```
t =clock;

Xguess=[0;0;0;0];
Is = 1e-13;
Vt = 0.025;

X=NewtonRaphson(Xguess,1e-5)
```

```
X = 4×1
    9.2957
    8.5914
   -0.7043
   -0.1718
```

```
[Fx,j]= nonlinearFunc(X)
```

```
Fx = 4×1
10^-12 ×
    0.9200
   -0.9200
   -0.9200
         0
j = 4×4
    6.8731   -6.8731         0    1.0000
   -6.8731    6.8931   -0.0000         0
         0   -0.0000    6.8731   -1.0000
    1.0000         0   -1.0000         0
```

```
fx=[X(4)+Is*( exp( (X(1) - X(2) )/Vt) -1) - Is*( exp(- X(1)/Vt) -1);...
    0.02*X(2)+(-Is*( exp( (X(1) - X(2) )/Vt) -1)   - Is*( exp( (X(3)- X(2) )/Vt) -1));...
    -X(4)+ Is*( exp( (X(3) - X(2) )/Vt) -1)   - Is*( exp( -X(3)/Vt) -1);...
    X(1)-X(3)-10]
```

```
fx = 4×1
10^-12 ×
    0.9200
   -0.9200
   -0.9200
         0
```

```
V2 = X(2,1)
```

```
V2 = 8.5914
```

```
time = etime(clock,t)
```

```
time = 0.0940
```

```
function [X_result]  = NewtonRaphson(Xguess,tol)

x_prev=Xguess;

for iteration=1:1000

    [F_prev,J_prev]  =  nonlinearFunc(x_prev);

   x_current = x_prev - J_prev \ F_prev;

    [F_current,J_current]  =  nonlinearFunc(x_current);

    normDeltaX(iteration)=norm(x_current - x_prev);

    if norm(F_current)<tol && (normDeltaX(iteration))<tol
        X_result=x_current;
       break
    end

    x_prev=x_current;

     iteration=iteration+1;

end
end
```

```
function [F,J]  =  nonlinearFunc(X)
%outputs :
% F is the nonlinear function,
% J is the Jacobian of the F.
%Input
% X is the vector of nodal voltages.
% input source
U =  zeros(4,1);
U(4,1) = 10;
U = U;
% G matrix
G = zeros(4,4);

G(2,2) = 0.02;
G(4,1) = 1;
G(1,4) = 1;

G(4,3) = -1;
G(3,4) = -1;

% g vector

Is = 1e-13;
```

```
Vt = 0.025;
g(1,1) =  Is*( exp( (X(1) - X(2) )/Vt) -1)    - Is*( exp(- X(1)/Vt) -1)  ;

g(2,1) =-Is*( exp( (X(1) - X(2) )/Vt) -1)    - Is*( exp( (X(3)- X(2) )/Vt) -1)  ;

g(3,1) = Is*( exp( (X(3) - X(2) )/Vt) -1)    - Is*( exp( -X(3)/Vt) -1)  ;

g(4,1)=0;
%% Set of nonlinear equations

F = G*X+g-U;

%% compute the Jacobian



gdX(1,1) = (Is/Vt)*( exp( (X(1) - X(2) )/Vt) )    + (Is/Vt)*( exp(- X(1)/Vt) );

gdX(1,2) = -(Is/Vt)*( exp( (X(1) - X(2) )/Vt) ) ;


gdX(2,1) = -(Is/Vt)*( exp( (X(1) - X(2) )/Vt) ) ;

gdX(2,2) = (Is/Vt)*( exp( (X(1)- X(2) )/Vt) ) + (Is/Vt)*( exp( (X(3)- X(2) )/Vt) ) ;

gdX(2,3) = -(Is/Vt)*( exp( (X(3)- X(2) )/Vt)) ;


gdX(3,2) = -(Is/Vt)*( exp( (X(3)- X(2) )/Vt)) ;

gdX(3,3) = (Is/Vt)*( exp( (X(3)- X(2) )/Vt))  + (Is/Vt)*( exp( -X(3)/Vt) );

gdX(3,4) = 0;

gdX(4,:)=0;

J = G+gdX;
end
```