14-9-2020 Sebin Wilson E

Roll No. 26

EXPERIMENT No:5

LOAD FLOW ANALYSIS USING GAUSS SEIDAL METHOD

Aim

To develop a computer program to solve the set of non-linear load flow equations using Gauss-Seidel load flow algorithm.

Software Platform

Scilab

Theory

Load flow analysis is the most frequently performed system study by electric utilities. This analysis is performed on a symmetrical steady-state operating condition of a power system under normal mode of operation and aims at obtaining bus voltages and line flows for a given load condition. This information is essential both for long term planning and next day operational planning. In long term planning, load flow analysis helps in investigating the effectiveness of alternative plans and choosing the best plan for system expansion to meet the projected operating state. In operational planning, it helps in choosing the best unit commitment plan and generation schedules to sun the system efficiently for the next day's load condition without violating the bus voltage and line flow operating limits.

The Gauss-Seidel method is an iterative algorithm for solving a set of non-linear algebraic equations. The relationship between network bus voltages and currents maybe represented by either loop equations or node equations. Node equations are normally preferred because the number of independent node equation is smaller than the number of independent loop equations.

The network equations in terms of bus admittance matrix can be written as,

$$I_{bus} = Y_{bus}.V$$

At the p^{th} bus, current injection:

$$I_p = Y_{p1}V_1 + Y_{p2}V_2 + \ldots Y_{pp}V_p + \ldots + Y_{pn}V_n$$

$$= \sum_{q=1}^{n} YpqVq$$

$$= \mathrm{YppVp} + \sum_{\substack{q=1 \\ q\neq p}}^{n} \mathrm{YpqVq}$$

$$Vp = \frac{1}{Ypp}\left[Ip - \sum_{\substack{q=1 \\ q\neq p}}^{n} YpqVq\right] p=2,\ 3\ldots n$$

At bus p, we can write

$$P_p - jQ_p = V_p^* I_p$$

Hence, the current at any node p is related to P, Q and V as follows:

$$I_p = \frac{P_p - jQ_p}{V_p^*}$$

(For any bus p except slack bus s)
Substituting for I_p

$$Vp = \frac{1}{Ypp}\left[\frac{P_p - jQ_p}{V_p^*} - \sum_{\substack{q=1 \\ q\neq p}}^{n} YpqVq\right]$$

P=2, 3…n

Program

Problem 1

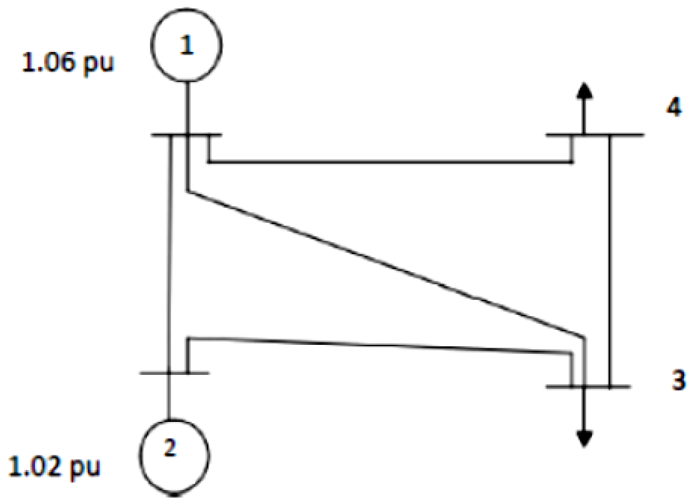
Find all the unknown parameters,losses and line flows for the given power system network data using Gauss- Seidal method.The Q limit for Bus 2 is $0.1 \leq Q_2 \leq 1$

Line data:

Line	From Bus	To Bus	Line Impedance	b/2
1	1	2	0.15+j0.4	j0.04
2	1	3	0.1+j0.5	j0.05
3	1	4	0.15+j0.6	j0.04
4	2	3	0.07+j0.25	j0.03
5	3	4	0.09+j0.3	j0.04

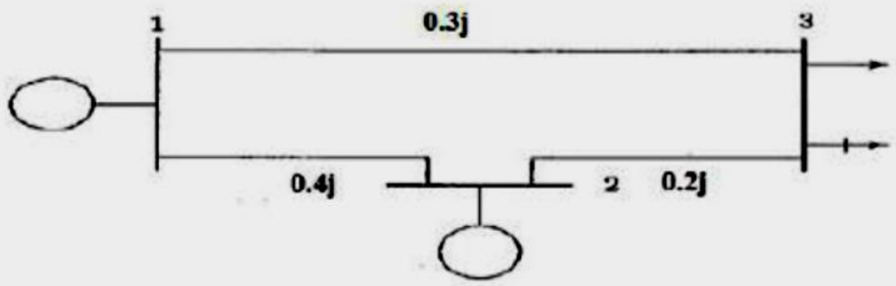
Bus data:

Bus No.	P_d	Q_d	P_g	Q_g	V	Bus type
1	2	0.6	-	-	1.06+j0	Slack
2	0	0	1.2	-	1.02	PV
3	0.7	0.5	0	0	-	PQ
4	0.6	0.3	0	0	-	PQ



Problem 2

For the system shown in figure determine the voltage at the end of the iteration by gauss siedal 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	-	-

Sample Program (All)

```
//start
clc ;
clear ;
//line inputs
disp("Enter the line data in the order-> From,To,Res,Reat,Half
Admit,Tap")
linedata =input("Enter line data:")
Yshunt=input("Enter shunt admittance:")
// line data extraction
from= linedata(:,1)
to= linedata(:,2)
imp= linedata(:,3)+ linedata(:,4)*%i
half_adm= linedata(:,5)*%i
bus_no= max(max(from,to));
Ybus= zeros(bus_no,bus_no);
line_number=length(from)
//Ybus building
for i=1:line_number
```

```
m=from(i);
n=to(i);
Ybus(m,m)=Ybus(m,m) +1/imp(i)+ (half_adm(i)) ;
Ybus(n,n)=Ybus(n,n) +1/imp(i)+ (half_adm(i)) ;
Ybus(m,n)= -1/ imp(i);
Ybus(n,m)=Ybus(m,n);
end
//Adding shunt to diagonal elements
for i=1:bus_no
    Ybus(i,i)=Ybus(i,i)+Yshunt(i)
end
//display Ybus
disp("Ybus Admittance is:")
disp(Ybus)
//Input and extract bus data. Taps are avoided
disp("Enter data in the order-> Bus, type, Vsp, theta, Pgi,
Qgi, Pli, Qli, Qmin, Qmax")
busdata = input("Enter bus data:")
bus=busdata(:,1)
typ = busdata(:,2)
qmin = busdata(:,9)
qmax = busdata(:,10)
//net p and q
p= busdata (:,5)- busdata(:,7)
q= busdata(:,6)- busdata(:,8)
v= busdata(:,3).*(cosd(busdata(:,4))+ %i*sind(busdata(:,4)));
//parameter setting
//default. Can take alpha as input() if needed
count =0;
err =1;
vold =v;
//gauss seidel method
while abs(err)>5*10^(-5)
//while count<23 //testing
    for i=2:bus_no
            sumyv=0;
            for j=1:bus_no
                if i~=j
                    sumyv=sumyv+Ybus(i,j)*v(j);
                end
            end
        if typ(i)==2
            q(i)=-imag(conj(v(i))*(sumyv+(Ybus(i,i)*v(i))));
            if q(i)<qmin (i) | q(n)>qmax (i)
                if q(i)<qmin (i)
                    q(i)= qmin (i);
                    else
                    q(i)= qmax (i);
                end
            end
        end
```

```
        v(i) =(1/Ybus(i,i)) *(((p(i)-%i*q(i))/(conj(v(i)))) -
sumyv);
    end
    count=count+1;
    err=max(abs(abs(v)-abs(vold)));
    vold=v;
end
//Load flow and slack power
Amp=zeros(bus_no,bus_no)
Powerflow=zeros(bus_no,bus_no)
Lineloss=zeros(line_number)
slackpower=0
for start=1:bus_no
    for fin=1:bus_no
        if(start~=fin)
            //-Ybus since off diagonal elements are negative
            Amp(start,fin)=-Ybus(start,fin)*(v(start)-v(fin))
            Amp(fin,start)=-Amp(start,fin)
           Powerflow(start,fin)=v(start)*(conj(Amp(start,fin)))
            Powerflow(fin,start)=v(fin)*(conj(Amp(fin,start)))
Lineloss(start,fin)=Powerflow(start,fin)+Powerflow(fin,start)
            if(start==1)
                slackpower=slackpower+(conj(v(1))*Amp(1,fin))
            end
        end
    end
end
//making sparse and removing duplicates (1,2) and (2,1)
Lineloss_mod=zeros(bus_no,bus_no)
for temp=1:line_number
    m=from(temp)
    n=to(temp)
    Lineloss_mod(m,n)=Lineloss(m,n)
end
Lineloss_mod=sparse(Lineloss_mod)
//disp output
disp("Voltage rectangular:",v)
volt=abs(v)
angle=atan(imag(v),real(v))*(180/%pi);
disp("Voltage:",volt)
disp("Angle:",angle)
printf("Gauss Seidel Load Flow converged after %i iteration.",
count)
disp("Line flow",Powerflow)
disp("Line losses",Lineloss_mod)
disp("Slack bus power",slackpower)
```

Sample Output – 1

```
"Enter the line data in the order-> From,To,Res,Reat,Half
Admit,Tap"

Enter line data:[1 2 0.15 0.4 0.04 1; 1 3 0.1 0.5 0.05 1; 1 4
0.15 0.6 0.04 1; 2 3 0.07 0.25 0.03 1; 3 4 0.09 0.3 0.04 1]

Enter shunt admittance:[0 0 0 0]

  "Ybus Admittance is:"

   1.5986901 - 5.5534852i  -0.8219178 + 2.1917808i  -0.3846154
+ 1.9230769i  -0.3921569 + 1.5686275i

  -0.8219178 + 2.1917808i   1.8604935 - 5.8309796i  -1.0385757
+ 3.7091988i   0.        + 0.i

  -0.3846154 + 1.9230769i  -1.0385757 + 3.7091988i   2.3406222
- 8.5703797i  -0.9174312 + 3.058104i

  -0.3921569 + 1.5686275i   0.        + 0.i         -0.9174312
+ 3.058104i    1.3095881 - 4.5467314i


  "Enter data in the order-> Bus, type, Vsp, theta, Pgi, Qgi,
Pli, Qli, Qmin, Qmax"

Enter bus data:[1 1 1.06 0 0.0 0 2 0.6 0 0; 2 2 1.02 0 1.2 0 0
0 0.1 1.0; 3 3 1.0 0 0 0 0.7 0.5 0 0; 4 3 1.0 0 0 0 0.6 0.3 0
0]


  "Voltage rectangular:"

   1.06      + 0.i

   1.097247  + 0.1162596i

   0.9374341 - 0.0679895i

   0.8673527 - 0.1499322i


  "Voltage:"

   1.06

   1.103389

   0.9398964

   0.8802161
```

```
  "Angle:"
   0.
   6.0482489
  -4.1482391
  -9.8073335
Gauss Seidel Load Flow converged after 14 iteration.
  "Line flow"
   0.        + 0.i         -0.3025552 + 0.0147538i   0.1885631
+ 0.2221271i   0.3293798 + 0.2579987i
   0.3148048 + 0.0179117i   0.        + 0.i           0.8853261
+ 0.5392084i   0.        + 0.i
  -0.1810073 - 0.1843483i  -0.8235434 - 0.318556i    0.
+ 0.i          0.3046431 + 0.1090253i
  -0.3060101 - 0.16452i     0.        + 0.i          -0.2939771
- 0.0734717i   0.        + 0.i

  "Line losses"
(  4,  4) sparse matrix
(  1,  2)     0.0122496 + 0.0326655i
(  1,  3)     0.0075558 + 0.0377788i
(  1,  4)     0.0233697 + 0.0934787i
(  2,  3)     0.0617827 + 0.2206523i
(  3,  4)     0.0106661 + 0.0355535i

  "Slack bus power"
   0.2153877 - 0.4948796i
```

Sample Output – 2

```
"Enter the line data in the order-> From,To,Res,Reat,Half
Admit,Tap"
Enter line data:[1 2 0 0.4 0 1; 2 3 0 0.2 0 1 ; 1 3 0 0.3 0 1]
Enter shunt admittance:[0 0 0]
```

```
"Ybus Admittance is:"

   0. - 5.8333333i   0. + 2.5i   0. + 3.3333333i

   0. + 2.5i         0. - 7.5i   0. + 5.i

   0. + 3.3333333i   0. + 5.i    0. - 8.3333333i


  "Enter data in the order-> Bus, type, Vsp, theta, Pgi, Qgi,
Pli, Qli, Qmin, Qmax"

Enter bus data:[1 1 1.05 0 0 0 0 0 0 0 ; 2 2 1.02 0 0.3 0 0 0
-0.1 1 ; 3 3 1 0 0 0 0.4 0.2 0 0]

  "Voltage rectangular:"

   1.05      + 0.i

   1.0208097 + 0.013926i

   1.0068945 - 0.0383506i

  "Voltage:"

   1.05

   1.0209046

   1.0076245

  "Angle:"

   0.

   0.7815845

  -2.1812259


Gauss Seidel Load Flow converged after 5 iteration.

  "Line flow"

   0.        + 0.i         -0.0365556 + 0.0766246i   0.134227
+ 0.1508694i

   0.0365556 - 0.0740096i   0.        + 0.i           0.265853
+ 0.0746638i

  -0.134227  - 0.1397732i  -0.265853  - 0.0600315i   0.
+ 0.i
```

```
  "Line losses"
(  3,  3) sparse matrix
(  1,  2)    0. + 0.002615i
(  1,  3)    2.776D-17 + 0.0110962i
(  2,  3)    0. + 0.0146323i

  "Slack bus power"
   0.0976714 - 0.227494i
```

Result

The given set of load flow equations for the given power system network were solved using Gauss-Seidel method.