

**EE-520 (171)**  
**Dr. Ibrahim O. Habiballah**  
**Home Work 2**

**Key Solution**

**Solution:**

a) Bus Admittance Matrix

$Y_{BUS} = -j$

150.0	-100.0			-50.0
-100.0	250.0	-50.0		-100.0
	-50.0	150.0	-100.0	
		-100.0	150.0	-50.0
-50.0	-100.0		-50.0	220.0

Use the Chained Data Structure Method for storing Symmetric  $Y_{BUS}$  (5 Points)

	STO	IC	NX	NFIRST
1	150.0	1	1	1
2	-100.0	2	1	4
3	-50.0	5	0	7
4	250.0	2	1	9
5	-50.0	3	1	11
6	-100.0	5	0	
7	150.0	3	1	
8	-100.0	4	0	
9	150.0	4	1	
10	-50.0	5	0	
11	220.0	5	0	

b) Bus Impedance Matrix

Consider the addition of the radial line between Bus 5 and the reference

$Z_{BUS} = j$  0.05

Consider the addition of the radial line between Bus 1 and Bus 5

$Z_{BUS} = j$  

0.05	0.05
0.05	0.07

Consider the addition of the radial line between Bus 2 and Bus 1

$Z_{BUS} = j$  

0.05	0.05	0.05
0.05	0.07	0.07

0.05	0.07	0.08
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$$Z_{BUS} = j$$

Consider the addition of the radial line between Bus 3 and Bus 2

$Z_{BUS} = j$	0.05	0.05	0.05	0.05
	0.05	0.07	0.07	0.07
	0.05	0.07	0.08	0.08
	0.05	0.07	0.08	0.1

Consider the addition of the radial line between Bus 4 and Bus 3

$Z_{BUS} = j$	0.05	0.05	0.05	0.05	0.05
	0.05	0.07	0.07	0.07	0.07
	0.05	0.07	0.08	0.08	0.08
	0.05	0.07	0.08	0.1	0.1
	0.05	0.07	0.08	0.1	0.11

Reorder the bus numbering from the sequence (5-1-2-3-4) to sequence (1-2-3-4-5)

$Z_{BUS} = j$	0.07	0.07	0.07	0.07	0.05
	0.07	0.08	0.08	0.08	0.05
	0.07	0.08	0.1	0.1	0.05
	0.07	0.08	0.1	0.11	0.05
	0.05	0.05	0.05	0.05	0.05

Consider the addition of the loop line between Bus 2 and Bus 5

$Z_{BUS-LOOP} = j$	0.07	0.07	0.07	0.07	0.05	0.02
	0.07	0.08	0.08	0.08	0.05	0.03
	0.07	0.08	0.1	0.1	0.05	0.03
	0.07	0.08	0.1	0.11	0.05	0.03
	0.05	0.05	0.05	0.05	0.05	0.0
	0.02	0.03	0.03	0.03	0.0	0.04

After applying bus elimination method

$Z_{BUS} = j$	0.06	0.055	0.055	0.055	0.05
	0.055	0.0575	0.0575	0.0575	0.05
	0.055	0.0575	0.0775	0.0775	0.05
	0.055	0.0575	0.0775	0.0875	0.05
	0.05	0.05	0.05	0.05	0.05

Consider the addition of the loop line between Bus 4 and Bus 5

$Z_{\text{BUS-LOOP}} = j$

0.06	0.055	0.055	0.055	0.05	0.005
0.055	0.0575	0.0575	0.0575	0.05	0.0075
0.055	0.0575	0.0775	0.0775	0.05	0.0275
0.055	0.0575	0.0775	0.0875	0.05	0.0375
0.05	0.05	0.05	0.05	0.05	0.0
0.005	0.0075	0.0275	0.0375	0.0	0.0575

After applying bus elimination method

$Z_{\text{BUS}} = j$

0.0596	0.0543	0.0526	0.0517	0.05
0.0543	0.0565	0.0539	0.0526	0.05
0.0526	0.0539	0.0643	0.0596	0.05
0.0517	0.0526	0.0596	0.0630	0.05
0.05	0.05	0.05	0.05	0.05

Use the Chained Data Structure Method for storing Symmetric  $Z_{\text{BUS}}$  (15 Points)

	STO	IC	NX	NFIRST
1	0.0596	1	1	1
2	0.0543	2	1	6
3	0.0526	3	1	10
4	0.0517	4	1	13
5	0.05	5	0	15
6	0.0565	2	1	
7	0.0539	3	1	
8	0.0526	4	1	
9	0.05	5	0	
10	0.0643	3	1	
11	0.0596	4	1	
12	0.05	5	0	
13	0.0630	4	1	
14	0.05	5	0	
15	0.05	5	0	

c) Multiplication of  $Z_{BUS}$  and  $Y_{BUS}$

1.0				
	1.0			
		1.0		
			1.0	
				1.0

d) Modification of  $Y_{BUS}$  after adding the loop line of 0.5 p.u. between Bus 3 and Bus 5

$Y_{BUS} = -j$

150.0	-100.0			-50.0
-100.0	250.0	-50.0		-100.0
	-50.0	152.0	-100.0	-2.0
		-100.0	150.0	-50.0
-50.0	-100.0	-2.0	-50.0	222.0

Use the Chained Data Structure Method for storing the modified  $Y_{BUS}$

	STO	IC	NX	NFIRST
1	150.0	1	1	1
2	-100.0	2	1	4
3	-50.0	5	0	7
4	250.0	2	1	9
5	-50.0	3	1	11
6	-100.0	5	0	
7	152.0	3	1	
8	-100.0	4	4	
9	150.0	4	1	
10	-50.0	5	0	
11	222.0	5	0	
12	-2.0	5	0	

e) Modification of  $Y_{BUS}$  after removing Bus 4

After applying bus elimination method

$Y_{BUS} = -j$

150.0	-100.0		-50.0
-100.0	250.0	-50.0	-100.0
	-50.0	85.33	-35.33
-50.0	-100.0	-35.33	205.33

Use the Chained Data Structure Method for storing the modified  $Y_{BUS}$

	STO	IC	NX	NFIRST
1	150.0	1	1	1
2	-100.0	2	1	4
3	-50.0	4	0	7
4	250.0	2	1	11
5	-50.0	3	1	0
6	-100.0	4	0	
7	85.33	3	5	
8	-100.0	4	4	
9	150.0	4	1	
10	-50.0	5	0	
11	205.33	4	0	
12	-35.33	4	0	