AMIRAJ
COLLEGE OF ENGINEERING & TECHNOLOGY

LABORATORY MANUAL

INTERCONNECTED POWER SYSTEM

SUBJECT CODE: 2170901

ELECTRICAL ENGINEERING DEPARTMENT

B.E. 7TH SEMESTER

NAME:______________________________

ENROLLMENT NO: ______________________________

BATCH NO: ______________________________

YEAR: ______________________________

Amiraj College of Engineering and Technology,
Nr.Tata Nano Plant, Khoraj, Sanand, Ahmedabad.

AMIRAJ

COLLEGE OF ENGINEERING & TECHNOLOGY

Amiraj College of Engineering and Technology,

Nr.Tata Nano Plant, Khoraj, Sanand, Ahmedabad.

CERTIFICATE

This is to certify that Mr. / Ms. ____ Of class____________________ Enrolment No ___________________________has Satisfactorily completed the course in ____________________________________as by the Gujarat Technological University for ____ Year (B.E.) semester___ of Electrical Engineering in the Academic year_________.

Date of Submission:-

Faculty Name and Signature

(Subject Teacher)

Head of Department

(Electrical)

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List of Experiments

Sr. No.	Title	Date of Performance	Date of submission	Sign	Remarks
1	MATLAB Program for Formation of YBUS By Direct inspection method				
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4	Load Flow Analysis Using Power World Simulator				
5	MATLAB Program to find Optimum Loading of Generators Neglecting transmission losses				
6	MATLAB Program to Find Optimum Loading of Generators with Penalty Factors				
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8	Simulink Model of Single Area Load Frequency control with and without Pi Controller				
9	Simulink Model for Two Area Load Frequency Control				
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EXPERIMENT-1 DATE:

MATLAB Program for Formation of YBUS By Direct Inspection method

AIM: To find theYbus of the Network shown in Fig:1.1 by Direct Inspection method.Solve the problem theoretically and verify with MATLAB.

PROBLEM: Formulate the YBUS of Network shown in Fig.1.1 by Direct Inspection Method

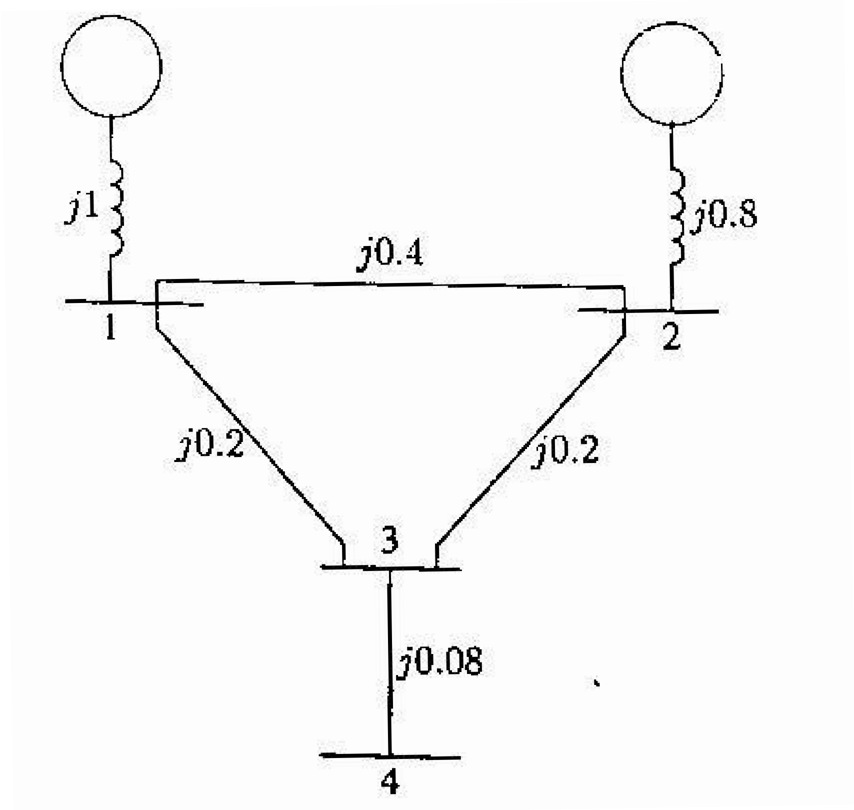


Fig:1.1 Power system network

Line Data

Element No.	From Bus	To Bus	R	X
1.	0	1	0	0.8
2.	0	2	0	0.8
3.	1	2	0	0.5
4.	1	3	0	0.4
5.	2	3	0	0.4
6.	3	4	0	0.04

MATLAB PROGRAM:

```
% Pract-1 Formation of YBus Using Direct Inspection method

function[Y] = admittance

linedata = linedata1;

nl = linedata(:,1);
nr = linedata(:,2);
R = linedata(:,3);
X = linedata(:,4);

% calculation of no. of elements and no. of Buses

nbr = length(linedata(:,1));
nbus = max(max(nl),max(nr));

Z = R+j*X; % calculation of Impedance

y = ones(nbr,1)./Z; % Ydata

Y = zeros(nbus,nbus); % Define Ybus

% Calculation of mutual Admittance
for k=1:nbr;
ifnl(k)>0 &nr(k)>0
        Y(nl(k), nr(k))=Y(nl(k),nr(k))-y(k);

        Y(nr(k), nl(k))=Y(nl(k),nr(k));
end
end

% Calculation of Self Admittance

for n=1:nbus
for k=1:nbr
ifnl(k) == n | nr(k)==n
Y(n,n)=Y(n,n)+ y(k);

else, end
end
end

% Line data to be considered:
functionlinedata = linedata1()      % Returns linedata.

%          |  From |  To    |    R    |    X    |
```

```
%           |  Bus   | Bus    |         |        |

linedata= [ 0        1         0        0.8
            0        2         0        0.8
            1        2         0        0.5
            1        3         0        0.4
            2        3         0        0.4
            3        4         0        0.04]
```

OUTPUT:

linedata =

0	1.0000	0	0.8000
0	2.0000	0	0.8000
1.0000	2.0000	0	0.5000
1.0000	3.0000	0	0.4000
2.0000	3.0000	0	0.4000
3.0000	4.0000	0	0.0400

ans =

0 - 5.7500i	0 + 2.0000i	0 + 2.5000i	0
0 + 2.0000i	0 - 5.7500i	0 + 2.5000i	0
0 + 2.5000i	0 + 2.5000i	0 -30.0000i	0 +25.0000i
0	0	0 +25.0000i	0 -25.0000i

CONCLUSION:

EXPERIMENT-2 **DATE:**

MATLAB Program for Formation of YBUS By Singular Transformation Method

AIM: To find the Ybus of the Network shown in Fig: 2.1 by Singular Transformation method. Solve the problem theoretically and verify with MATLAB.

PROBLEM: Formulate the YBUS of Network shown in Fig.2.1 by Singular Transformation Method

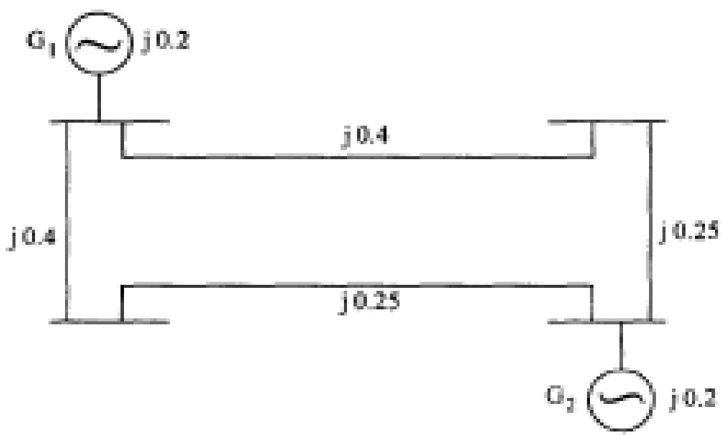


Fig 2.1: Four Bus Power System Network

MATLAB PROGRAM:

```
% Pract-2 Formation of YbusBy Singular Transformation

% Line Data

ydata=[1  0  1  1/(j*0.2)  0   0
       2  1  3  1/(j*0.4)  0   0
       3  2  3  1/(j*0.25)  0  0
       4  2  0  1/(j*0.2)  0   0
       5  2  4  1/(j*0.25)  0   0
       6  1  4  1/(j*0.4)   0   0];

elements=max(ydata(:,1)); % no of elements
yprimitive=zeros(elements,elements); % Primitive admittance matrix

% Formation of Primitive admittance matrix yprimitive

fori=1:elements,
yprimitive(i,i)=ydata(i,4);
if(ydata(i,5)~=0);
j=ydata(i,5);

ymutual=ydata(i,6);
yprimitive(i,j)=ymutual;
end
end

buses = max(max(ydata(:,2)),max(ydata(:,3)));
A=zeros(elements,buses);

% Formation of Bus incidence matrix A

fori=1:elements

ifydata(i,2)~=0;
A(i,ydata(i,2))=1;
end

ifydata(i,3)~=0;
A(i,ydata(i,3))=-1;
end
end

% Formation of YBUS Matrix

YBUS=A'*yprimitive*A
```

OUTPUT:

YBUS =

0 -10.0000i	0	0 + 2.5000i	0 + 2.5000i
0	0 -13.0000i	0 + 4.0000i	0 + 4.0000i
0 + 2.5000i	0 + 4.0000i	0 - 6.5000i	0
0 + 2.5000i	0 + 4.0000i	0	0 - 6.5000i

CONCLUSION:

EXPERIMENT-3 DATE:

MATLAB Program to Solve Load Flow Equations By Gauss-Seidel Method

AIM: To find load flow solution of the given power system using Gauss-Seidel method theoretically for one iteration and obtain full solution using MATLAB.

PROBLEM:

For the sample power system shown below, the generators are connected at all the four buses, while loads are at buses 2 and 3. Values of real and reactive powers are listed in the table. All buses other than the slack are PQ type. Assuming a flat voltage start, find the voltages and bus angles at the three buses at the end of first GS iteration.

Input data:

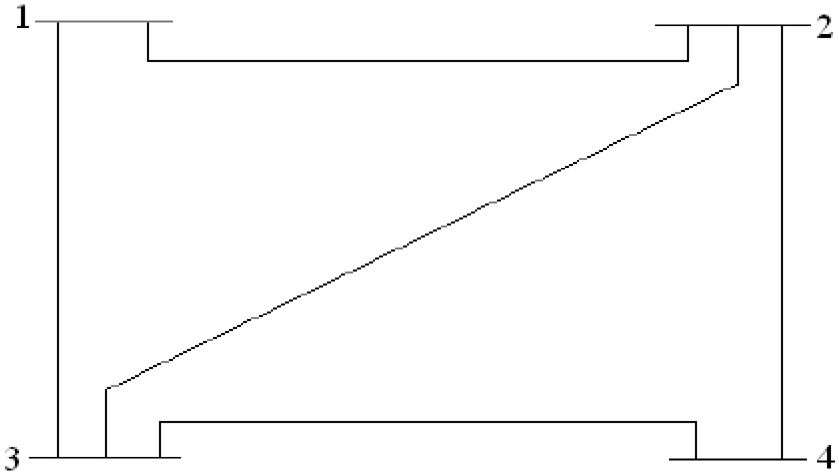


Figure: a simple 4-bus power system

Bus	P_i , pu	Q_i , pu	V_i , pu	Remarks
1	-	-	$1.04\angle 0^0$	Slack bus
2	0.5	-0.2	-	PQ bus
3	-1.0	0.5	-	PQ bus
4	0.3	-0.1	-	PQ bus

For the above system, the bus admittance matrix is

$$Y_{BUS} = \begin{bmatrix} +3-j9 & -2.00+j6 & -1.00+j3 & 0 \\ -2+j6 & +3.666-j11 & -0.666+j2 & -1+j3 \\ -1+j3 & -0.666+j2 & +3.666-j11 & -2+j6 \\ 0 & -1.00+j3 & -2.00+j6 & +3-j9 \end{bmatrix}$$

Write a MATLAB program to solve the load flow equations of theabove sample power system by using Gauss-Seidel method.

MATLAB PROGRAM:

```
% Pract-3 Load flow using gauss siedel method
clc
clear
n=4;
V=[1.04 1 1 1];
Y=[3-j*9 -2+j*6 -1+j*3 0
-2+j*6 3.666-j*11 -0.666+j*2 -1+j*3
-1+j*3 -0.666+j*2 3.666-j*11 -2+j*6
0 -1+j*3 -2+j*6 3-j*9];
type=ones(n,1);
typechanged=zeros(n,1);
Qlimitmax=zeros(n,1);
Qlimitmin=zeros(n,1);
Vmagfixed=zeros(n,1);
type(2)=2;
Qlimitmax(2)=1.0;
Qlimitmin(2)=-0.2;
Vmagfixed(2)=1.04;
diff=10;
noofiter=1;
Vprev=V;
while (diff>0.00001 | noofiter==1),
abs(V);
abs(Vprev);
Vprev=V;
P=[inf 0.5 -1 0.3];
Q=[inf -0.3 0.5 -0.1];
S=[inf 0.5-j*0.2 -1.0+j*0.5 0.3-j*0.1];
fori=2:n,
if type(i)==2 |typechanged(i)==1,
if (Q(i)>Qlimitmax(i)| Q(i)<Qlimitmin(i))
if (Q(i)<Qlimitmin(i))
Q(i)=Qlimitmin(i);
else
Q(i)=Qlimitmax(i);
end
type(i)=1;
typechanged(i)=1;
else
type(i)=2;
typechanged(i)=0;
end
end
sumyv=0;
for k=1:n,
if(i~=k)

sumyv=sumyv+Y(i,k)*V(k);
end
end
V(i)=(1/Y(i,i))*((P(i)-j*Q(i))/conj(V(i))-sumyv)
if type(i)==2 &typechanged(i)~=1,
V(i)=PolarTorect(Vmagfixed(i),angle(V(i)*180/pi))
end
end
diff=max(abs(abs(V(2:n))-abs(Vprev(2:n))));
noofiter=noofiter+1;
end
```

OUTPUT:

no of iterations	V1	V2	V3	V4
1	1.04	1.0191 + 0.0464i	1.0280 - 0.0870i	1.0250 - 0.0092i
2	1.04	1.0290 + 0.0269i	1.0352 - 0.0934i	1.0334 - 0.0208i
3	1.04	1.0335 + 0.0223i	1.0401 - 0.0999i	1.0385 - 0.0269i
4	1.04	1.0360 + 0.0193i	1.0427 - 0.1034i	1.0413 - 0.0304i
5	1.04	1.0374 + 0.0176i	1.0442 - 0.1053i	1.0429 - 0.0324i
6	1.04	1.0382 + 0.0167i	1.0450 - 0.1064i	1.0437 - 0.0335i
7	1.04	1.0386 + 0.0161i	1.0455 - 0.1070i	1.0442 - 0.0341i
8	1.04	1.0388 + 0.0158i	1.0457 - 0.1074i	1.0445 - 0.0344i
9	1.04	1.0390 + 0.0157i	1.0459 - 0.1076i	1.0446 - 0.0346i
10	1.04	1.0390 + 0.0156i	1.0460 - 0.1077i	1.0447 - 0.0347i
11	1.04	1.0391 + 0.0155i	1.0460 - 0.1078i	1.0448 - 0.0348i
12	1.04	1.0391 + 0.0155i	1.0460 - 0.1078i	1.0448 - 0.0348i
13	1.04	1.0391 + 0.0155i	1.0460 - 0.1078i	1.0448 - 0.0348i
14	1.04	1.0391 + 0.0155i	1.0461 - 0.1078i	1.0448 - 0.0349i

CONCLUSION:

EXPERIMENT-4 **DATE:**

Power World Simulator forLoad Flow Analysis

AIM: To find the total Real and Reactive power losses, Power flows and Voltage Profile by Load Flow Analysis by Power World Simulator

PROBLEM: A Three Bus System is simulated in Power World Simulator.

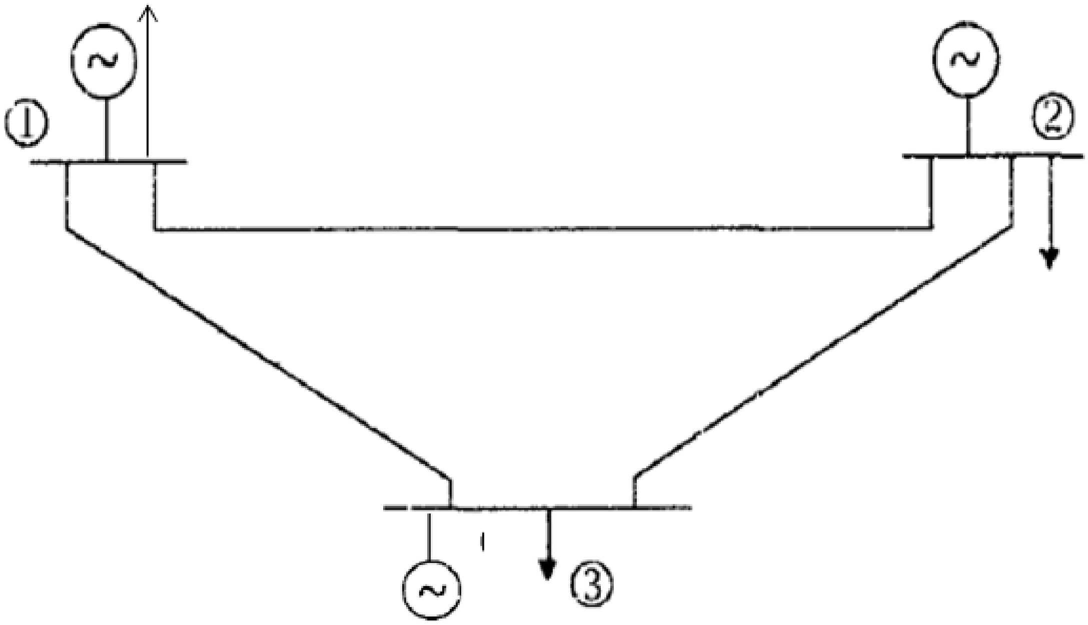
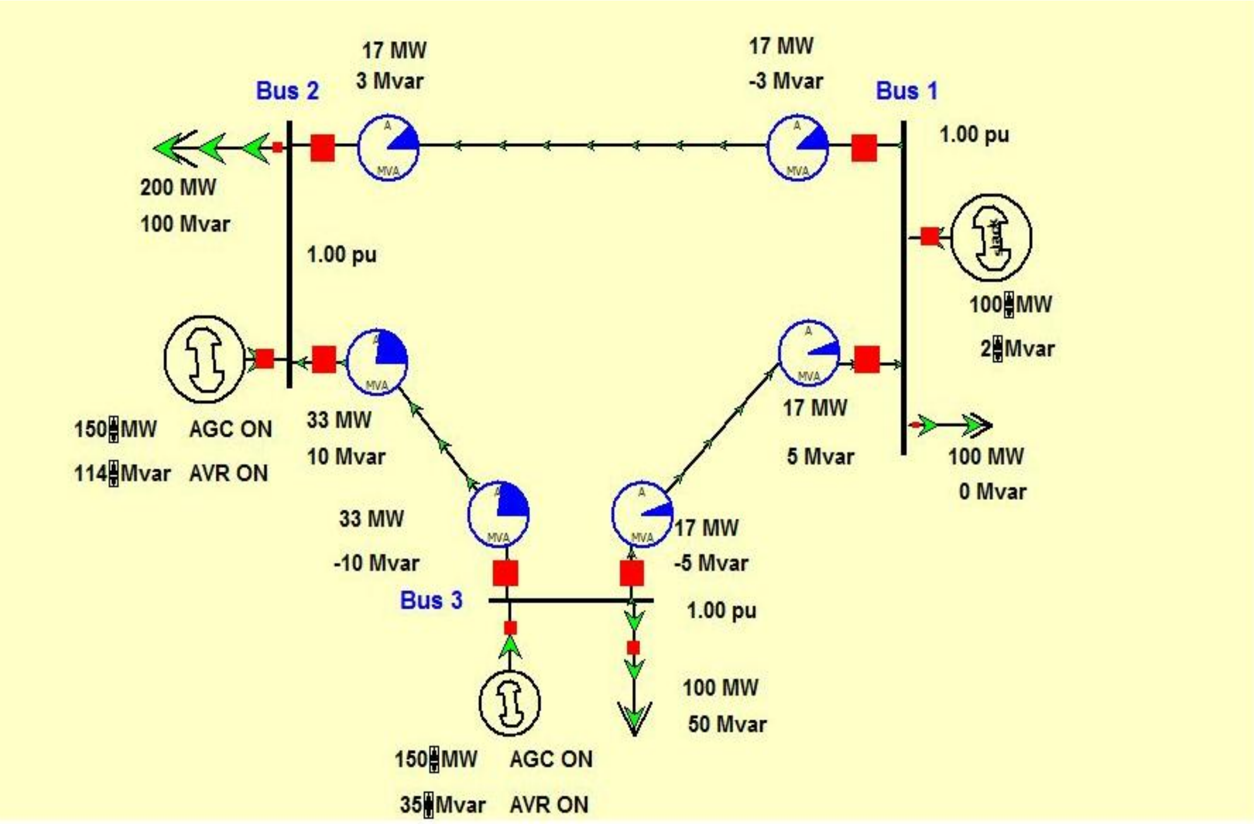
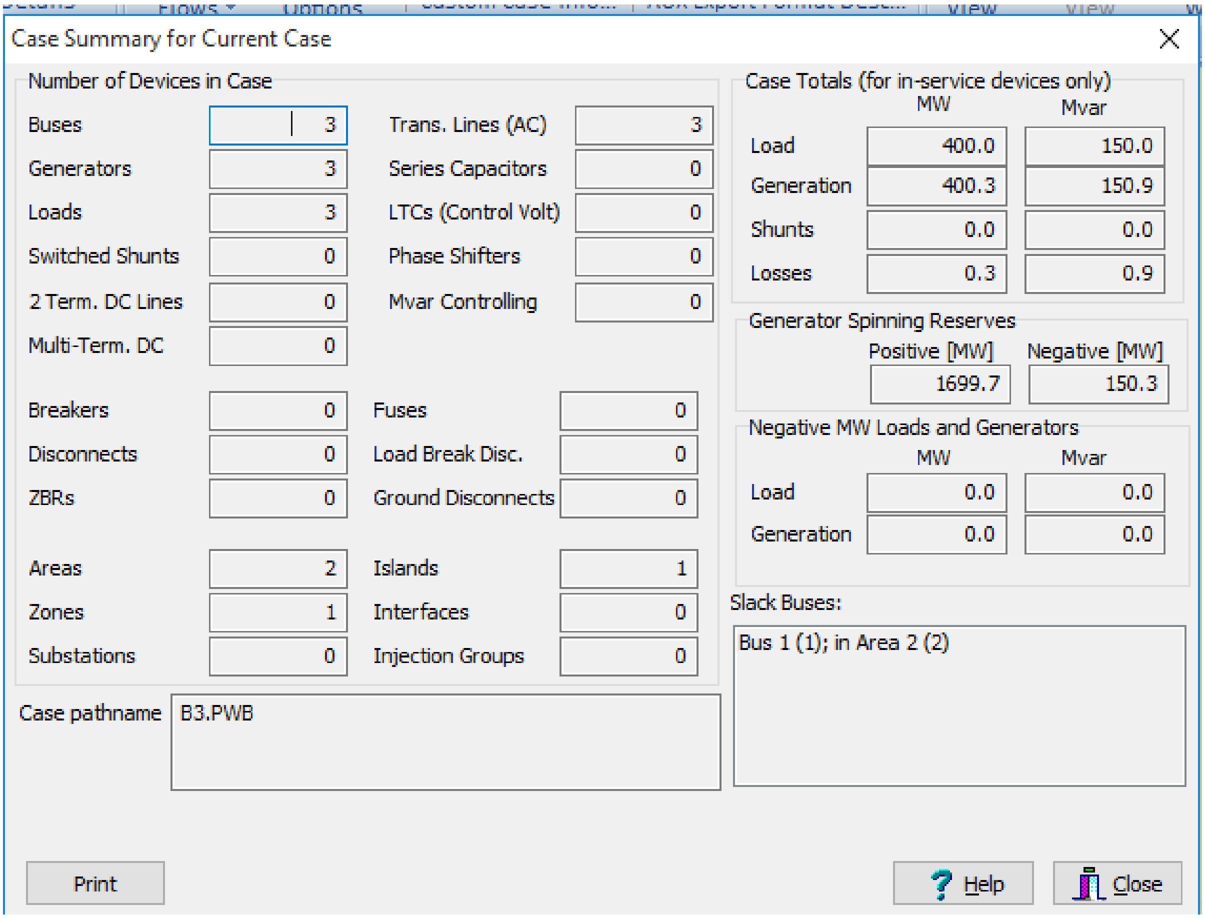


Fig 4.1: Three Bus Power System

POWERWORLD SIMULATOR DIAGRAM:



OUTPUT:



Bus Flows

BUS	1 Bus 1	345.0	MW	Mvar	MVA	%	1.0000	0.00	2 2	
GENERATOR 1			100.26	1.79R	100.3					
LOAD 1			100.00	0.00	100.0					
TO	2 Bus 2	1	17.05	-3.33	17.4	12				
TO	3 Bus 3	1	-16.79	5.12	17.6	6				
BUS	2 Bus 2	345.0	MW	Mvar	MVA	%	1.0000	-0.51	1 Home	
GENERATOR 1			150.00	113.70R	188.2					
LOAD 1			200.00	100.00	223.6					
TO	1 Bus 1	1	-17.02	3.48	17.4	12				
TO	3 Bus 3	1	-32.98	10.22	34.5	23				
BUS	3 Bus 3	345.0	MW	Mvar	MVA	%	1.0000	0.53	1 Home	
GENERATOR 1			150.00	35.41R	154.1					
LOAD 1			100.00	50.00	111.8					
TO	1 Bus 1	1	16.84	-4.97	17.6	6				
TO	2 Bus 2	1	33.16	-9.62	34.5	23				

EXPERIMENT-5 DATE:

MATLAB Program to Find Optimum Loading Of Generators Neglecting Transmission Losses

AIM: To find optimum loading of two units for the given load neglecting transmission losses and verify using MATLAB.

PROBLEM:

Incremental fuel costs in rupees per MWh for a plant consisting of two units are:

$$\frac{dF_1}{dP_1} = 0.2P1 + 40 \text{and} \frac{dF_2}{dP_2} = 0.25P2 + 30$$

Assume that both units are operating at all times, and total load varies from 40 MW to 250MW, and the maximum and minimum loads on each unit are to be 125 MW and 20 MW respectively. How will the load be shared between the two units as the system load varies over the full range? What are the corresponding values of the plant incremental costs?

Solve the problem theoretically and verify using MATLAB.

MATLAB PROGRAM:

```
% Pract5- MATLAB Program for Optimal Loading of generators with neglecting
% transmission losses

% the demand is taken as 231.25 MW, n is no of generators, Pd stands for
load
%demand; alpha and beta arrays denote alpha beta coefficients for given
%generators

clc
clearall

n=2;Pd=231.25;alpha=[0.20 0.25];beta=[40 30];

% initial guess for lamda
lamda =20;lamdaprev=lamda;

% tolerance is eps and increment in lamda is deltalamda
eps=1;deltalamda=0.25;

% the min. and max.limits of each generating unit are stored in arrays
Pgmin and Pgmax

Pgmax= [125 125];Pgmin= [20 20];Pg = 100*ones(n,1);

while abs(sum(Pg)-Pd)>eps

fori = 1:n,
Pg(i)=(lamda-beta(i))/alpha(i);
ifPg(i)>Pgmax(i)
Pg(i)=Pgmax(i);
end

ifPg(i)<Pgmin(i)
Pg(i)=Pgmin(i);
end
end

if (sum(Pg)-Pd)<0
lamdaprev=lamda;
lamda=lamda+deltalamda;
else
lamdaprev=lamda;
lamda=lamda-deltalamda;
end
end
disp('The final value of Lamda is')
lamdaprev
disp('The distribution of load shared by two units is')
Pg
```

OUTPUT:

The final value of Lamda is

lamdaprev =61.2500

The distribution of load shared by two units is

Pg =

106.2500

125.0000

CONCLUSION:

EXPERIMENT-6 **DATE:**

MATLAB Program to Find Optimum Loading of Generators with Penalty Factors

AIM: To find optimum loading of two units for the given load with penalty factor and verify using MATLAB.

PROBLEM:

A two-bus system is shown in figure. If 100 MW is transmitted from plant 1 to theload, a transmission loss of 10 MW is incurred. Find the required generation for each plant and the power received by load when the system λ is Rs 25/MWh. The incremental fuel costs of the two plants are given below:

$$\frac{dC_1}{dP_{G1}} = 0.02\,P_{G1} + 16.0 \text{ Rs/MWh}$$

$$\frac{dC_2}{dP_{G2}} = 0.04\,P_{G2} + 20.0 \text{ Rs/MWh}$$

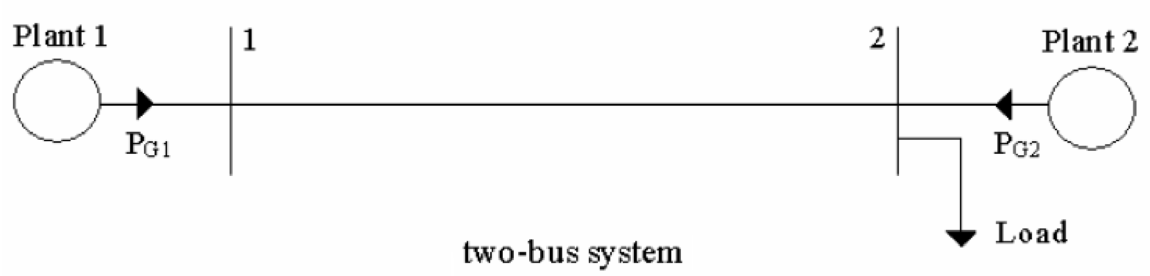


Fig: 5.1 Two Bus System

Solve the problem theoretically. Use the data in the following MATLAB program

MATLAB PROGRAM:

```
% Prac 6 - MATLAB program for optimal loading of generators including
penalty factors
% Pd stands for load demand, alpha and beta arrays denote alpha beta
coefficients
%for given generators, and n is the no of generators

clc
clear
n=2;Pd=237.04;
alpha=[0.020 0.04];
beta=[16 20];

% initial guess for lamda is 20;tolerance is eps and increment in lamda is
deltalamda
lamda = 20; lamdaprev = lamda ; eps = 1; deltalamda = 0.25;
% the min. and max.limits of each generating unit are stored in arrays
Pgmin and Pgmax
Pgmax=[200 200];Pgmin=[0 0];
B = [0.0010 0
    0 0];

noofiter=0;PL=0;Pg = zeros(n,1);
while abs(sum(Pg)-Pd-PL)>eps
fori=1:n,

sigma=B(i,:)*Pg-B(i,i)*Pg(i);
Pg(i)=(1-beta(i)/(lamda-(2*sigma)))/(alpha(i)/lamda+2*B(i,i));


%PL=Pg'*B*Pg;

ifPg(i)>Pgmax (i)
Pg(i)=Pgmax (i);
end
ifPg(i)<Pgmin(i)
Pg(i)=Pgmin(i);
end
end
PL = Pg'*B*Pg;
if (sum(Pg)-Pd-PL)<0
lamdaprev=lamda;
lamda=lamda+deltalamda;
else
lamdaprev=lamda;
lamda=lamda-deltalamda;
end
noofiter=noofiter + 1;
Pg;
end
```

```
disp ('The no of iterations required are')
noofiter
disp ('The final value of lamda is')
lamdaprev
disp ('The optimal loading of generators including penalty factors is')
Pg
disp('The losses are')
PL
```

OUTPUT:

The no of iterations required are noofiter =21

The final value of lamda is lamdaprev =25

The optimal loading of generators including penalty factors is

Pg =

128.5714

125.0000

The losses are

PL = 16.5306

CONCLUSION:

EXPERIMENT-7 **DATE:**

MATLAB Program for equal incremental cost for optimal dispatch

AIM: To Demonstrate the concept of equal incremental cost for optimal dispatch.

PROBLEM:

The fuel-cost function for three thermal plants in $/h are given by

$$C_1 = 500 + 5.3P_1 + 0.004{P^2}_1$$

$$C_2 = 400 + 5.5P_2 + 0.006{P^2}_2$$

$$C_3 = 200 + 5.8P_3 + 0.009{P^2}_3$$

MATLAB PROGRAM:

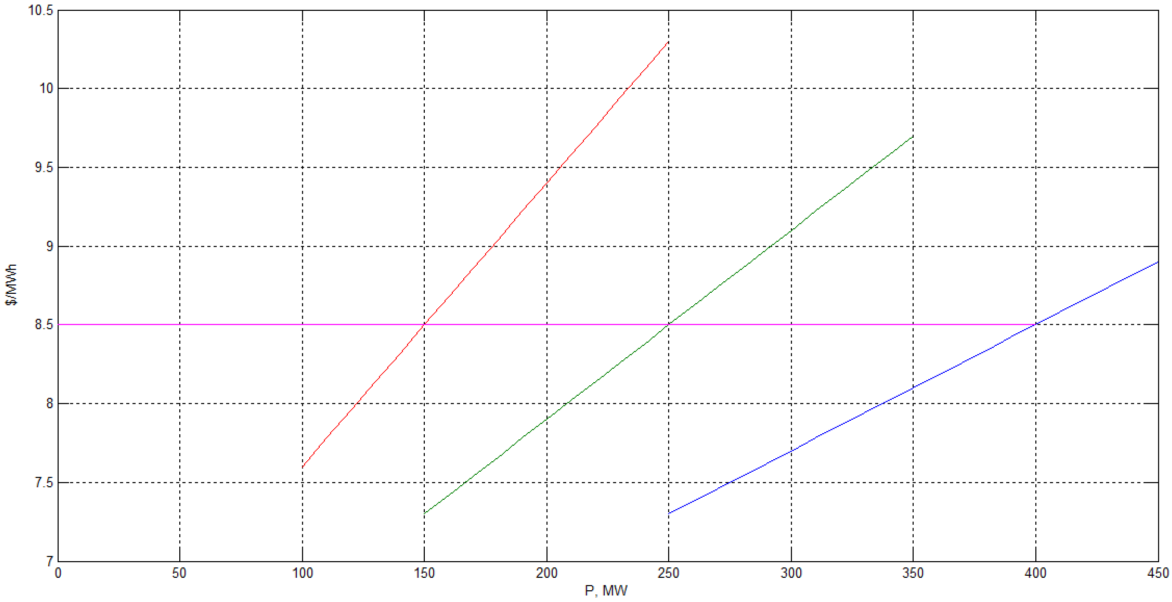
```
% Pract7  MATLAB Program for Equal incremental cost for optimal dispatch
% Iterative solution Using Newton method
alpha =[500; 400; 200];
beta = [5.3; 5.5; 5.8]; gama=[.004; .006; .009];
PD=800;
DelP = 10;                % Error in DelP is set to a high value
lambda = input('Enter estimated value of Lambda = ');
fprintf('\n ')
disp(['   Lambda      P1       P2        P3        DP'...
'     grad      Delambda'])
iter = 0;                                   % Iteration counter
while abs(DelP)  >= 0.001                % Test for convergence
iter = iter + 1;                            % No. of iterations
P = (lambda - beta)./(2*gama);
DelP =PD - sum(P);                                   % Residual
J = sum( ones(length(gama), 1)./(2*gama));      % Gradient sum
Delambda = DelP/J;                         % Change in variable
disp([lambda, P(1), P(2), P(3), DelP, J, Delambda])
lambda = lambda + Delambda;               % Successive solution
end
totalcost = sum(alpha + beta.*P + gama.*P.^2)
%Graphical Demonstration of Example 7.4
axis([0 450  6.5 10.5]);
P1=250:10:450; P2 = 150:10:350; P3=100:10:250;
IC1= 5.3 + 0.008*P1;
IC2= 5.5 + 0.012*P2;
IC3= 5.8 + 0.018*P3;
Px = 0:100:400;
plot(P1, IC1, P2, IC2, P3, IC3, Px, lambda*ones(1, length(Px)),'-m'),
xlabel('P, MW'), ylabel(' $/MWh'), grid
```

OUTPUT:

Enter estimated value of Lambda = 8.5

Lambda	P1	P2	P3	DP	grad	Delambda
8.5000	400.0000	250.0000	150.0000	0	263.8889	0

totalcost = 6.6825e+003



CONCLUSION:

EXPERIMENT-8 DATE:

Simulink Model of Single Area Load Frequency control with and without Pi Controller

AIM: To find dynamic response of the given single area load frequency control problemtheoretically and to plot and verify the results in SIMULINK.

PROBLEM:

The parameters for load frequency control of a single area are:

Speed governor gain	Kg=10
Time constant of speed governor	Tg=0.4
Speed regulation of speed governor	R=3
Gain of turbine	Kt=0.1
Time constant of turbine	Tt=0.5
Gain of power system	Kp=100
Time constant of power system	Tp=20
Changes in the load	ΔPD=0.01 pu

An integral controller with gain Ki=0.09 is now used to reduce steady state error.What is the dynamic response of the system with and without the controller?

Obtain the dynamic response of the system with and without the PI controller by developing a SIMULINK model and verify the responses.

THEORETICAL MODEL:

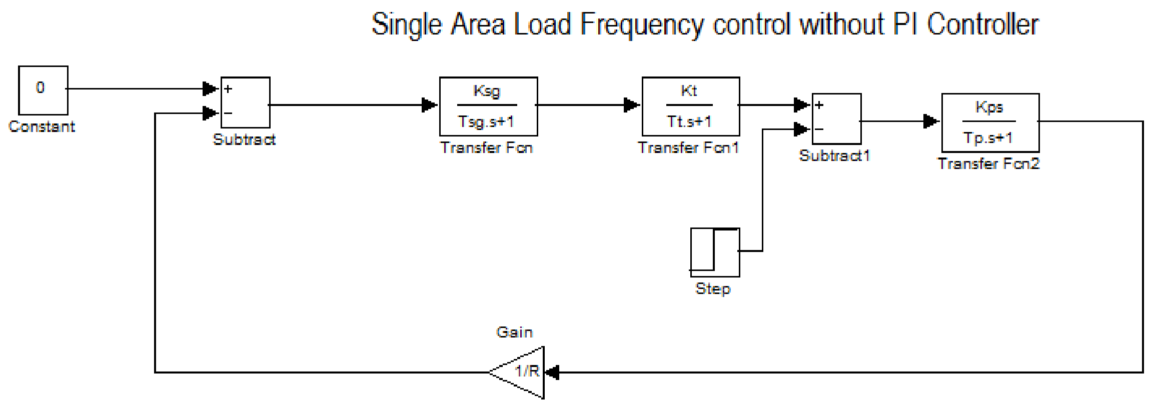


Fig 8.1: Single Area Load Frequency control without PI Controller

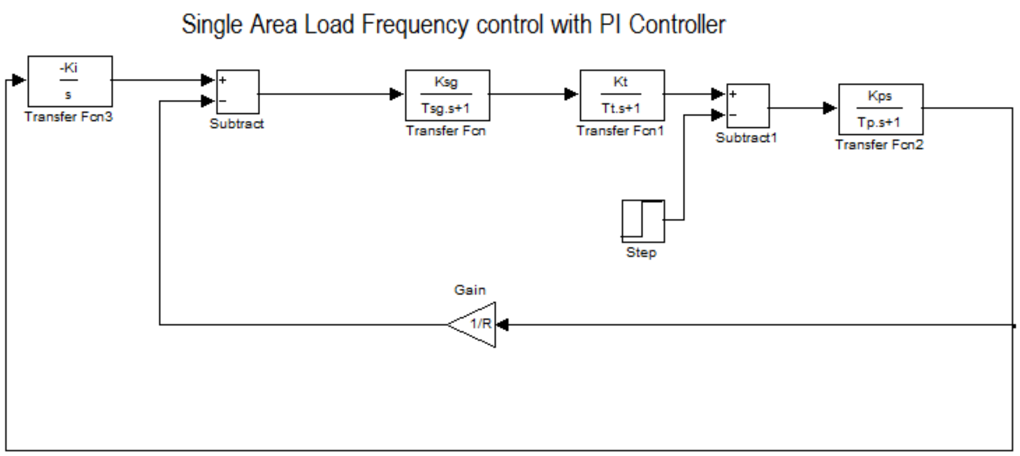
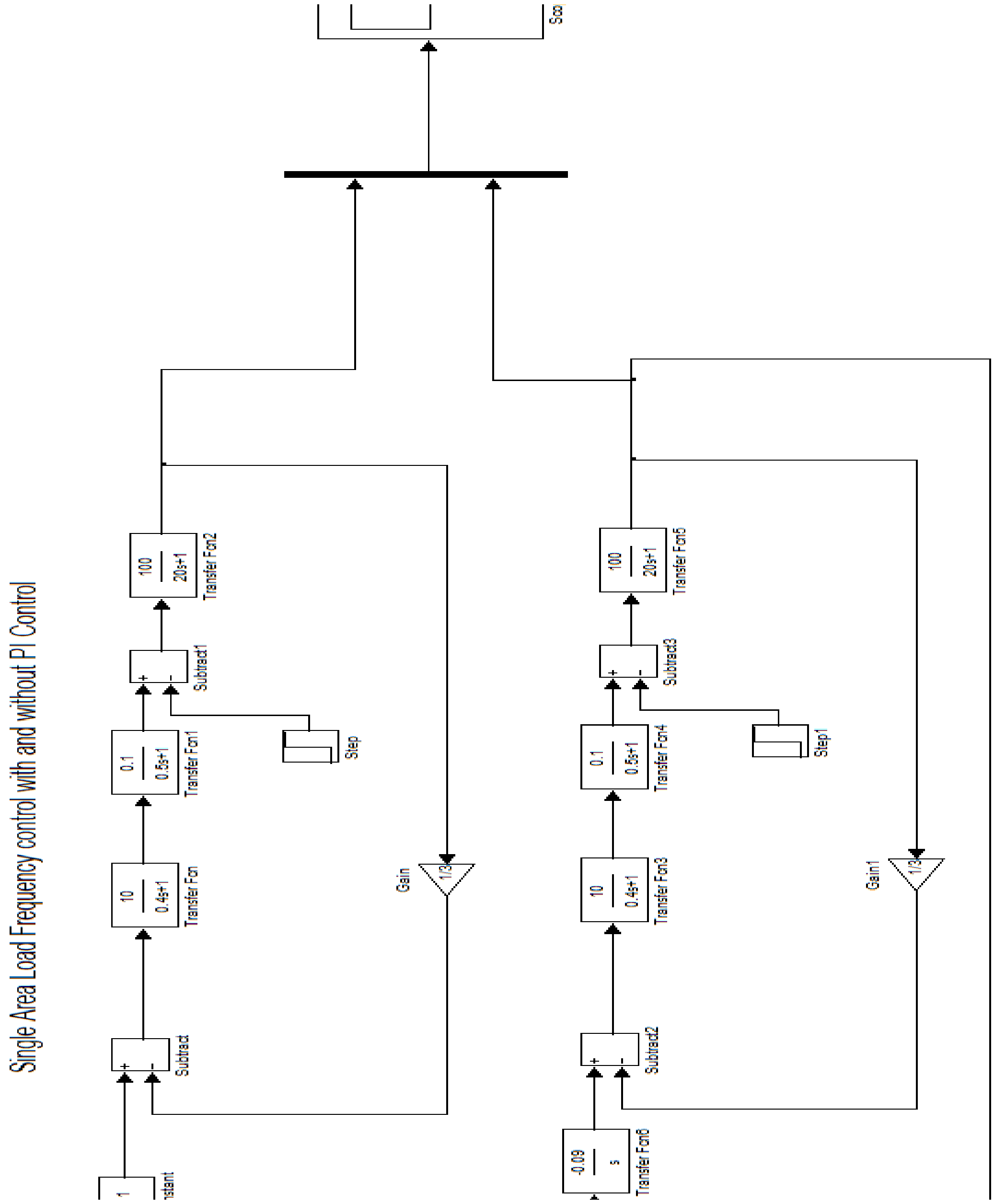
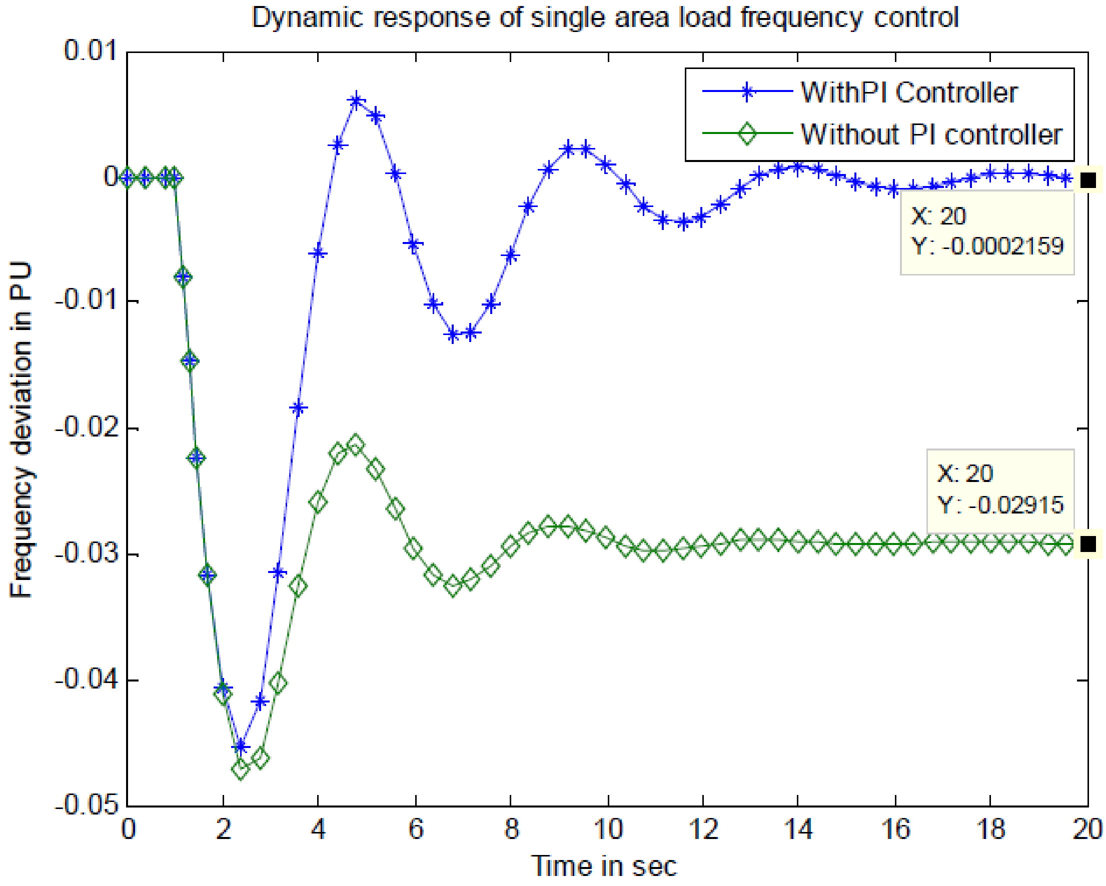


Fig 8.2: Single Area Load Frequency control with PI Controller

MATLAB SIMULINK MODEL:



OUTPUT:


Dynamic response of single area load frequency control
WithPI Controller
Without PI controller
X: 20
Y: -0.0002159
X: 20
Y: -0.02915
Frequency deviation in PU
Time in sec
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
0
2
4
6
8
10
12
14
16
18
20

CONCLUSION:

EXPERIMENT-9 **DATE:**

SIMULINK MODEL FOR TWO AREA LOAD FREQUENCY CONTROL

AIM: To find dynamic response of the given two - area load frequency controlproblem theoretically and to plot and verify the results in SIMULINK.

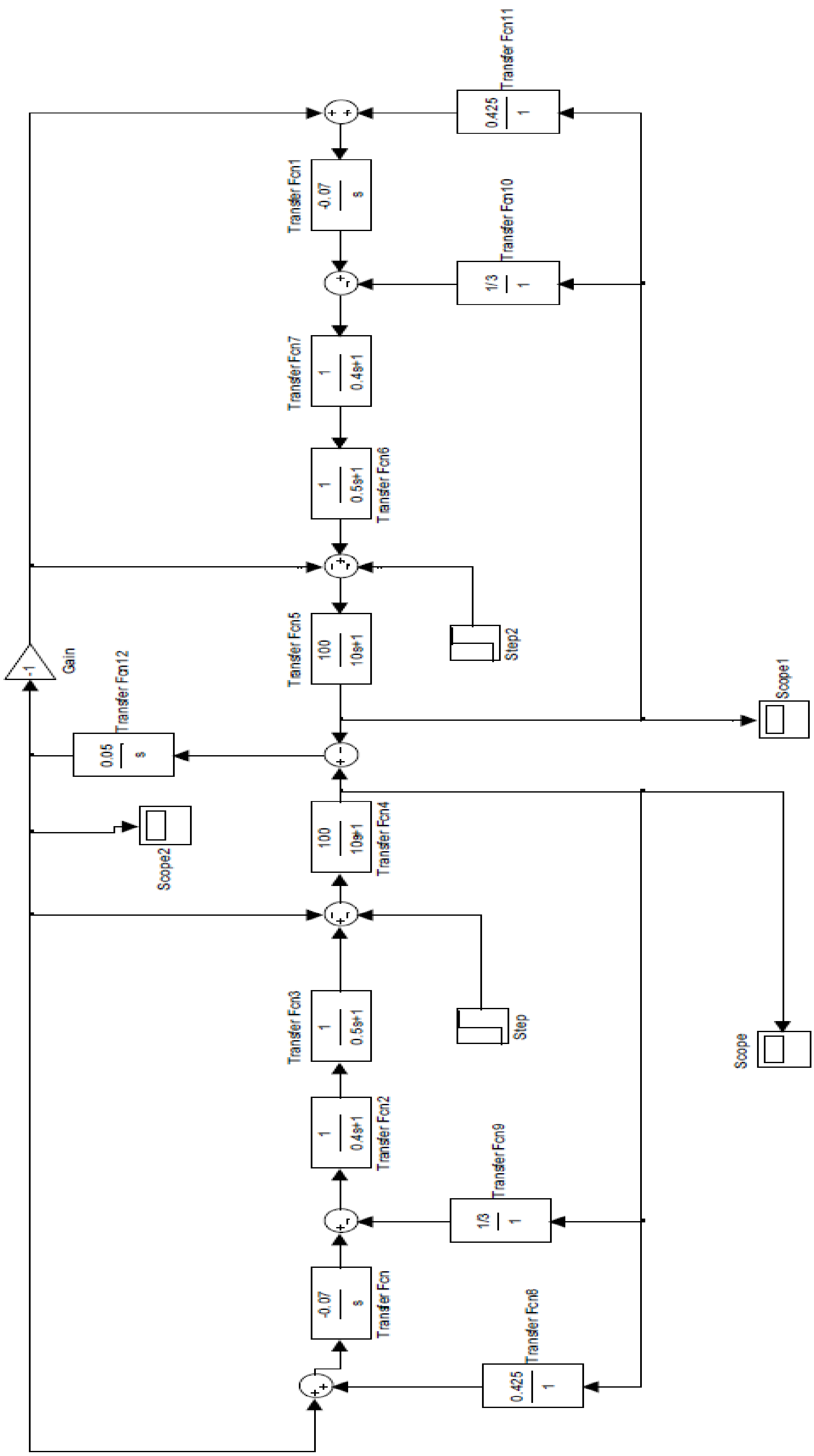
PROBLEM:

The parameters for load frequency control of a two area are:

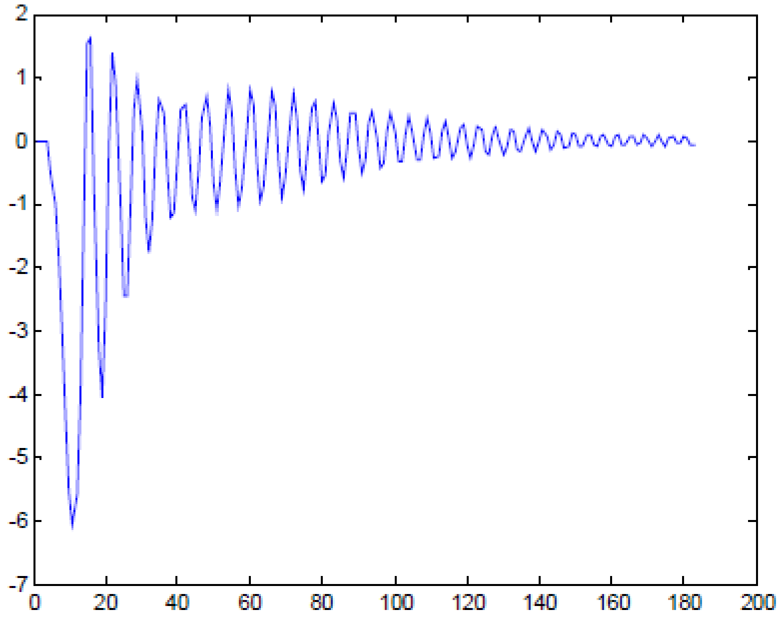
Speed governor gain	Ksg=1
Time constant of speed governor	Tsg=0.4
Speed regulation of speed governor	R=3
Gain of turbine	Kt=1
Time constant of turbine	Tt=0.5
Gain of power system	Kps=100
Time constant of power system	Tps=10
Proportional plus integral gain	Ki=0.07
Synchronizing co-efficient	Tr=0.05
Frequency bias	0.425s

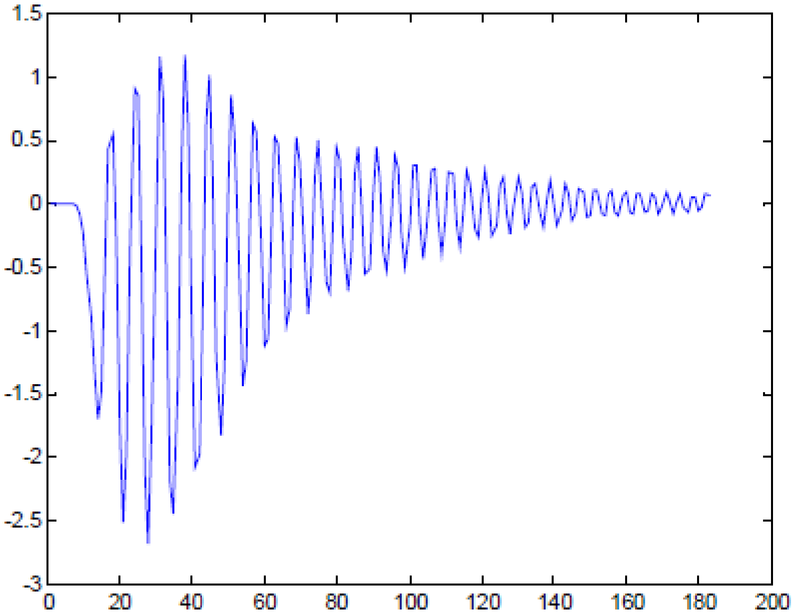
Develop a SIMULINK model for two area load frequency control with PI controller and obtain the frequency deviations in both areas and tie-line power deviations for a load change of 1pu in Area-2

SIMULINK MODEL:



OUTPUT:





CONCLUSION:

EXPERIMENT-10 DATE:

MATLAB Program for Transient Stability of Single Machine Infinite Bus

AIM: To find the response of the Transient Behaviour of Single machine connected with infinite bus and plot the Swing Curve.

PROBLEM:

A 20 MVA, 50Hz Generator delivers 18 MW over a double circuit line to an infinite bus. The Generator has kinetic energy of 2.52MJ/MVA at rated speed. The generator transient reactance is Xd'=0.35pu. Each transmission circuit has R=0 and a reactance of 0.2 pu on a 20MVA base. E'=1.1pu and infinite bus voltage V =1.0<0º. A Three-phase short circuit occurs at the midpoint of one of the transmission lines. Plot Swing Curves with fault cleared by simultaneous opening of breakers at both ends of the line at 2.5 cycles and 6.25 cycles after the occurrence of fault. Also plot the swing curve over the period of 0.5s if the fault is sustained.

```
% Pract-10 Program for transient stability of single machine connected to
infinite
% bus

clc;
clear;
t=0;
tf=0;
tfinal=0.5;
tc=0.125;
tstep=0.05;

M=2.52/(180*50);
i=2;
delta=21.54*pi/180;
ddelta=0;
time(1)=0;
ang(1)=21.64;
Pm=0.9
Pmaxbf=2.44;
Pmaxdf=0.88;
Pmaxaf=2.00;

while t<tfinal,
if (t==tf),
Paminus=0.9-Pmaxbf*sin(delta);
Paplus=0.9-Pmaxdf*sin(delta);

Paav=(Paminus+Paplus)/2;
        Pa=Paav;
end

if (t==tc),

Paminus=0.9-Pmaxdf*sin(delta);
Paplus=0.9-Pmaxaf*sin(delta);
Paav=(Paminus+Paplus)/2;
        Pa=Paav;
end

if (t>tf&t<tc),

           Pa=Pm-Pmaxdf*sin(delta);
end

if (t>tc),

           Pa=Pm-Pmaxaf*sin(delta);
end

t,Pa
ddelta=ddelta+(tstep*tstep*Pa/M);
delta=(delta*180/pi+ddelta)*pi/180;
deltadeg=delta*180/pi;
           t=t+tstep;
pause;
time(i)=t;
ang(i)=deltadeg;
```

```
i=i+1
end
axis([0 0.6 0 160])
plot(time,ang,'ko-')
```

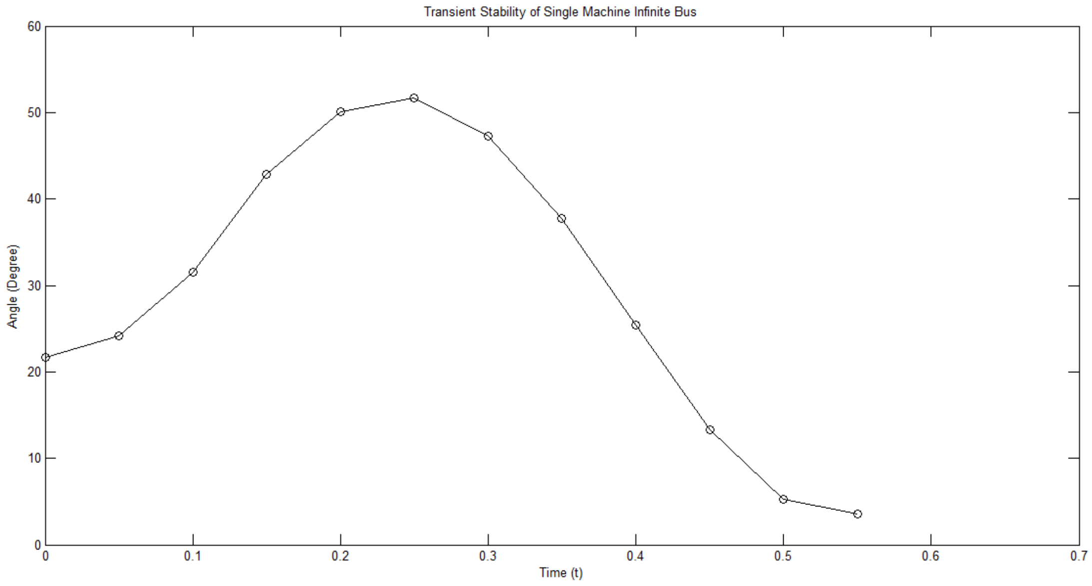
OUTPUT:

time =

0 0.0500 0.1000 0.1500 0.2000 0.2500 0.3000 0.3500 0.4000 0.4500 0.5000 0.5500

ang =

21.6400 24.1340 31.5512 42.8927 50.1159 51.6723 47.2558 37.7610 25.3667 13.3579 5.2593 3.5595



CONCLUSION:

APPENDIX-1

APPENDIX-2

APPENDIX-3

APPENDIX-4

APPENDIX-5

APPENDIX-6

APPENDIX-7

APPENDIX-8

APPENDIX-9

APPENDIX-10