

**For 7 – bus system:****Line Data:**

Sl. No.	(From bus)	(To bus)	(Line impedance) (R + jX)	Line charging admittance (b/2)
1	1	2	0.0000+0.1000j	0.000j
2	6	2	0.0175+0.0628j	0.030j
3	6	5	0.0777+0.2013j	0.025j
4	2	5	0.0573+0.158j	0.020j
5	2	4	0.0607+0.171j	0.020j
6	2	3	0.0431+0.14j	0.015j
7	5	4	0.011+0.028j	0.010j
8	4	3	0.0810+0.2065j	0.025j
9	6	7	0.0000+0.1000j	0.010j

**Bus Data:**

1. Bus No.
2. Type of Bus, 0==slack, 1==PV, 2==PQ.
3. Initial Choice for Voltage(V)
4. Nominal Bus Voltage ( $V_n$ )
5. Initial Choice for Angle(A)
6. Generation Specification ( $P_g + jQ_g$ )
7. Nominal Load Specification ( $P_{dn} + jQ_{dn}$ )
8. Reactive Generation Maximum ( $Q_{gmax}$ )
9. Reactive Generation Minimum ( $Q_{gmin}$ )

Sl. No.	1	2	3	4	5	6	7	8	9
1	1	0	1.06	1.00	0.0	0+0j	0.0+0.0j	1.05	-10.0
2	2	2	1.00	1.00	0.0	0+0j	0.0+0.0j	0.00	0.00
3	3	2	1.00	1.00	0.0	0+0j	0.2+0.1j	0.00	0.00
4	4	2	1.00	1.00	0.0	0+0j	0.4+0.05j	0.00	0.00
5	5	2	1.00	1.00	0.0	0+0j	0.45+0.1j	0.00	0.00
6	6	2	1.00	1.00	0.0	0+0j	0.6+0.1j	0.00	0.00
7	7	1	1.00	1.00	0.0	0.4+0j	0.0+0.0j	10.0	-10.0

## RESULTS:

### Y-BUS

Y-Bus matrix for the 7-bus system:

Y\_Bus =

0.0000 -10.0000i	0.0000 +10.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i
0.0000 +10.0000i	9.9982 -42.0027i	-2.0086 + 6.5245i	-1.8436 + 5.1935i	-2.0285 + 5.5935i	-4.1176 +14.7762i	0.0000 + 0.0000i
0.0000 + 0.0000i	-2.0086 + 6.5245i	3.6548 -10.6814i	-1.6462 + 4.1969i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i
0.0000 + 0.0000i	-1.8436 + 5.1935i	-1.6462 + 4.1969i	15.6445 -40.2746i	-12.1547 +30.9392i	0.0000 + 0.0000i	0.0000 + 0.0000i
0.0000 + 0.0000i	-2.0285 + 5.5935i	0.0000 + 0.0000i	-12.1547 +30.9392i	15.8521 -40.8012i	-1.6689 + 4.3235i	0.0000 + 0.0000i
0.0000 + 0.0000i	-4.1176 +14.7762i	0.0000 + 0.0000i	0.0000 + 0.0000i	-1.6689 + 4.3235i	5.7864 -29.0347i	0.0000 +10.0000i
0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 +10.0000i	0.0000 - 9.9900i

### POWER FLOWS:

Complex Power Flow in lines between ith and jth bus(in p.u.):

S =

0.0000 + 0.0000i	1.2696 + 0.3327i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i
-1.2696 - 0.1793i	0.0000 + 0.0000i	0.2741 + 0.0466i	0.3119 + 0.0177i	0.3325 + 0.0223i	0.3508 + 0.0925i	0.0000 + 0.0000i
0.0000 + 0.0000i	-0.2710 - 0.0679i	0.0000 + 0.0000i	0.0709 - 0.0322i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i
0.0000 + 0.0000i	-0.3063 - 0.0439i	-0.0705 - 0.0182i	0.0000 + 0.0000i	-0.0234 + 0.0119i	0.0000 + 0.0000i	0.0000 + 0.0000i
0.0000 + 0.0000i	-0.3265 - 0.0476i	0.0000 + 0.0000i	0.0234 - 0.0324i	0.0000 + 0.0000i	-0.1469 - 0.0200i	0.0000 + 0.0000i
0.0000 + 0.0000i	-0.3486 - 0.1479i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.1486 - 0.0274i	0.0000 + 0.0000i	-0.4000 + 0.0753i
0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.4000 - 0.0800i	0.0000 + 0.0000i

### LINE LOSSES:

Line losses:	Line	P_Loss (MW)	Q_Loss (MVar)
	1 - 2	0.000000	15.330946
	1 - 3	0.000000	0.000000
	1 - 4	0.000000	0.000000
	1 - 5	0.000000	0.000000
	1 - 6	0.000000	0.000000
	1 - 7	0.000000	0.000000
	2 - 3	0.317840	-2.125368
	2 - 4	0.559465	-2.617050
	2 - 5	0.600913	-2.534714
	2 - 6	0.226233	-5.540383
	2 - 7	0.000000	0.000000
	3 - 4	0.039773	-5.041015
	3 - 5	0.000000	0.000000
	3 - 6	0.000000	0.000000
	3 - 7	0.000000	0.000000
	4 - 5	0.001114	-2.044773
	4 - 6	0.000000	0.000000
	4 - 7	0.000000	0.000000
	5 - 6	0.164092	-4.746012
	5 - 7	0.000000	0.000000
	6 - 7	-0.000000	-0.473062

Total loss: 1.909430 + i-9.791429 MVA

**THE MODIFIED BUS DATA:**

Bus No.	Bus Type	Vmag	Delta	P(MW)	Q(MVAR)	Qmax	Qmin
1	0	1.0600	0	126.9576	39.7926	1.05	-10.0
2	2	1.0294	-6.6812	0	0	0.00	0.00
3	2	1.0096	-8.6439	-20	-10	0.00	0.00
4	2	1.0050	-9.4940	-40	-5	0.00	0.00
5	2	1.0045	-9.4410	-45	-10	0.00	0.00
6	2	1.0131	-7.7224	-60	-10	0.00	0.00
7	1	1.0000	-5.4598	40	-13.3640	10.0	-10.0

The total active power loss: 1.909430 MW

The total reactive power loss: -9.791429 MVAR

The total power loss: (1.909430 + -9.791429i) MVA

**CASE-I: PV BUS Q LIMIT VIOLATION**

BUS NO.	Qmax OLD (MVar)	Qmin OLD (MVar)	Qmax NEW (MVar)	Qmin NEW (MVar)
7	1000	-1000	1000	-10

**RESULTS:**

ITERATIONS		LINE	LINE FLOWS			
OLD	NEW		OLD		NEW	
			P(MW)	Q(MVAr)	P(MW)	Q(MVAr)
92	111	1 - 2	126.96	39.79	126.93	35.62
		6 - 2	-34.73	- 19.42	-34.81	-16.50
		6 - 5	14.74	-3.67	14.81	-3.09
		2 - 5	33.30	2.82	33.26	2.44
		2 - 4	31.24	2.23	31.2	1.94
		2 -3	27.44	4.93	27.42	4.76
		5 - 4	2.26	-3.75	2.3	-3.43
		4 -3	-7.07	-1.97	-7.06	-1.88
		6 -7	-40	13.09	-40	9.59

BUS NO.	VOLTAGE MAG.		DELTA		POWER INJECTED			
	OLD	NEW	OLD	NEW	P OLD (MW)	P NEW (MW)	Q OLD (MVar)	Q NEW (MVar)
1	1.0600	1.0600	0	0.0000	126.9576	126.9346	39.7926	35.627
2	1.0294	1.0333	-6.6812	-6.6546	0	0	0	0.0000
3	1.0096	1.0138	-8.6439	-8.6044	-20	-20	-10	-10.0000
4	1.0050	1.0094	-9.4940	-9.4508	-40	-40	-5	-5.0000
5	1.0045	1.0090	-9.4410	-9.3996	-45	-45	-10	-10.0000
6	1.0131	1.0189	-7.7224	-7.7167	-60	-60	-10	-10.0000
7	1.0000	1.0092	-5.4598	-5.4876	40	40	-13.3640	-10.0000

TOTAL ACTIVE POWER LOSS	
PL OLD (MW)	PL NEW (MW)
1.9641	1.9276

**OBSERVATION:**

**CASE- II: LOAD INCREASE AT BUS 3**

BUS NO.	P old (MW)	Q old (MVar)	P new( MW)	Q new (MVar)
3	20	10	40	20

**RESULTS:**

ITERATIONS		LINE	LINE FLOWS			
OLD	NEW		OLD		NEW	
			P(MW)	Q(MVAr)	P(MW)	Q(MVAr)
92	94	1 - 2	126.96	39.79	147.68	52.10
		6 - 2	-34.73	- 19.42	-36.40	-14.78
		6 - 5	14.74	-3.67	16.40	-1.59
		2 - 5	33.30	2.82	35.83	3.82
		2 - 4	31.24	2.23	34.22	3.65
		2 -3	27.44	4.93	40.98	13.28
		5 - 4	2.26	-3.75	6.30	-1.27
		4 -3	-7.07	-1.97	-0.19	1.41
		6 -7	-40	13.09	-40	-6.75

BUS NO.	VOLTAGE MAG.		DELTA		POWER INJECTED			
	OLD	NEW	OLD	NEW	P OLD (MW)	P NEW (MW)	Q OLD (MVar)	Q NEW (MVar)
1	1.0600	1.060000	0	0	126.9576	147.683320	39.7926	52.095007
2	1.0294	1.020410	-6.6812	-7.8475	0	0.00	0	0.00
3	1.0096	0.984008	-8.6439	-10.7579	-20	-40	-10	-20
4	1.0050	0.991913	-9.4940	-10.9645	-40	-40	-5	-5.00
5	1.0045	0.991913	-9.4410	-10.8601	-45	-45	-10	-10.00
6	1.0131	1.006548	-7.7224	-9.0081	-60	-60	-10	-10.00
7	1.0000	1.000000	-5.4598	-6.7306	40	40	-13.3640	-6.752869

TOTAL ACTIVE POWER LOSS	
PL OLD (MW)	PL NEW (MW)
1.9641	2.6902

### OBSERVATION:

### CASE-III: Increasing R/X ratio (series comp. 30% compensation):

#### Y Bus Matrix:

Y<sub>Bus</sub> =

0.0000	-14.2857i	0.0000	+14.2857i	0.0000	+ 0.0000i	0.0000	+ 0.0000i	0.0000	+ 0.0000i	0.0000	+ 0.0000i	0.0000	+ 0.0000i
0.0000	+14.2857i	18.6402	-56.1608i	-3.7604	+ 8.5503i	-3.3699	+ 6.6454i	-3.6930	+ 7.1283i	-7.8169	+19.6361i	0.0000	+ 0.0000i
0.0000	+ 0.0000i	-3.7604	+ 8.5503i	6.7106	-13.7751i	-2.9502	+ 5.2648i	0.0000	+ 0.0000i	0.0000	+ 0.0000i	0.0000	+ 0.0000i
0.0000	+ 0.0000i	-3.3699	+ 6.6454i	-2.9502	+ 5.2648i	28.0954	-50.6548i	-21.7753	+38.7996i	0.0000	+ 0.0000i	0.0000	+ 0.0000i
0.0000	+ 0.0000i	-3.6930	+ 7.1283i	0.0000	+ 0.0000i	-21.7753	+38.7996i	28.4691	-51.3149i	-3.0008	+ 5.4420i	0.0000	+ 0.0000i
0.0000	+ 0.0000i	-7.8169	+19.6361i	0.0000	+ 0.0000i	0.0000	+ 0.0000i	-3.0008	+ 5.4420i	10.8177	-39.2989i	0.0000	+14.2857i
0.0000	+ 0.0000i	0.0000	+ 0.0000i	0.0000	+ 0.0000i	0.0000	+ 0.0000i	0.0000	+ 0.0000i	0.0000	+14.2857i	0.0000	-14.2757i

### RESULTS:

ITERATIONS		LINE	LINE FLOWS			
OLD	NEW		OLD		NEW	
			P(MW)	Q(MVAr)	P(MW)	Q(MVAr)
92	58	1 - 2	126.96	39.79	127.64	81.30
		6 - 2	-34.73	- 19.42	-33.69	- 65.72
		6 - 5	14.74	-3.67	13.69	-12.42
		2 - 5	33.30	2.82	33.48	5.33
		2 - 4	31.24	2.23	31.56	3.89
		2 -3	27.44	4.93	28.07	5.67
		5 - 4	2.26	-3.75	1.33	-8.37
		4 -3	-7.07	-1.97	-7.69	-3.68
		6 -7	-40	13.09	-40	68.14

BUS NO.	VOLTAGE MAG.		DELTA		POWER INJECTED			
	OLD	NEW	OLD	NEW	P OLD (MW)	P NEW (MW)	Q OLD (MVar)	Q NEW (MVar)
1	1.0600	1.0600	0	0	126.9576	127.643946	39.7926	81.295532
2	1.0294	1.037621	-6.6812	-1.995204	0	0.00	0	0.00
3	1.0096	1.023047	-8.6439	-2.462234	-20	-20	-10	-10
4	1.0050	1.016238	-9.4940	-2.675535	-40	-40	-5	-5
5	1.0045	1.015775	-9.4410	-2.624552	-45	-45	-10	-10
6	1.0131	1.020273	-7.7224	-1.745805	-60	-60	-10	-10
7	1.0000	1.000000	-5.4598	-1.071903	40	40	-13.3640	-68.3414

TOTAL ACTIVE POWER LOSS	
PL OLD (MW)	PL NEW (MW)
1.9641	2.66

**OBSERVATION:**

**CASE-IV: PV BUS VOLTGAE CHANGE (Bus 7 changes voltage to 1.06)**

BUS NO.	PV BUS VOLTAGE MAGNITUDE	
	OLD VALUE (pu)	NEW VALUE (pu)
7	1	1.06

**RESULTS:**

ITERATIONS		LINE	LINE FLOWS			
OLD	NEW		OLD		NEW	
			P(MW)	Q(MVAr)	P(MW)	Q(MVAr)
92	92	1 - 2	126.96	39.79	126.80	12.88
		6 - 2	-34.73	- 19.42	-35.21	0.06
		6 - 5	14.74	-3.67	15.21	0.22

		2 - 5	33.30	2.82	33.05	0.34
		2 - 4	31.24	2.23	31.03	0.29
		2 - 3	27.44	4.93	27.32	3.79
		5 - 4	2.26	-3.75	2.52	-1.65
		4 - 3	-7.07	-1.97	-6.98	-1.35
		6 - 7	-40	13.09	-40	-10.27

BUS NO.	VOLTAGE MAG.		DELTA		POWER INJECTED			
	OLD	NEW	OLD	NEW	P OLD (MW)	P NEW (MW)	Q OLD (MVar)	Q NEW (MVar)
1	1.0600	1.0600	0	0.00	126.9576	126.795094	39.7926	12.875976
2	1.0294	1.054658	-6.6812	- 6.512429	0	0.00	0	0.00
3	1.0096	1.036814	-8.6439	- 8.393481	-20	-20	-10	-10
4	1.0050	1.033876	-9.4940	- 9.220942	-40	-40	-5	-5
5	1.0045	1.033987	-9.4410	- 9.179649	-45	-45	-10	-10
6	1.0131	1.050586	-7.7224	- 7.686424	-60	-60	-10	-10
7	1.0000	1.0600	-5.4598	- 5.627983	40	40	-13.3640	9.573451

TOTAL ACTIVE POWER LOSS	
PL OLD (MW)	PL NEW (MW)
1.9641	1.8017

**OBSERVATION:**



**CASE-V: Effect of change in slack bus position (Take 7 as slack bus)**

BUS NO.	TYPE OF BUS
1	1 (PV bus)
2	2 (PQ bus)
3	2 (PQ bus)
4	2 (PQ bus)
5	2 (PQ bus)
6	2 (PQ bus)
7	0 (Slack bus)

**RESULTS:**

ITERATIONS		LINE	LINE FLOWS			
OLD	NEW		OLD		NEW	
			P(MW)	Q(MVAr)	P(MW)	Q(MVAr)
92	128	1 - 2	126.96	39.79	0.00	43.08
		6 - 2	-34.73	- 19.42	70.29	-29.98
		6 - 5	14.74	-3.67	37.68	-6.88
		2 - 5	33.30	2.82	22.56	4.85
		2 - 4	31.24	2.23	23.25	3.68
		2 -3	27.44	4.93	23.52	5.66
		5 - 4	2.26	-3.75	13.84	-6.58
		4 -3	-7.07	-1.97	-3.26	-2.86
		6 -7	-40	13.09	-167.97	26.86

BUS NO.	VOLTAGE MAG.		DELTA		POWER INJECTED			
	OLD	NEW	OLD	NEW	P OLD (MW)	P NEW (MW)	Q OLD (MVAr)	Q NEW (MVAr)
1	1.0600	1.0600	0	-12.2478	126.9576	0.000976	39.7926	43.080784
2	1.0294	1.019358	-6.6812	-12.2479	0	0.00	0	0.00
3	1.0096	0.999933	-8.6439	-13.9243	-20	-20	-10	-10
4	1.0050	0.996483	-9.4940	-14.2941	-40	-40	-5	-5
5	1.0045	0.996431	-9.4410	-14.0349	-45	-45	-10	-10
6	1.0131	1.013688	-7.7224	-9.538132	-60	-60	-10	-10
7	1.0000	1.000000	-5.4598	0.00	40	167.972072	-13.3640	-0.673963

TOTAL ACTIVE POWER LOSS	
PL OLD (MW)	PL NEW (MW)
1.9641	2.9791

**OBSERVATION:**

**Conclusion:**