

Scilab Manual for  
Power System Simulation  
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# Experiment: 1

## Computation of Transmission line Parameters

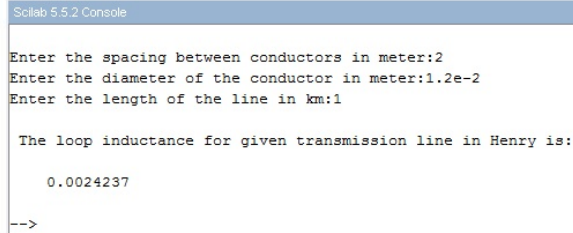
**Scilab code Solution 1.1** Inductance of Single Phase line

```
1 //Program to find loop inductance of a single phase
   transmission line//
2 //This program requires user input. Sample Problem
   and user input with output are available in the
   result file//
3 //Scilab Version 5.5.2 ; OS:Windows
4 clc;
5 clear;
6 d=input('Enter the spacing between conductors in
   meter: ')
7 dia=input('Enter the diameter of the conductor in
   meter: ')
8 r=dia/2
9 l=input('Enter the length of the line in km:')
10 li=10^(-7)*(1+4*(log(d/r)))*l*1000
11 disp(li,'The loop inductance for given transmission
   line in Henry is:')
12
13
```



**PROBLEM :**

A single phase line has two parallel conductors 2 meters apart. The diameter of each conductor is 1.2 cm. Calculate the loop inductance per km of the line.

**OUTPUT:**


```

Scilab 5.5.2 Console

Enter the spacing between conductors in meter:2
Enter the diameter of the conductor in meter:1.2e-2
Enter the length of the line in km:1

The loop inductance for given transmission line in Henry is:

0.0024237

-->

```

Figure 1.1: Inductance of Single Phase line

```

14 //SAMPLE INPUT:
15
16 //Enter the spacing between conductors in meter: 2
17 //Enter the diameter of the conductor in meter: 1.2e
    -2
18 //Enter the length of the line in km: 1
19
20 //OUTPUT:
21 //The loop inductance for given transmission line
    in Henry is:
22
23 // 0.0024237

```

---

**Scilab code Solution 1.2** Inductance of Three Phase line

```

1 //Program to find loop inductance of a three phase
    transmission line assuming completely transposed
    line//

```

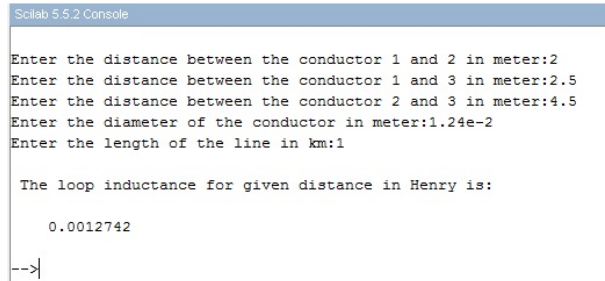
```

2 //This program requires user input. Sample Problem
   and user input with output are available in the
   result file//
3 //Scilab Version 5.5.2 ; OS:Windows
4 clc;
5 clear;
6 d12=input('Enter the distance between the conductor
   1 and 2 in meter:')
7 d23=input('Enter the distance between the conductor
   1 and 3 in meter:')
8 d31=input('Enter the distance between the conductor
   2 and 3 in meter:')
9 deq=(d12*d23*d31)^(1/3)
10 dia=input('Enter the diameter of the conductor in
   meter:')
11 r=dia/2
12 l=input('Enter the length of the line in km:')
13 li=10^(-7)*(0.5+2*(log(deq/r)))*l*1000
14 disp(li,'The loop inductance for given distance in
   Henry is:')
15
16
17 //SAMPLE INPUT:
18 //Enter the distance between the conductor 1 and 2
   in meter:2
19 //Enter the distance between the conductor 1 and 3
   in meter:2.5
20 // the distance between the conductor 2 and 3 in
   meter:4.5
21 //Enter the diameter of the conductor in meter:1.24e
   -2
22 //Enter the length of the line in km:1
23
24 //OUTPUT:
25 //The loop inductance for given distance in Henry
   is:
26
27 // 0.0012742

```

**PROBLEM :**

The three conductors of a 3-phase line are arranged at the corners of a triangle of sides 2 m, 2.5 m and 4.5 m. Calculate the inductance per km of the line when the conductors are regularly transposed. The diameter of each conductor is 1.24 cm.

**OUTPUT:**


```

Scilab 5.5.2 Console

Enter the distance between the conductor 1 and 2 in meter:2
Enter the distance between the conductor 1 and 3 in meter:2.5
Enter the distance between the conductor 2 and 3 in meter:4.5
Enter the diameter of the conductor in meter:1.24e-2
Enter the length of the line in km:1

The loop inductance for given distance in Henry is:

    0.0012742

-->

```

Figure 1.2: Inductance of Three Phase line

**Scilab code Solution 1.3** Capacitance of Single Phase line

```

1 //Program to find the capacitance of a single phase
  transmission line//
2 //This program requires user input. Sample Problem
  and user input with output are available in the
  result file//
3 //Scilab Version 5.5.2 ; OS:Windows
4 clc;
5 clear;
6 dia=input('Enter the diameter of the conductor in
  meter: ')
7 r=dia/2
8 d=input('Enter the spacing between the conductors in

```

```

        meter: ')
9  l=input('Enter the length of the line in km:')
10 c=((%pi*8.854*10^(-12)*l*1000)/log(d/r))
11 disp(c,'the capacitance of the line for given
    distance is:')
12
13
14
15 //SAMPLE INPUT:
16 //Enter the diameter of the conductor in meter:2e-2
17 //Enter the spacing between the conductors in meter
    :3
18 //Enter the length of the line in km:1
19
20 //OUTPUT:
21 //the capacitance of the line for given distance is
    :
22
23 // 4.877D-09

```

---

#### Scilab code Solution 1.4 Capacitance of Three Phase line

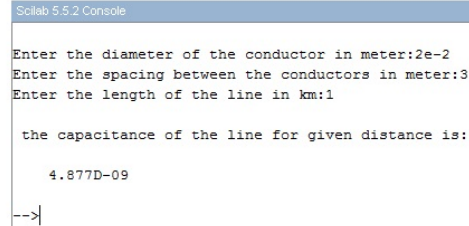
```

1 //Program to find line to neutral capacitance of a
    three phase transmission line assuming completely
    transposed line//
2 //This program requires user input. Sample Problem
    and user input with output are available in the
    result file//
3 //Scilab Version 5.5.2 ; OS:Windows
4 clc;
5 clear;
6 d12=input('Enter the distance between the conductor
    1 and 2 in meter:')

```

**PROBLEM :**

A single-phase transmission line has two parallel conductors 3 meters apart, diameter of each conductor being 2 cm. Calculate the capacitance of the line per km.

**OUTPUT:**


```

Scilab 5.5.2 Console

Enter the diameter of the conductor in meter:2e-2
Enter the spacing between the conductors in meter:3
Enter the length of the line in km:1

the capacitance of the line for given distance is:

4.877D-09

-->|

```

Figure 1.3: Capacitance of Single Phase line

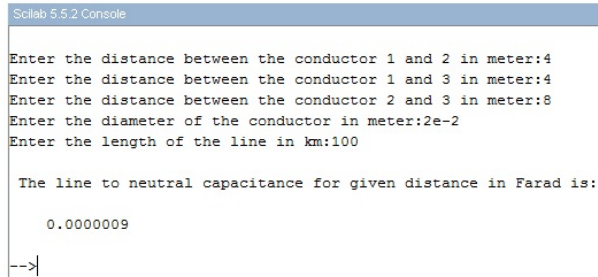
```

7 d23=input('Enter the distance between the conductor
  1 and 3 in meter:')
8 d31=input('Enter the distance between the conductor
  2 and 3 in meter:')
9 deq=(d12*d23*d31)^(1/3)
10 dia=input('Enter the diameter of the conductor in
  meter:')
11 r=dia/2
12 l=input('Enter the length of the line in km:')
13 Cn=((2*%pi*8.85*10^-12)/(log(deq/r)))*l*1000
14 disp(Cn,'The line to neutral capacitance for given
  distance in Farad is:')
15
16
17 //SAMPLE INPUT:
18
19 //Enter the distance between the conductor 1 and 2
  in meter:4
20 //Enter the distance between the conductor 1 and 3
  in meter:4
21 //Enter the distance between the conductor 2 and 3

```

**PROBLEM :**

A 3-phase, 50 Hz, 132 kV overhead line has conductors placed in a horizontal plane 4 m apart. Conductor diameter is 2 cm. If the line length is 100 km, calculate the capacitance to neutral per phase assuming complete transposition.

**OUTPUT:**


```

Scilab 5.5.2 Console

Enter the distance between the conductor 1 and 2 in meter:4
Enter the distance between the conductor 1 and 3 in meter:4
Enter the distance between the conductor 2 and 3 in meter:8
Enter the diameter of the conductor in meter:2e-2
Enter the length of the line in km:100

The line to neutral capacitance for given distance in Farad is:

    0.0000009

-->|

```

Figure 1.4: Capacitance of Three Phase line

```

in meter:8
22 //Enter the diameter of the conductor in meter:2e-2
23 //Enter the length of the line in km:100
24
25 //OUTPUT:
26 //The line to neutral capacitance for given
    distance in Farad is:
27
28 // 0.0000009

```

---

## Experiment: 2

# Modelling of Transmission Lines

Scilab code Solution 2.1 Nominal T method

```
1 // Calculation of Transmission Line parameters using
   Nominal-T method//
2 // This program requires user input. Sample problem
   with user input and result are available in the
   result file//
3 // Scilab Version 5.5.2 ; OS: Windows
4 clc;
5 clear;
6 pl=input('Enter the power supplied to the load:');
7 vr=input('Enter the receiving end voltage:');
8 pf=input('Enter the power factor:');
9 spf=sin(acos(pf));
10 z=input('Enter the series impedance value of single
   conductor:');
11 y=input('Enter the shunt admittance value:');
12 e=(z*y)/2;
13 a=(1+e); // calculation of transmission
   line parameters
14 b=z*(1+e/2);
```

```

15 c=y;
16 d=a;
17 disp(d,c,b,a,'The values of ABCD parameters
    respectively are')
18 vrph=vr/sqrt(3);           //receiving end voltage per
    phase
19 ir=pl/(sqrt(3)*vr*pf);      //receiving end current
20 irv=ir*(pf-%i*spf);         // receiving end
    current in vector form
21 vsph=(a*vrph+b*irv);        //sending end voltage
    per phase
22 vsh=abs(vsph);              // magnitude of sending
    end voltage per phase
23 reg=((abs(vsh/a)-abs(vrph))/vrph)*100;           //
    calculation of percentage regulation
24 disp(reg,'regulation of the line is')
25
26
27 //SAMPLE INPUT:
28 //Enter the power supplied to the load:30e6
29 //Enter the receiving end voltage:132e3
30 //Enter the power factor:0.85
31 //Enter the series impedance value of single
    conductor:20+52*%i
32 //Enter the shunt admittance value:315e-6*%i
33
34
35 //OUTPUT:
36 //The values of ABCD parameters respectively are
37
38 // 0.99181 + 0.00315i
39
40 //19.8362 + 51.81856i
41
42 //0.000315i
43
44 // 0.99181 + 0.00315i
45

```



## PROBLEM

A balanced 3-phase load of 30 MW is supplied at 132 KV, 50 Hz and 0.85 pf lagging by means of a transmission line. The series impedance of a single conductor is  $(20+j52)$  ohms and the total phase neutral admittance is  $315 \times 10^{-6}$  Siemen. Using nominal T method determine Transmission line ABCD-parameters and the regulation of the line.

## OUTPUT

```
Scilab 5.5.2 Console

Enter the power supplied to the load:30e6
Enter the receiving end voltage:132e3
Enter the power factor:0.85
Enter the series impedance value of single conductor:20+52*i
Enter the shunt admittance value:315e-6*i

The values of ABCD parameters respectively are

0.99181 + 0.00315i
19.8362 + 51.81856i
0.000315i
0.99181 + 0.00315i

regulation of the line is

9.2540724

-->
```

Figure 2.1: Nominal T method

```
46 //regulation of the line is
47
48 // 9.2540724
```

---

## Scilab code Solution 2.2 Nominal pi Method

```
1 // Calculation of Transmission Line parameters using
  Nominal-pi method//
2 // This Program requires user input. Sample Problem
  with user input and result are available in the
```

```

        result file//
3 //Scilab Version 5.5.2 ; OS:Windows
4 clc;
5 clear;
6 d=input('Enter the value of distance:');
7 rkm=input('Enter the value of resistance per km:');
8 xlm=input('Enter the value of inductive reactance
    per km:');
9 yshkm=input('Enter the value of shunt admittance per
    km:');
10 pl=input('Enter the value of power delivered:');
11 vl=input('Enter the value of line voltage:');
12 pf=input('Enter the value of power factor:');
13 vr=vl/sqrt(3); //phase voltage
14 r=rkm*d; //total resistance of the
    transmission line
15 xl=xlm*d; //total inductive reactance
    of the transmission line
16 ysh=yshkm*d; //total shunt admittance of
    the transmission line
17 zs=r+(xl*%i); //total impedance
18 a=1+(ysh*zs)/2; //calculation of
    transmission line parameters
19 b=zs;
20 c=ysh*(1+(ysh*zs)/4);
21 d=a;
22 disp(d,c,b,a,'the values of ABCD parameters
    respectively are:')
23 ilo=pl/((sqrt(3)*vl*pf));
24 sp=sin(acos(pf));
25 ir=ilo*(pf-%i*sp);
26 icl=(vr*ysh)/2;
27 il=ir+icl;
28 vs=(vr+(il*(r+(%i*xl)))); //sending end voltage
29 reg=((abs(vs)/abs(a)-abs(vr))/abs(vr))*100; //
    calculation of percentage regulation
30 disp(reg,'regulation of the line is');
31

```

```

32 //SAMPLE INPUT:
33 //Enter the value of distance:100
34 //Enter the value of resistance per km:0.1
35 //Enter the value of inductive reactance per km:0.2
36 //Enter the value of shunt admittance per km:4e-6*%i
37 //Enter the value of power delivered:10e6
38 //Enter the value of line voltage:66e3
39 //Enter the value of power factor:0.8
40
41 //OUTPUT:
42 //the values of ABCD parameters respectively are:
43
44 // 0.996 + 0.002i
45
46 //10. + 20.i
47
48 // - 0.0000004 + 0.0003992i
49
50 // 0.996 + 0.002i
51
52 //regulation of the line is
53
54 // 5.8069405

```

---

### PROBLEM

A 3 phase, 50 Hz, 100 Km line has a resistance, inductive reactance and capacitive shunt admittance of  $0.1\Omega/\text{Km}$ ,  $0.2\Omega/\text{Km}$  and  $4 \times 10^{-6} \text{ S/Km}$  per phase. If the line delivers 10 MW at 110 KV and 0.8 pf lagging, determine the transmission line ABCD-parameters and the regulation of the line using nominal-pi method.

### OUTPUT

```
Scilab 5.5.2 Console

Enter the value of distance:100
Enter the value of resistance per km:0.1
Enter the value of inductive reactance per km:0.2
Enter the value of shunt admittance per km:4e-6*i
Enter the value of power delivered:10e6
Enter the value of line voltage:66e3
Enter the value of power factor:0.8

the values of ABCD parameters respectively are:

0.996 + 0.002i

10. + 20.i

- 0.0000004 + 0.0003992i

0.996 + 0.002i

regulation of the line is

5.8069405

-->
```

Figure 2.2: Nominal pi Method

## Experiment: 3

### Formation of Bus Admittance matrix

Scilab code Solution 3.1 Bus Admittance Matrix

```
1
2 //Program to find out bus admittance matrix of a
   power system of any size//
3 //This program requires user input. A sample problem
   with user input and output is available in the
   result file//
4 //Scilab Version 5.5.2 ; OS:Windows
5 clc;
6 clear;
7 linedata=input('Enter line data in order of strt bus
   ,end bus,series resistance ,series reactance ,shunt
   susceptance:')
8 sb=linedata(:,1) //Starting bus number of all the
   lines stored in variable sb
9 eb=linedata(:,2) //Ending bus number of all the
   lines stored in variable eb
10 lz=linedata(:,3)+linedata(:,4)*%i; //lineimpedance=
   R+jX
11 sa=-linedata(:,5)*%i; //shunt admittance=-jB
```

```

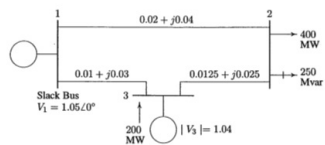
12 nb=max(max(sb,eb));
13 ybus=zeros(nb,nb);
14 for i=1:length(sb)
15     m=sb(i);
16     n=eb(i);
17     ybus(m,m)=ybus(m,m)+1/lz(i)+sa(i);
18     ybus(n,n)=ybus(n,n)+1/lz(i)+sa(i);
19     ybus(m,n)=-1/lz(i);
20     ybus(n,m)=ybus(m,n);
21 end
22 disp(ybus,'The Bus Admittance matrix is:')
23
24 //SAMPLE INPUT:
25
26 //Enter line data in order of strt bus,end bus,
    series resistance,series reactance,shunt
    susceptance:[1 2 0.02 0.04 0;1 3 0.01 0.03 0;2 3
    0.0125 0.025 0]
27
28 //OUTPUT:
29 //The Bus Admittance matrix is:
30
31 //      20. - 50.i   - 10. + 20.i   - 10. + 30.i
32 //   - 10. + 20.i    26. - 52.i   - 16. + 32.i
33 //   - 10. + 30.i   - 16. + 32.i    26. - 62.i

```

---

## PROBLEM:

For the network shown in figure, determine the bus admittance matrix .



## OUTPUT:

```

Scale 5.5.2 Console
Enter line data in order of strt bus,end bus,series resistance,series reactance,shunt susceptance:[1 2 0.02 0.04 0;1 3 0.01 0.03 0;2 3 0.0125 0.025 0]

20. - 50.i - 10. + 20.i - 10. + 30.i
- 10. + 20.i 26. - 52.i - 16. + 32.i
- 10. + 30.i - 16. + 32.i 26. - 62.i
-->

```

Figure 3.1: Bus Admittance Matrix

## Experiment: 4

# Formation of Bus Impedance matrix

### Scilab code Solution 4.1 Bus Impedance Matrix

```
1
2 //Program to determine bus impedance matrix of a
   power system of any size using building algorithm
   //
3 //This program needs user input. Sample problem with
   user input and output is available in the result
   file //
4 //Scilab Version 5.5.2 ; OS:Windows
5 clc;
6 clear;
7 linedata=input('enter the line data values in the
   order of starting bus,ending bus,resistance and
   reactance:') //note:enter 0 for reference bus
8 sb=linedata(:,1)
9 eb=linedata(:,2)
10 z=linedata(:,3)+linedata(:,4)*%i //impedance z=R+
   jX
11 zbus=[];
12 check=[];
```



```

13 for i=1:length(sb)
14     m=sb(i);
15     n=eb(i);
16     mn=min(m,n);
17     nm=max(m,n);
18     ncheck=length(find(check==nm)); //Variable
        used for checking whether bus nm is already
        existing
19     mcheck=length(find(check==mn)); //Variable
        used for checking whether bus mn is already
        existing
20     [rows columns]=size(zbus);
21 //Condition for connection of line between reference
    bus and new bus
22     if mn==0 & ncheck==0
23         zbus=[zbus zeros(rows,1);zeros(1,rows) z(i)
            ];
24         check=[check nm];
25 //Condition for connection of line between existing
    bus and new bus
26         else if mcheck>0 & ncheck==0
27             zbus=[zbus zbus(:,mn);zbus(mn,:) zbus(mn
                ,mn)+z(i)];
28             check=[check nm];
29 //Condition for connection of line between reference
    bus and existing bus
30             elseif mn==0 & ncheck>0
31                 zbus=[zbus zbus(:,nm);zbus(nm,:) zbus(nm
                    ,nm)+z(i)];
32 //Modifying Z bus size using Kron's
        reduction technique
33         zbusn=zeros(rows,rows);
34         for r=1:rows
35             for t=1:columns
36                 zbusn(r,t)=zbus(r,t)-(zbus(r,
                    rows+1)*zbus(rows+1,t))/(zbus
                    (rows+1,rows+1));
37             end

```

```

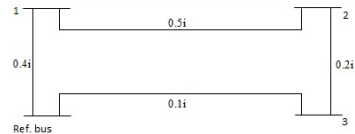
38         end
39         zbus=zbusn
40 //Condition for connection of line between two
    existing buses
41     elseif mcheck>0 & ncheck>0
42         zbus=[zbus zbus(:,nm)-zbus(:,mn);zbus(nm
            ,:)-zbus(mn,:),z(i)+zbus(mn,nm)+zbus(
            nm,nm)-2*zbus(nm,mn)];
43         //Modifying Z bus size using Kron's
            reduction tehnique
44         zbusn=zeros(rows,rows);
45         for r=1:rows
46             for t=1:columns
47                 zbusn(r,t)=zbus(r,t)-(zbus(r,rows
                    +1)*zbus(rows+1,t))/(zbus(rows
                    +1,rows+1));
48             end
49         end
50         zbus=zbusn;
51     end
52 end
53 end
54 disp(zbus,'The bus impedance matrix is:');
55
56
57 //SAMPLE INPUT:
58
59 //enter the line data values in the order of
    starting bus,ending bus,resistance and reactance
    :[0 1 0 0.5;1 2 0 0.2;2 3 0 0.1;3 0 0 0.4]
60
61 //OUTPUT:
62 //The bus impedance matrix is:
63
64 //      0.2916667i      0.2083333i      0.1666667i
65 //      0.2083333i      0.2916667i      0.2333333i
66 //      0.1666667i      0.2333333i      0.2666667i

```

---

**PROBLEM:**

Determine the bus impedance matrix of the given power system, where the per unit values of line impedances are marked in the diagram.

**OUTPUT:**

```
Scilab 5.5.2 Console
enter the line data values in the order of starting bus,ending bus,resistance and reactance:[0 1 0 0.5;1 2 0 0.2;2 3 0 0.1;3 0 0 0.4]

0.2916667i    0.2083333i    0.1666667i
0.2083333i    0.2916667i    0.2333333i
0.1666667i    0.2333333i    0.2666667i
-->
```

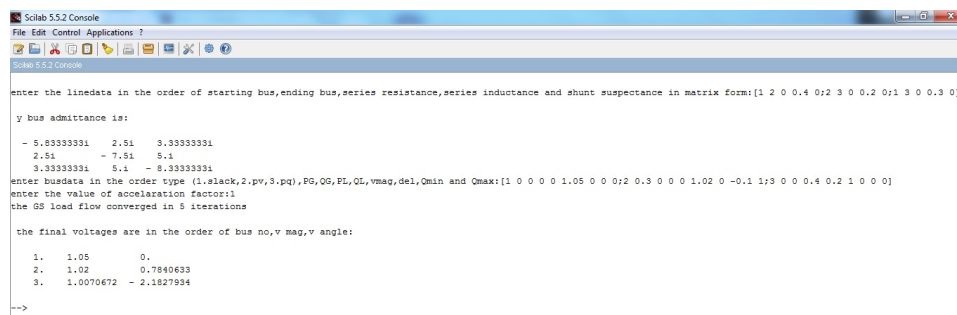
Figure 4.1: Bus Impedance Matrix

# Experiment: 5

## Load flow solution using Gauss-Seidal method

### Scilab code Solution 5.1 Gauss Seidal Load Flow

- 1 //Program to find out power system voltage at the end of the iteration by gauss siedal method//
- 2 //This program requires user input. A sample problem



```
Scilab 5.2.2 Console
File Edit Control Applications ?
[Icons]

enter the linedata in the order of starting bus,ending bus,series resistance,series inductance and shunt susceptance in matrix form:[1 2 0 0.4 0;2 3 0 0.2 0;1 3 0 0.3 0]

y bus admittance is:

- 5.8333333i  2.5i  3.3333333i
 2.5i        - 7.5i  5.1
 3.3333333i  5.1   - 8.3333333i

enter busdata in the order type (1:slack,2:pv,3:pq),PG,QG,PL,QL,vmag,dcl,Qmin and Qmax:[1 0 0 0 1.05 0 0 0;2 0.3 0 0 1.02 0 -0.1 1;3 0 0 0.4 0.2 1 0 0]
enter the value of acceleration factor:1
the GS load flow converged in 5 iterations

the final voltages are in the order of bus no,v mag,v angle:

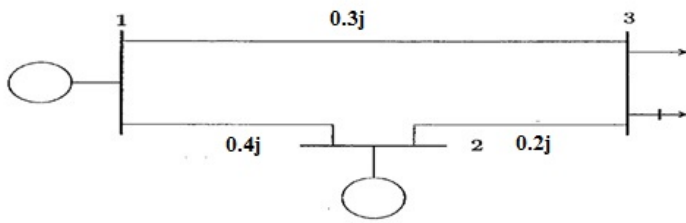
1.  1.05      0.
2.  1.02      0.7840633
3.  1.0070672 - 2.1827934

-->
```

Figure 5.1: Gauss Seidal Load Flow

### **PROBLEM:**

For the system shown in figure determine the voltage at the end of the iteration by gauss seidal method. Assume that base MVA as 100.



Bus no	Voltage	Generator		Load		Q min	Q max
	In p.u	P	Q	P	Q		
1	1.05	-	-	-	-	-	-
2	1.02	0.3	-	-	-	-10	100
3	-	-	-	0.4	0.2	-	-

Figure 5.2: Gauss Seidal Load Flow

```

        with user input and output is available in the
        result file//
3 //Question of example problem is available in file "
    GaussSeidalQuestionFile.jpg" and result is
    available in the file "GaussSeidalOutputFile.jpg"
4 //Scilab Version 5.5.2 ; OS:Windows
5 clc;
6 clear;
7 linedata=input('enter the linedata in the order of
    starting bus,ending bus,series resistance ,series
    inductance and shunt susceptance in matrix form:'
    )
8 sb=linedata(:,1) //Starting bus number of all the
    lines stored in variable sb //
9 eb=linedata(:,2) //Ending bus number of all the
    lines stored in variable eb //
10 lz=linedata(:,3)+linedata(:,4)*%i //lineimpedance=
    R+jX //
11 sa=-linedata(:,5)*%i //shunt admittance=-jB //
12 nb=max(max(sb,eb)); //number of buses calculation
    //
13 y=zeros(nb,nb);
14 for i=1:length(sb) // starting of admittance bus
    matrix calculation part //
15     m=sb(i);
16     n=eb(i);
17     y(m,m)=y(m,m)+1/lz(i)+(sa(i)/2);
18     y(n,n)=y(n,n)+1/lz(i)+(sa(i)/2);
19     y(m,n)=-1/lz(i);
20     y(n,m)=y(m,n);
21 end // end of admittance bus matrix
    calculation part //
22 disp(y,'y bus admittance is:');
23 busdata=input('enter busdata in the order type (1.
    slack ,2.pv ,3.pq ),PG,QG,PL,QL,vmag,del ,Qmin and
    Qmax: ')
24 typ=busdata(:,1) // type of all buses in the power
    system is stored in typ variable //

```

```

25 qmin=busdata(:,8) // minmum limit of Q for all the
    buses is stored in the variable qmin//
26 qmax=busdata(:,9) // maximum limit of Q for all the
    buses is stored in the variable qmax//
27 p=busdata(:,2)-busdata(:,4) // real power of all the
    buses are calculated and is stored in the
    variable p //
28 q=busdata(:,3)-busdata(:,5) // reactive power of
    all the buss are calculated and is stored in the
    variable q //
29 v=busdata(:,6).*(cosd(busdata(:,7))+%i*sind(busdata
    (:,7)));
30 alpha=input('enter the value of accelaration factor:
    ');
31 iter=1;
32 err=1;
33 vn(1)=v(1);
34 vold=v(1);
35 while abs(err)>5*10^(-5) // starting of calculation
    part of bus voltage for first iteration //
36     for i=2:nb
37         sumyv=0;
38         for j=1:nb
39             sumyv=sumyv+y(i,j)*v(j);
40         end
41         if typ(i)==2
42             q(i)=-imag(conj(v(i)*sumyv));
43             if q(i)<qmin(i) |q(n)>qmax(i)
44                 vn(i)=(1/y(i,i))*(((p(i)-%i*q(i))/(
                    conj(v(i))))-(sumyv-y(i,i)*v(i)))
                    ;
45                 vold(i)=v(i);
46                 v(i)=vn(i);
47                 typ(i)=3
48             if q(i)<qmin(i)
49                 q(i)=qmin(i);
50             else
51                 q(i)=qmax(i);

```

```

52         end
53     else
54         vn(i)=(1/y(i,i))*(((p(i)-%i*q(i))/(conj(
           v(i))))-(sumyv-y(i,i)*v(i)));
55         ang=atan(imag(vn(i)),real(vn(i)));
56         vn(i)=abs(v(i))*(cos(ang)+%i*sin(ang));
57         vold(i)=v(i);
58         v(i)=vn(i);
59     end
60     elseif typ(i)==3
61         vn(i)=(1/y(i,i))*(((p(i)-%i*q(i))/(conj(
           v(i))))-(sumyv-y(i,i)*v(i)));
62         vold(i)=v(i);
63         v(i)=vn(i);
64     end
65     end
66     err=max(abs(abs(v)-abs(vold)));
67
68     iter=iter+1;
69     for i=2:nb
70         if err>5*10^(-6) &typ(i)==3
71             v(i)=vold(i)+alpha*(v(i)-vold(i));
72         end
73     end
74     end
75     printf('the GS load flow converged in %d iterations
           \n',iter-1);
76     nn=1:nb;
77     res=[nn' abs(v) (atan(imag(v),real(v)))*(180/%pi)]
78     disp(res,'the final voltages are in the order of bus
           no,v mag,v angle:');
79
80     //SAMPLE INPUT and OUTPUT
81     //enter the linedata in the order of starting bus,
           ending bus,series resistance,series inductance
           and shunt susceptance in matrix form:[1 2 0 0.4
           0;2 3 0 0.2 0;1 3 0 0.3 0]
82

```



```

83 //y bus admittance is:
84
85 // - 5.8333333i      2.5i      3.3333333i
86 //      2.5i          - 7.5i      5.i
87 //      3.3333333i      5.i      - 8.3333333i
88 //enter busdata in the order type (1.slack,2.pv,3.pq
      ),PG,QG,PL,QL,vmag,del,Qmin and Qmax:[1 0 0 0 0
      1.05 0 0 0 0;2 0.3 0 0 0 1.02 0 -0.1 1;3 0 0 0.4
      0.2 1 0 0 0]
89 //enter the value of accelaration factor:1
90 //the GS load flow converged in 5 iterations
91
92 //the final voltages are in the order of bus no,v
      mag,v angle:
93
94 //      1.      1.05      0.
95 //      2.      1.02      0.7840633
96 //      3.      1.0070672 - 2.1827934

```

---

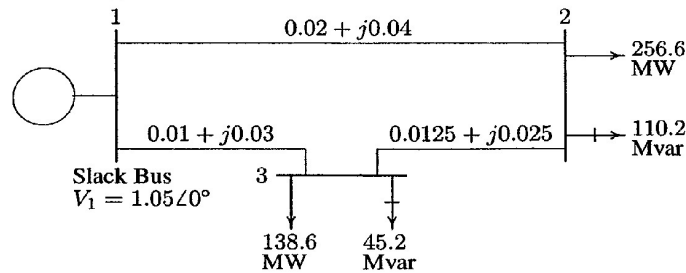
## Experiment: 6

### Load flow solution using Newton-Raphson method

**Scilab code Solution 6.1** Newton Raphson load Flow

```
1
2 //Program to find out load flow solution using
   Newton Raphson method//
3 //This program requires user input. A sample problem
   with user input and output is available in the
   result file//
4 //Example problem is available in the file "
   NRQuestionFile.jpg" and user input and output is
   available in the file "NRResultFile"
5 //Scilab Version 5.5.2 ; OS:Windows
6
7 clear;
8 clc;
9 linedata=input('Enterlinedata in the order line no.,
   Frombus,Tobus,series resistance,series reactance,
```

Figure shows the one-line diagram of a simple three-bus power system with generation at bus 1. The magnitude of voltage at bus 1 is adjusted to 1.05 per unit. The scheduled loads at buses 2 and 3 are as marked on the diagram. Line impedances are marked in per unit on a 100-MVA base and the line charging susceptances are neglected.



Determine the bus voltages and angle of all 3 buses using Newton Raphson method.

Figure 6.1: Newton Raphson load Flow

```

SciLab 5.5.2 Console
File Edit Control Applications ?
SciLab 5.5.2 Console
Enterlinedata in the order line no.,Frombus,Tobus,series resistance,series reactance,Line charging admittance:[1 1 2 0.02 0.04 0;2 2 3 0.0125 0.025 0;3 3 1 0.01 0.03 0]
Enter busdata in the order busno.,real power,reactivepower,busvoltage,bus type 1-for slack 2-for PQ and 3-for PV:[1 0 0 1.05 1;2 -2.566 -1.102 1 2;3 -1.386 -0.452 1 2]
Enter the number of PV bus:0

Bus admittance matrix
Y =
20. - 50.i - 10. + 20.i - 10. + 30.i
- 10. + 20.i 26. - 52.i - 16. + 32.i
- 10. + 30.i - 16. + 32.i 26. - 62.i

The load flow solution converged at iteration
4.

bus no Type voltage angle
1. 1. 1.05 0.
2. 2. 0.9818350 - 0.0611482
3. 2. 1.0012492 - 0.0499584
-->

```

Figure 6.2: Newton Raphson load Flow

```

        Line charging admittance:');
10 Busdata=input('Enter busdata in the order busno.,
    real power, reativepower, busvoltage, bus type 1-for
    slack 2-for PQ and 3-for PV:');
11 npv=input('Enter the number of PV bus:');
12
13 //Determination of bus admittance matrix//
14 nb=max(Busdata(:,1));
15 nl=max(linedata(:,1));
16 Psp=Busdata(:,2);
17 Qsp=Busdata(:,3);
18 vsp=Busdata(:,4);
19 rem=Busdata(:,5);
20 Y=zeros(nb,nb);
21 sb=linedata(:,2);
22 eb=linedata(:,3);
23 z=linedata(:,4)+linedata(:,5)*%i;
24 ly=linedata(:,6);
25 for i=1:nl
26     m=sb(i)
27     n=eb(i);
28     Y(m,m)=Y(m,m)+1/z(i)+ly(i)/2;
29     Y(n,n)=Y(n,n)+1/z(i)+ly(i)/2;
30     Y(m,n)=-1/z(i);
31     Y(n,m)=Y(m,n);
32 end
33 disp('Bus admittance matrix')
34 print(%io(2),Y)
35
36 //NR Load flow//
37 absY=abs(Y);
38 thetaY=atan(imag(Y),real(Y));
39 v=vsp';
40 iteration=1;
41 ang=zeros(1,nb);
42 mismatch=ones(2*nb-2-npv,1);
43 while max(abs(mismatch))>0.0001
44     J1=zeros(nb-1,nb-1);

```

```

45     J2=zeros(nb-1,nb-npv-1);
46     J3=zeros(nb-npv-1,nb-1);
47     J4=zeros(nb-npv-1,nb-npv-1);
48     P=zeros(nb,1);
49     Q=P;
50     del_P=Q;
51     del_Q=Q;
52     del_del=zeros(nb-1,1);
53     del_v=zeros(nb-1-npv,1);
54     ang;
55     mag=abs(v);
56     for i=2:nb
57         for j=1:nb
58             P(i)=P(i)+mag(i)*mag(j)*absY(i,j)*cos(
                    thetaY(i,j)-ang(i)+ang(j));
59             if rem(i)~=3
60                 Q(i)=Q(i)+mag(i)*mag(j)*absY(i,j)*
                    sin(thetaY(i,j)-ang(i)+ang(j));
61             end
62         end
63     end
64     Q=-1*Q;
65     del_P=Psp-P;
66     del_Q=Qsp-Q;
67     for i=2:nb
68         for j=2:nb
69             if j~=i
70                 J1(i-1,j-1)=-mag(i)*mag(j)*absY(i,j)*sin
                    (thetaY(i,j)-ang(i)+ang(j));
71                 J2(i-1,j-1)=mag(i)*absY(i,j)*cos(thetaY(
                    i,j)-ang(i)+ang(j));
72                 J3(i-1,j-1)=-mag(i)*mag(j)*absY(i,j)*cos
                    (thetaY(i,j)-ang(i)+ang(j));
73                 J4(i-1,j-1)=-mag(i)*absY(i,j)*sin(thetaY
                    (i,j)-ang(i)+ang(j));
74             end
75         end
76     end

```

```

77 for i=2:nb
78     for j=1:nb
79         if j~=i
80             J1(i-1,i-1)=J1(i-1,i-1)+mag(i)*mag(j)*
                absY(i,j)*sin(thetaY(i,j)-ang(i)+ang(
                    j));
81             J2(i-1,i-1)=J2(i-1,i-1)+mag(j)*absY(i,j)
                *cos(thetaY(i,j)-ang(i)+ang(j));
82             J3(i-1,i-1)=J3(i-1,i-1)+mag(i)*mag(j)*
                absY(i,j)*cos(thetaY(i,j)-ang(i)+ang(
                    j));
83             J4(i-1,i-1)=J4(i-1,i-1)+mag(j)*absY(i,j)
                *sin(thetaY(i,j)-ang(i)+ang(j));
84         end
85     end
86     J2(i-1,i-1)=2*mag(i)*absY(i,i)*cos(thetaY(i,i))+
        J2(i-1,i-1);
87     J4(i-1,i-1)=-2*mag(i)*absY(i,i)*sin(thetaY(i,i))
        -J4(i-1,i-1);
88 end
89 J=[J1 J2;J3 J4]
90 lenJ=length(J1);
91 i=2;
92 j=1;
93 while j<=lenJ
94     if rem(i)==2
95         j=j+1;
96     else
97         J(:,length(J1)+j)=[];
98         lenJ=lenJ-1;
99     end
100 end
101 i=i+1;
102 lenJ=length(J1);
103 i=1;
104 j=2;
105 while i<=lenJ
106     if rem(j)==2

```

```

107         i=i+1;
108     else
109         J(length(J1)+i,:)=[];
110         lenJ=lenJ-1;
111         Q(i+1)=[]
112         del_Q(i+1,:)=[]
113     end
114     // j=j+1;
115     end
116 P(1,:)=[]
117 Q(1,:)=[]
118 del_P(1,:)=[];
119 del_Q(1,:)=[];
120 mismatch=[del_P;del_Q];
121 del=J\mismatch;
122 del_del=del(1:nb-1);
123 del_v=del(nb:length(del));
124 ang=ang(2:nb)+del_del';
125 j=1;
126 for i=2:nb
127     if rem(i)==2
128         v(i)=v(i)+del_v(j);
129         j=j+1;
130     end
131 end
132 mag=abs(v);
133 ang=[0 ang];
134 nbr=1:nb;
135 iteration=iteration+1;
136 end
137 disp(iteration-1,'The load flow solution cnverged at
    iteration ')
138 disp('bus no    Type    voltage    angle')
139 disp([nbr' rem mag' ang'])
140
141
142 //SAMPLE INPUT and OUTPUT:
143 //Enterlinedata in the order line no.,Frombus,Tobus,

```

```

        series resistance ,series reactance ,Line charging
        admittance:[1 1 2 0.02 0.04 0;2 2 3 0.0125 0.025
        0;3 3 1 0.01 0.03 0]
144 //Enter busdata in the order busno.,real power ,
        reativepower ,busvoltage ,bus type 1—for slack 2—
        for PQ and 3—for PV:[1 0 0 1.05 1;2 -2.566 -1.102
        1 2;3 -1.386 -0.452 1 2]
145 //Enter the number of PV bus:0
146
147 // Bus admittance matrix
148 // Y =
149
150 //      20. - 50.i   - 10. + 20.i   - 10. + 30.i
151 //      - 10. + 20.i      26. - 52.i   - 16. + 32.i
152 //      - 10. + 30.i   - 16. + 32.i      26. - 62.i
153
154 // The load flow solution cnverged at iteration
155
156 //      4.
157
158 // bus no      Type      voltage      angle
159
160 //      1.      1.      1.05          0.
161 //      2.      2.      0.9818350   - 0.0611482
162 //      3.      2.      1.0012492   - 0.0499584

```

---



# Experiment: 7

## Symmetrical Fault Analysis

### Scilab code Solution 7.1 Symmetrical Fault Analysis

```
1 //Program to find out fault current ,post-fault
   voltages and line flow of a given network//
2 //This program requires user input. A sample problem
   with user input and output is available in the
   result files. Question is available in the file "
   SymmetricalFaultQuestionFile.jpg" and result is
   available in the file "SymmetricalFaultResultFile
   .jpg"//
3 //Scilab Version 5.5.2 ; OS:Windows
4 clc;
5 clear;
6 linedata=input('enter the line data values in the
   order of starting bus,ending bus,resistance and
   reactance: ')
7 f=input('enter the bus at wich fault occurs:')
8 bv=input('enter the pre-fault bus voltage:')
9 sb=linedata(:,1) //Starting bus number of all the
```

### PROBLEM:

The generators at buses 1 and 3 of the network has impedances  $j1.5$  p.u. If a  $3\phi$  short circuit fault occurs at bus 2, when there is no load (all bus voltages are equal to 1.0 p.u), find initial symmetrical current in fault in the line 1-3 and post fault voltages using bus building algorithm.

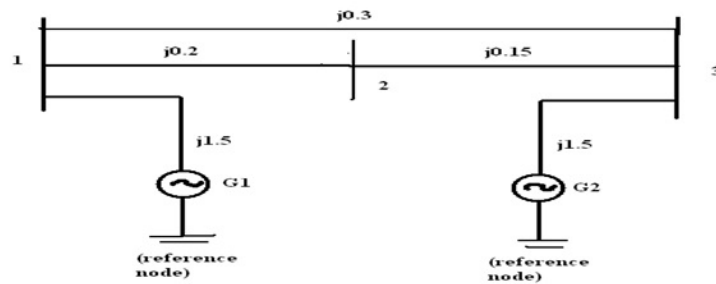


Figure 7.1: Symmetrical Fault Analysis

```
Solve: 5.5.2 Console

enter the line data values in the order of starting bus, ending bus, resistance and reactance: [0 1 0 1.5; 1 2 0 0.2; 2 3 0 0.15; 3 0 0 1.5; 1 3 0 0.3]
enter the bus at which fault occurs: 2
enter the pre-fault bus voltage: 1

the impedance matrix is:

0.7745830i  0.7464881i  0.7254170i
0.7464881i  0.8362160i  0.7535119i
0.7254170i  0.7535119i  0.7745830i

the fault current is:

- 1.1958633i
]
the post fault voltages v1,v2,v3 respectively are:

0.1073022

0

0.0989028
enter the starting bus, ending bus and the impedance between them to calculate the line flow: 1
enter the ending bus to calculate the line flow: 3
enter the impedance between the above buses: 0.3*j1

the line flow current is:

- 0.0279980i
```

Figure 7.2: Symmetrical Fault Analysis

```

        lines stored in variable sb //
10  eb=linedata(:,2) //Ending bus number of all the
    lines stored in variable eb //
11  z=linedata(:,3)+linedata(:,4)*%i //lineimpedance=R+
    jX //
12  zbus=[];
13  check=[];
14  for i=1:length(sb) //starting of impedance matrix
    calculation part//
15      m=sb(i);
16      n=eb(i);
17      mn=min(m,n);
18      nm=max(m,n);
19      ncheck=length(find(check==nm));
20      mcheck=length(find(check==mn));
21      [rows columns]=size(zbus);
22      if mn==0 & ncheck==0
23          zbus=[zbus zeros(rows,1);zeros(1,rows) z(i)
                ];
24          check=[check nm];
25          else if mcheck>0 & ncheck==0
26              zbus=[zbus zbus(:,mn);zbus(mn,:) zbus(mn
                ,mn)+z(i)];
27              check=[check nm];
28              elseif mn==0 & ncheck>0
29                  zbus=[zbus zbus(:,nm);zbus(nm,:) zbus(nm
                ,nm)+z(i)];
30                  zbusn=zeros(rows,rows);
31                  for r=1:rows
32                      for t=1:columns
33                          zbusn(r,t)=zbus(r,t)-(zbus(r,
                              rows+1)*zbus(rows+1,t))/(zbus
                              (rows+1,rows+1));
34                      end
35                  end
36                  zbus=zbusn
37              elseif mcheck>0 & ncheck>0
38                  zbus=[zbus zbus(:,nm)-zbus(:,mn);zbus(nm

```

```

        ,:)-zbus(mn,:),z(i)+zbus(mn,nm)+zbus(
        nm,nm)-2*zbus(nm,mn)];
39     zbusn=zeros(rows,rows);
40     for r=1:rows
41         for t=1:columns
42             zbusn(r,t)=zbus(r,t)-(zbus(r,rows
                    +1)*zbus(rows+1,t))/(zbus(rows
                    +1,rows+1));
43         end
44     end
45     zbus=zbusn;
46 end
47 end
48 end //ending of impedance bus matrix calculation
    part//
49 disp(zbus,'the impedance matrix is:');
50 ifa=bv/zbus(f,f) //calculation of fault current//
51 disp(ifa,'the fault current is:')
52 disp('the post fault voltages v1,v2,v3 respectively
    are:');
53 for i=1:n
54     v(i)=bv-(ifa*zbus(i,f)); //calculation of postfault
        bus voltages//
55     disp(v(i));
56 end
57 a=input('enter the starting bus to calculate the
    line flow:');
58 b=input('enter the ending bus to calculate the line
    flow:');
59 zs=input('enter the impedance between the above
    buses:');
60 i13=(v(a)-v(b))/zs; //calculation of line flows//
61 disp(i13,'the line flow current is:')
62
63 //SAMPLE INPUT and OUTPUT:
64 //enter the line data values in the order of
    starting bus,ending bus,resistance and reactance
    :[0 1 0 1.5;1 2 0 0.2;2 3 0 0.15;3 0 0 1.5;1 3 0

```

```

        0.3]
65 //enter the bus at wich fault occurs:2
66 //enter the pre-fault bus voltage:1
67
68 // the impedance matrix is:
69
70 //      0.7745830 i      0.7464881 i      0.7254170 i
71 //      0.7464881 i      0.8362160 i      0.7535119 i
72 //      0.7254170 i      0.7535119 i      0.7745830 i
73
74 // the fault current is:
75
76 //      - 1.1958633 i
77
78 // the post fault voltages v1,v2,v3 respectively are
79      :
80 //      0.1073022
81
82 //      0
83
84 //      0.0989028
85 //enter the starting bus to calculate the line flow
86      :1
87 //enter the ending bus to calculate the line flow:3
88 //enter the impedance between the above buses:0.3*%i
89
90
91 // the line flow current is:
92
93 //      - 0.0279980 i

```

---

## Experiment: 8

# Unsymmetrical Fault Analysis

Scilab code Solution 8.1 Unsymmetrical Fault Analysis

```
1
2 //Program to find out unsymmetrical fault current//
3 //This program requires user input. A sample problem
  with user input and output is available in the
  result file. Question is available in the file"
  UnsymmetricalFaultQuestionFile.jpg" and result is
  available in the file"
  UnsymmetricalFaultResultFile.jpg"//
4 //Scilab Version 5.5.2 ; OS:Windows
5 clc ;
6 clear;
7 a=input('Enter the positive sequence,negative
  sequence and zero sequence of first generator in
  matrix form:')
8 PG1=a(:,1);//positive sequence of generator 1 is
  stored in the variable PG1
9 NG1=a(:,2);//negative sequence of generator 1 is
  stored in the variable NG1
10 ZG1=a(:,3);//negative sequence of generator 1 is
  stored in the variable ZG1
11 b=input('Enter the positive sequence,negative
```

```

sequence and zero sequence of first transformer
in matrix form:')
12 PT1=b(:,1);//positive sequence of transformer 1 is
    stored in the variable PT1
13 NT1=b(:,2);//positive sequence of transformer 1 is
    stored in the variable NT1
14 ZT1=b(:,3);//positive sequence of transformer 1 is
    stored in the variable ZT1
15 c=input('Enter the positive sequence,negative
    sequence and zero sequence of first transmission
    line in matrix form:')
16 PTL=c(:,1);//positive sequence of transmission line
    1 is stored in the variable PTL
17 NTL=c(:,2);//positive sequence of transmission line
    1 is stored in the variable NTL
18 ZTL=c(:,3);//positive sequence of transmission line
    1 is stored in the variable ZTL
19 d=input('Enter the positive sequence,negative
    sequence and zero sequence of second transformer
    in matrix form:')
20 PT2=d(:,1);//positive sequence of transformer is
    stored in the variable PT2
21 NT2=d(:,2);//positive sequence of transformer 1 is
    stored in the variable NT2
22 ZT2=d(:,3);//positive sequence of transformer 1 is
    stored in the variable ZT2
23 e=input('Enter the positive sequence,negative
    sequence and zero sequence of second generator in
    matrix form:')
24 PG2=e(:,1);//positive sequence of transformer 1 is
    stored in the variable PG2
25 NG2=e(:,2);//positive sequence of transformer 1 is
    stored in the variable NG2
26 ZG2=e(:,3);//positive sequence of transformer 1 is
    stored in the variable ZG2
27 MVAB=input('Enter the value of base MVA:');
28 KVB=input('Enter the value of base KV:');
29 z1=((PG1*%i+PT1*%i)*(PTL*%i+PT2*%i+PG2*%i))/((PG1*%i

```

```

+PT1*%i)+(PTL*%i+PT2*%i+PG2*%i)); // calculation of
positive impedance
30 z2=((NG1*%i+NT1*%i)*(NTL*%i+NT2*%i+NG2*%i))/((NG1*%i
+NT1*%i)+(NTL*%i+NT2*%i+NG2*%i)); // calculation of
negative impedance
31 z0=((ZG1*%i+ZT1*%i)*(ZTL*%i+ZT2*%i+ZG2*%i))/((ZG1*%i
+ZT1*%i)+(ZTL*%i+ZT2*%i+ZG2*%i)); // calculation of
zero impedance
32 Ib=(MVAB*(10^6))/((1.732*KVB*(10^3))) //calculating
base current
33 disp(z0,z2,z1,'the values of positive(z1) negative(
z2),zero(z0) sequence impedance respectively are
');
34 disp('OPTION','LG FAULT=1','LL FAULT=2','LLG FAULT=3
');
35 MENU=input('Enter the choice of fault:')
36 if MENU==1 //calculating Line to Ground fault
37     If=(3*(1))/(z0+z1+z2)
38     FAULTCURRENT=If*Ib;
39     disp(FAULTCURRENT,'The fault current is :');
40 end
41 if MENU==2 //Calculating Line to Line Fault
42     If=((-1.732j)*(1))/(z1+z2)
43     FAULTCURRENT=If*Ib;
44     disp(FAULTCURRENT,'The fault current is :');
45 end
46 if MENU==3 //calculating Line-Line-Ground fault
47     z=(z0*z2)/(z0+z2);
48     Ia1=(1)/(z1+z);
49     Ia0=(-1+(Ia1*z1))/z0;
50     If=3*Ia0;
51     FAULTCURRENT=If*Ib;
52     disp(FAULTCURRENT,'The fault current is :');
53 end
54
55 //SAMPLE INPUT and OUTPUT
56
57 //Enter the positive sequence ,negative sequence and

```



```

        zero sequence of first generator in matrix form
        :[0.32  0.26  0.09]
58 //Enter the positive sequence,negative sequence and
    zero sequence of first transformer in matrix form
    :[0.23  0.23  0.23]
59 //Enter the positive sequence,negative sequence and
    zero sequence of first transmission line in
    matrix form:[0.56  0.56  0.09]
60 //Enter the positive sequence,negative sequence and
    zero sequence of second transformer in matrix
    form:[0.16  0.16  0.16]
61 //Enter the positive sequence,negative sequence and
    zero sequence of second generator in matrix form
    :[0.38  0.24  0.15]
62 //Enter the value of base MVA:100
63 //Enter the value of base KV:110
64
65 // the values of positive(z1) negative(z2),zero(z0)
    sequence impedance    respectivel
66 //      y are
67
68 //      0.3666667 i
69
70 //      0.3244138 i
71
72 //      0.1777778 i
73
74 // LLG FAULT=3
75
76 // LL FAULT=2
77
78 // LG FAULT=1
79
80 // OPTION
81 //Enter the choice of fault:3
82
83 // The fault current is :
84

```

## Unsymmetrical Fault

### PROBLEM

Find the positive, negative and zero sequence for a given power system. Also find LG, LL, LLG fault current.

G1:  $Z_1 = 0.32$ ;  $Z_2 = 0.26$ ;  $Z_3 = 0.09$

T1:  $Z_1 = 0.23$ ;  $Z_2 = 0.23$ ;  $Z_3 = 0.23$

T2:  $Z_1 = 0.16$ ;  $Z_2 = 0.16$ ;  $Z_3 = 0.16$

Transmission Line:  $Z_1 = Z_2 = 0.56$ ;  $Z_3 = 0.09$

G2:  $Z_1 = 0.38$ ;  $Z_2 = 0.24$ ;  $Z_3 = 0.15$

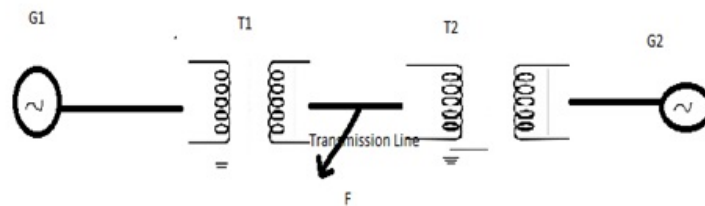


Figure 8.1: Unsymmetrical Fault Analysis

```

Scilab 5.5.2 Console

Enter the positive sequence,negative sequence and zero sequence of first generator in matrix form:[0.32 0.26 0.09]
Enter the positive sequence,negative sequence and zero sequence of first transformer in matrix form:[0.23 0.23 0.23]
Enter the positive sequence,negative sequence and zero sequence of first transmission line in matrix form:[0.56 0.56 0.09]
Enter the positive sequence,negative sequence and zero sequence of second transformer in matrix form:[0.16 0.16 0.16]
Enter the positive sequence,negative sequence and zero sequence of second generator in matrix form:[0.38 0.24 0.15]
Enter the value of base MVA:100
Enter the value of base KV:110

the values of positive(z1) negative(z2),zero(z0) sequence impedance  respectively are

    0.3666667i

    0.3244138i

    0.1777778i

LLG FAULT=3

LL FAULT=2

LG FAULT=1

OPTION
Enter the choice of fault:3

The fault current is :

    2112.5397i

```

Figure 8.2: Unsymmetrical Fault Analysis

## Experiment: 9

# Small Signal and transient Stability Analysis of Single-machine Infinite bus system

### Scilab code Solution 9.1 SMIB Stability Analysis

```
1 //Program to find out transient stability analysis
   of single machine – infinite bus system //
2 //An example problem and outputs are available in
   files 'result1' and 'result2'
3 //Scilab Version 5.5.2 ; OS:Windows
4
5 clc;
6 clear;
7
8 xd=0.3;
9
```

Consider a synchronous machine characterized by the following parameters:

$$X_d = 1.0 \quad X_q = 0.6 \quad X'_d = 0.3 \quad \text{per unit}$$

and negligible armature resistance. The machine is connected directly to an infinite bus of voltage 1.0 per unit. The generator is delivering a real power of 0.5 per unit at 0.8 power factor lagging. Determine the voltage behind transient reactance neglecting the saliency effect. Also find the power angle curve.

#### Result

Code 552Code

The voltage behind transient reactance in pu is

1.18 + 0.15i

→

Figure 9.1: SMIB Stability Analysis

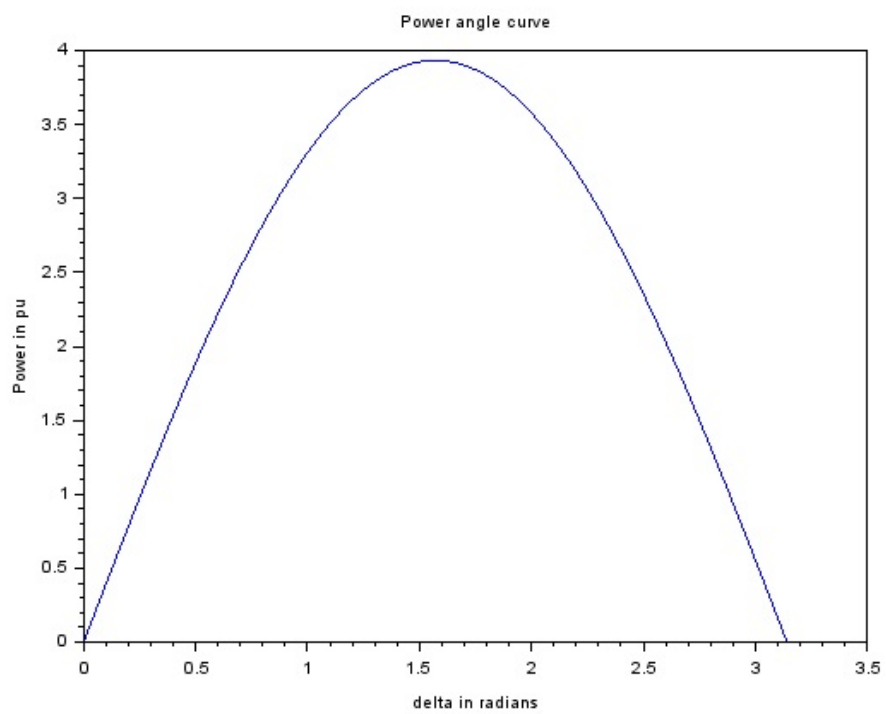


Figure 9.2: SMIB Stability Analysis

```

10 theta=acos(0.8); //
    Power factor angle
11
12 S=(0.5/0.8)*cos(theta)+%i*sin(theta); //
    Apparant Power
13 V=1; //
    Prefault vltage is assumed to be 1 pu
14 Ia=(conj(S)/V); //
    Pefault steady state current
15
16 E=V+(%i*xd)*(Ia); //
    Voltage behind transient reactance
17
18 disp(E,'The voltage behind transient reactance in pu
    is ')
19
20 //To find the power angle curve
21
22 delta=0:0.001:%pi;
23 P=((E*V)/xd)*(sin(delta));
24
25 plot(delta,P)
26 xlabel('delta in radians')
27 ylabel('Power in pu')
28 title('Power angle curve')

```

---

## Experiment: 10

# Small Signal and transient Stability Analysis of Multi machine Power Systems

Scilab code Solution 10.1 Multimachine Stability Analysis

```
1 //Program to find out transient stability analysis
  of multi machine at the end of the iteration //
2 //This program requires user input. A sample problem
  with user input and output is available in the
  result file//
3 //Scilab Version 5.5.2 ; OS:Windows
4 //program for transient stability analysis of multi
  machine//
5 clc;
6 clc;
7 clear;
8 f=input('enter the frequency:');
9 bv=input('enter the base value in MVA:');
10 v=input('enter the value of bus voltage in p.u:');
11 e=input('enter the value of transient reactance
  voltage in pu:');
12 ld=input('enter the total load:');
```



```

13 x1=input('enter the prefault reactance in p.u:');
14 x2=input('enter the post fault reactance value:');
15 x3=input('enter during the fault reactance value:');
16 delt=input('enter the time interval in seconds:');
17 H=input('enter the inertia constant:');
18 pe1=ld/bv;
19
20 pe2=0;
21 delnot=asin((pe1*x1)/(e*v));
22
23 omeganot=2*3.14*f;
24
25
26 ddel=omeganot-(2*3.14*f);
27
28 ddelomega=((3.14*f)*(pe1-pe2))/H;
29
30 //end of first step at t=0.05sec
31 del1=(delnot+(ddel*delt));//predicted values
32
33 delomega1=ddel+(ddelomega*delt);
34
35 //derivation at the end of t=0.05sec
36 ddel1=ddel+(ddelomega*delt);
37
38 ddelomega=((3.14*f)*(pe1-pe2))/H;
39
40 delc1=delnot+((delt/2)*(ddel+ddel1));
41
42 delomegac1=ddel+((delt/2)*(ddelomega+ddelomega));
43
44 ddelc1=ddel+((delt/2)*(ddelomega+ddelomega));
45
46 ddelomegac=((3.14*f)*(pe1-pe2))/H;
47
48 delp2=delc1+ddelc1*delt;
49
50 delomegap2=(delomegac1+(ddelomega*delt));

```

```

51
52 ddelomegap=((3.14*f)*(pe1-pe2))/H);
53
54
55 delc2=delc1+(delt/2*(ddelc1+delomegap2));
56
57 delomegac=(delomegac1+(ddelomega*delt));
58
59 ddelc2=(delomegac1+(ddelomega*delt));
60
61 ddelomegac2=((3.14*f)*(pe1-pe2))/H);
62
63 delp3=delc2+delomegac*delt;
64
65 delomega3=delomegac+ddelomegac2*delt;
66
67 //derivation at the end of t=0.15sec
68 disp('The final values at the end of t=0.15 sec are
        displayed below')
69 ddelp3=delomegac+ddelomegac2*delt;
70 disp(ddelp3,'ddelp3=');
71 ddelomega3=((3.14*f)*(pe1-pe2))/H);
72 disp(ddelomega3,'ddelomega3=');
73 disp('corrected values');
74 delc3=delc2+((delt/2)*(delomegac+delomega3));
75 disp(delc3,'delc3=');
76 delomegac3=delomegac+((delt/2)*(ddelomega3+
        ddelomega3));
77 disp(delomegac3,'delomegac3=');
78
79 //SAMPLE INPUT:
80 //enter the frequency:50
81 //enter the base value in MVA:500
82 //enter the value of bus voltage in p.u:1
83 //enter the value of transient reactance voltage in
    pu:450/400
84 //enter the total load:460
85 //enter the prefault reactance in p.u:0.5

```

```

86 //enter the post fault reactance value:0.75
87 //enter during the fault reactance value:1
88 //enter the time interval in seconds:0.05
89 //enter the inertia constant:2.5
90
91
92 //OUTPUT
93 // The final values at the end of t=0.15 sec are
   displayed below
94
95 // ddelp3=
96
97 //      8.6664
98
99 // ddelomega3=
100
101 //      57.776
102
103 // corrected values
104
105 // delc3=
106
107 //      1.0712162
108
109 // delomegac3=
110
111 //      8.6664

```

---

### Transient Stability of Multi Machine

A 50 HZ, 500 MVA, 400 KV generator (with transformer) is connected to a 400 kV infinite bus bar through an interconnector. The generator has  $H=2.5$  MJ/MVA, voltage behind transient reactance of 450kV and is loaded 460 MW. The transfer reactance between generator and bus bar under various conditions are:

Prefault: 0.5 p.u.  
During fault: 1.0 p.u.  
Post fault: 0.75 p.u.

Calculate swing equation using intervals of 0.05 sec and assuming that the fault is cleared at 0.15 sec.

OUTPUT:

Scilab 5.5.2 Console

```
enter the frequency:50
enter the base value in MVA:500
enter the value of bus voltage in p.u:1
enter the value of transient reactance voltage in pu:450/400
enter the total load:460
enter the prefault reactance in p.u:0.5
enter the post fault reactance value:0.75
enter during the fault reactance value:1
enter the time interval in seconds:0.05
enter the inertia constant:2.5

The final values at the end of t=0.15 sec are displayed below

ddelp3=

    8.6664

ddelomega3=

    57.776

corrected values

delc3=

    1.0712162

delomegac3=

    8.6664
```

Figure 10.1: Multimachine Stability Analysis

## Experiment: 11

# Electromagnetic Transients in Power Systems

This code can be downloaded from the website [www.scilab.in](http://www.scilab.in)

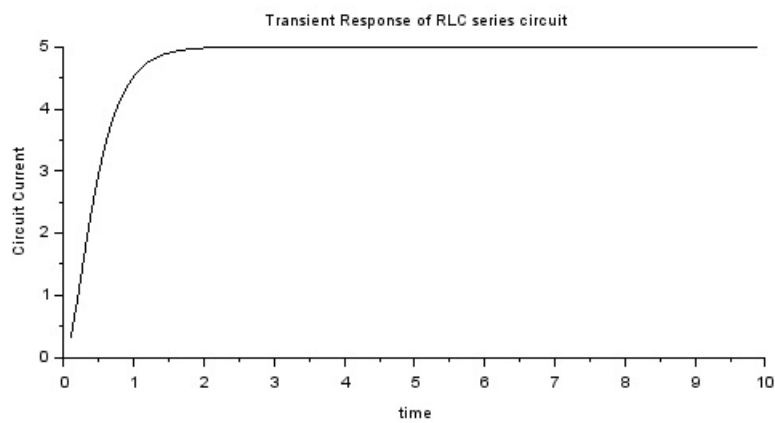


Figure 11.1: Transient in RLC series circuit with DC source

## **Experiment: 12**

### **Load frequency dynamics of single Area Power Systems**

This code can be downloaded from the website [www.scilab.in](http://www.scilab.in)

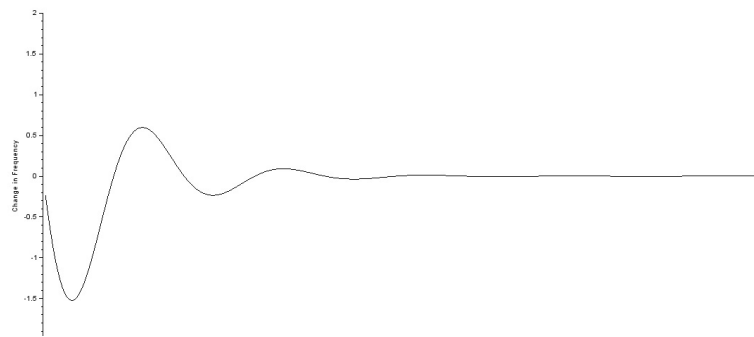


Figure 12.1: Single Area Control



## Experiment: 13

# Load frequency dynamics of two Area Power Systems

This code can be downloaded from the website [www.scilab.in](http://www.scilab.in)

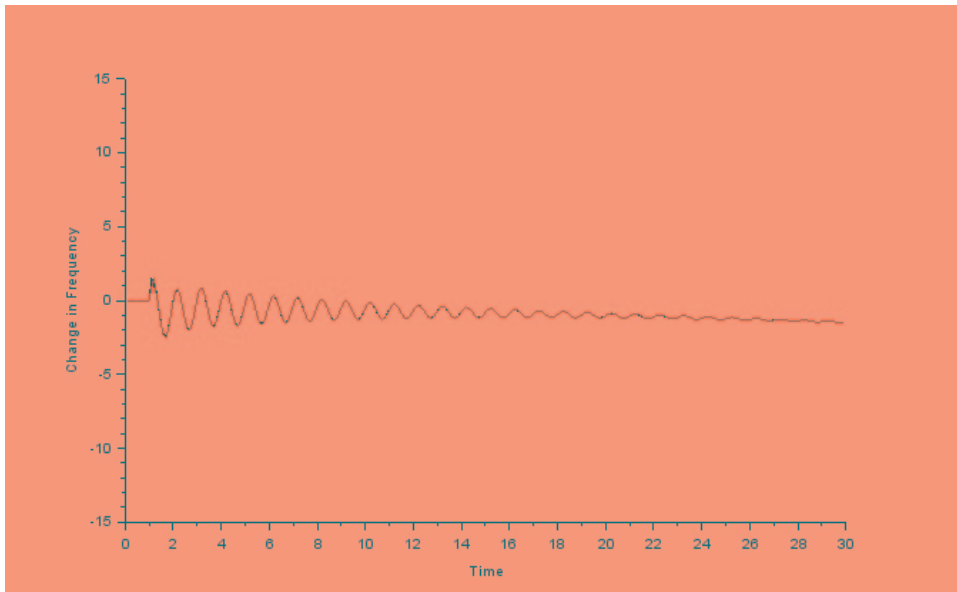


Figure 13.1: Two Area Control

## Experiment: 14

### Economic dispatch in power systems neglecting losses

Scilab code Solution 14.1 Economic Load Dispatch Excluding Losses

```
1 //Program to find out Economic load dispatch
  neglecting losses//
2 //This program requires user input. A sample problem
  with user input and output is available in the
  result file//
3 //Question and result of example problem is
  available in file "EDwithoutLoss.jpg"
4 //Scilab Version 5.5.2 ; OS:Windows
5
6 clear;
7 clc;
8 n=input('Enter no. of units :');
9 F=input('Enter the cost coefficient in matrix form :
  ');
10 constraint=input('Enter min and max values of P for
  all units:');
11 pd=input('Enter total demand:');
```

Determine the economic generation schedule of three generating unit in a power system to meet a system load of 275 MW. The Cost equations and the operating limits of each unit are given below.

$$\begin{array}{ll} F_1 = 0.05P_1^2 + 23.5P_1 + 700 & ; \quad 40 \leq P_1 \leq 150 \\ F_2 = 0.2P_2^2 + 20P_2 + 850 & ; \quad 40 \leq P_2 \leq 150 \\ F_3 = 0.09P_3^2 + 18P_3 + 960 & ; \quad 40 \leq P_3 \leq 150 \end{array}$$

#### OUTPUT

Scilab 5.5.2 Console

```
Enter no. of units :3
Enter the cost coefficient in matrix form :[0.05 23.5 700;0.2 20 850;0.09 18 960]
Enter min and max values of P for all units:[40 150;40 150;40 150]
Enter total demand:275

The optimum schedule is:
P =

130.53846
41.384615
103.07692
```

Figure 14.1: Economic Load Dispatch Excluding Losses

```
12 a=F(:,1);b=F(:,2);c=F(:,3);
13 Pmin=constraint(:,1);
14 Pmax=constraint(:,2);
15 chk=zeros(n,1);
16 rem=1;
17 while rem==1
18     sx=0;sy=0;
19     for i=1:n
20         if i~=chk(i)
21             sx=sx+b(i)/(2*a(i));
22             sy=sy+1/(2*a(i));
23         end
24     end
25     lamda=(pd+sx)/sy;
26     sch=0;
27     for i=1:n
28         if i~=chk(i)
29             P(i)=(lamda-b(i))/(2*a(i));
30             if P(i)<Pmin(i)|P(i)>Pmax(i)
31                 if P(i)< Pmin(i)
32                     P(i)=Pmin(i);
```

```

33             else
34                 P(i)=Pmax(i);
35             end
36             pd=pd-P(i);
37             chk(i)=i;
38             sch=sch+1;
39         end
40     end
41     if sch==0
42         rem=0;
43     else
44         rem=1;
45     end
46 end
47 end
48 disp('The optimum schedule is:')
49 print(%io(2),P)
50
51 //SAMPLE INPUT
52 //Enter no. of units :3
53 //Enter the cost coefficient in matrix form :[0.05
    23.5 700;0.2 20 850;0.09 18 960]
54 //Enter min and max values of P for all units:[40
    150;40 150;40 150]
55 //Enter total demand:275
56
57 //OUTPUT
58 // The optimum schedule is:
59 // P =
60
61 //      130.53846
62 //      41.384615
63 //      103.07692

```

---

## Experiment: 15

### Economic dispatch in power systems Including losses

Scilab code Solution 15.1 Economic Load Dispatch Including Losses

```
1 //Program for Economic Load Dispatch problem
   including loss coefficients//
2 //This program requires user input. A sample problem
   with user input and output is available in the
   result file named "EDwithLoss.jpg"//
3 //Scilab Version 5.5.2 ; OS:Windows
4 clear;
5 clc;
6 n=input('Enter no. of units :');
7 B=input('Enter the loss coefficient in matrix form :
   ');
8 a=B(:,1); //loss coefficients stored in variable a
9 b=B(:,2); //loss coefficients stored in variable b
10 c=B(:,3); //loss coefficients stored in variable c
11 pg=input('Enter the power of the units in matrix
   form in p.u:');
12 bv=input('Enter the base value');
```

#### ECONOMIC DISPATCH PROBLEM INCLUDING LOSSES

The transmission loss coefficients are given by

B=

$$\begin{bmatrix} 0.01 & -0.0003 & -0.0002 \\ -0.0003 & 0.0025 & -0.0005 \\ -0.0002 & -0.0005 & 0.0031 \end{bmatrix}$$

Three plants A, B, C supply powers of 50 MW, 100 MW and 200 MW respectively. Calculate the transmission loss in the network in p. u value and the incremental transmission loss of the three plants. Assume base value= 200MVA.

Scilab 5.5.2 Console

```
Enter no. of units :3
Enter the loss coefficient in matrix form :[0.01 -0.0003 -0.0002;-0.0003 0.0025 -0.0005;-0.0002 -0.0005 0.0031]
Enter the power of the units in matrix form in p.u:[50/200 100/200 200/200]
Enter the base value200
```

The transmission power loss in pu is

0.003675

The incremental losses in pu are

0.0043  
0.00135  
0.0056

Figure 15.1: Economic Load Dispatch Including Losses

```

13 pl=0;
14 for i=1:n//calculation of power loss
15     for j=1:n
16         pl=pl+pg(j)*B(i,j)*pg(i);
17     end
18 end
19 disp(pl,'The transmission power loss in pu is',);
20 ITL=zeros(n,1);//Calculation of incremental
    transmission loss
21 for i=1:n
22     for j=1:n
23         ITL(i)=ITL(i)+2*B(i,j)*pg(j);
24
25     end
26 end
27 disp(ITL,'The incremental losses in pu are');
28
29 //SAMPLE INPUT:
30
31 //Enter no. of units :3
32 //Enter the loss coefficient in matrix form :[0.01
    -0.0003 -0.0002;-0.0003 0.0025 -0.0005;-0.0002
    -0.0005 0.0031]
33 //Enter the power of the units in matrix form in p.u
    :[50/200 100/200 200/200]
34 //Enter the base value200
35
36 //OUTPUT
37 //The transmission power loss in pu is
38
39 //    0.003675
40
41 // The incremental losses in pu are
42
43 //    0.0043
44 //    0.00135
45 //    0.0056

```

---