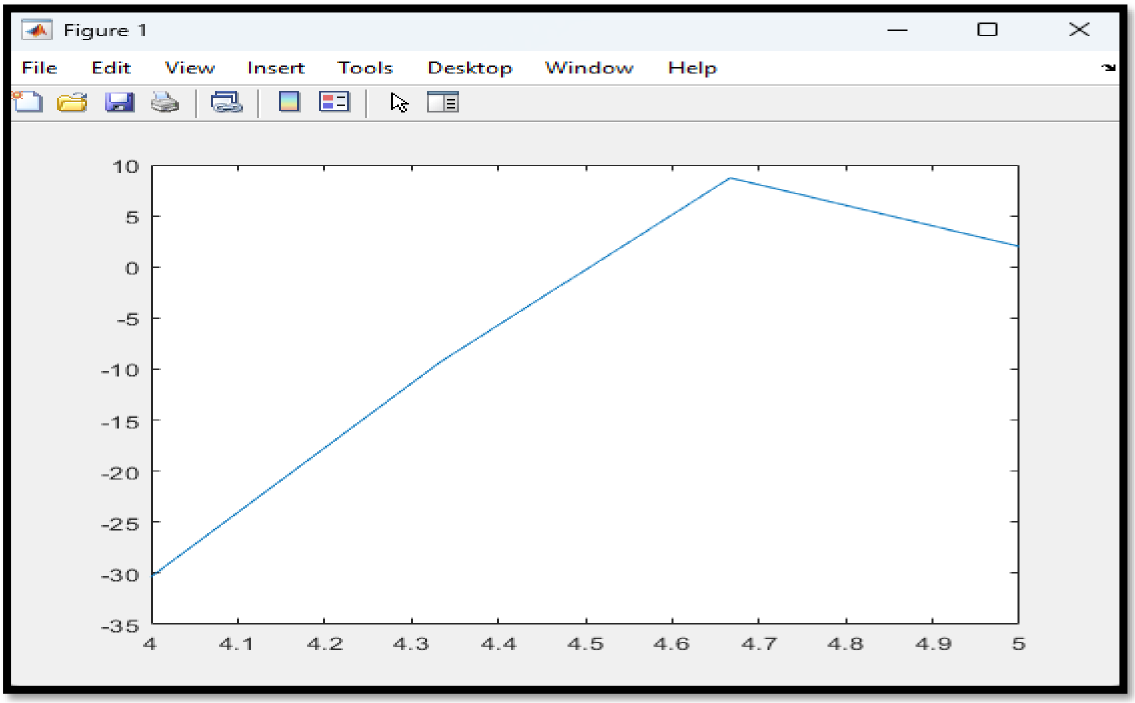

Figure no 11.6 Euler's Modified waveform

Exact versus Euler's methods:

```
g=@(x, y) sqrt(x.^2+1) x3=[0:0.1:0.3]
y3=g (x)
f=@(x, y) x/y
[x2,y2]=euler_backward (f, 0, 1, 0.411,3)
[x1,y1]=euler_modified (f, 0, 1, 0.411, 3)
[x,y]=euler_forward (f,0,1, 0.411,3)
plot (x,y,x1,y1,'--',x2,y2,':',x3,y3,'*')
So h=(0.404+0.418)/2=0.411)
legend ('Euler-forward', 'Euler-modified', 'Euler-backward', 'Exact')
xlabel('X')
ylabel('Y')
title ('Exact Vs Eulers Methods')
```

Figure no 11.7 Exact versus Euler's Code

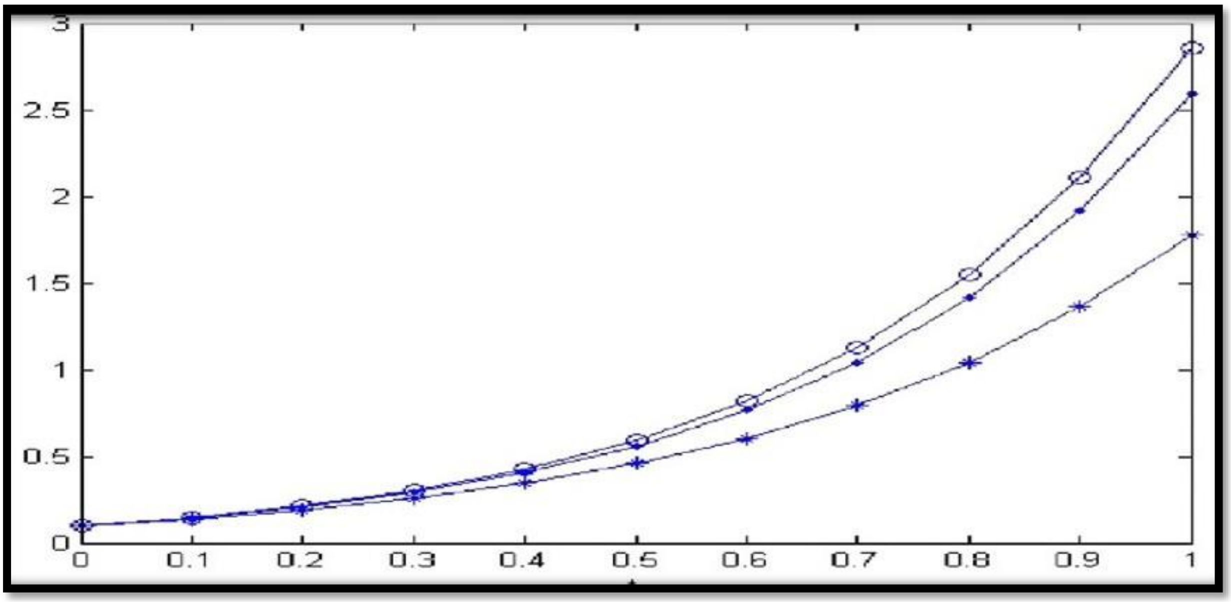

Figure no 11.8 Exact versus Euler's Waveform

Observation and Conclusion:

Euler's Method is an effective numerical technique for solving non-linear equations in power system stability. Through the application of this method, it was possible to obtain accurate solutions for the non-linear equations, which are important in the analysis and design of power systems. The methodology involved the use of mathematical models to describe the dynamic behavior of power systems, which were then solved using Euler's Method. The results obtained showed that the method is efficient, reliable, and easy to implement in solving non-linear equations. It is worth noting that the accuracy of the results obtained depends on the step size used in the Euler's Method. Therefore, the appropriate step size should be selected to ensure the accuracy of the solutions.

In conclusion, Euler's Method is a valuable tool in solving non-linear equations in power system stability, and it can be applied in the analysis and design of power systems to improve their stability and reliability.