```
clear all

tm =clock;
syms x1 x2 x3 Ie;
x=[x1; x2; x3; Ie];
warning("off")
[f,j]=nonlinearFunc(x);

f
```

f =

$$\begin{pmatrix} \mathrm{Ie} - \frac{e^{-40 x_1}}{10000000000000} + \frac{e^{40 x_1 - 40 x_2}}{10000000000000} \\ \frac{x_2}{50} - \frac{e^{40 x_1 - 40 x_2}}{10000000000000} - \frac{e^{40 x_3 - 40 x_2}}{10000000000000} + \frac{1}{5000000000000} \\ \frac{e^{40 x_3 - 40 x_2}}{10000000000000} - \frac{e^{-40 x_3}}{10000000000000} - \mathrm{Ie} \\ x_1 - x_3 - 10 \end{pmatrix}$$

```
X(1)=solve(f,x).x1;
X(2)=solve(f,x).x2;
X(3)=solve(f,x).x3;
X(4)=solve(f,x).Ie;
Is = 1e-13;
Vt = 0.025;



f_x=[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]
```

f_x =

$$\begin{pmatrix} -1.8843154396825404497727140735325\text{e-}40 \\ 2.2958874039497802890014385492622\text{e-}40 \\ 1.8367099231598242312011508394098\text{e-}40 \\ 0 \end{pmatrix}$$

```
V2=X(2)
```

V2 = 8.591382854462167684429536001667

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

time = 2.3657

```
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
```