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Milestone 2: Jacobian

Below see the results of a verification of our simulator for one iteration of the Newton Raphson Power Flow solver.

Code Output:
Flat Start:

```
Bus Voltages for System 1
1       2       3       4       5       6       7
1       1.0     1.0     1.0     1.0     1.0     1.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0
```

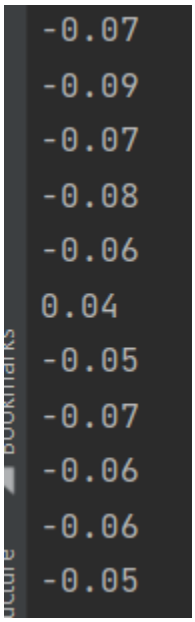
$\Delta P \; and \; \Delta Q$ for all 7 buses, Mismatch

```
0.0
0.0
-110.0
-100.0
-100.0
0.0
200.0
0.0
0.06
-49.93
-69.89
-64.89
0.05
0.0
```

Jacobian with only essential terms after removal of slack bus terms, and Q and V terms from PV buses:

2	3	4	5	6	7	2	3	4	5	6
115.87	-28.93	-72.31	0.0	0.0	0.0	30.26	-8.23	-20.57	0.0	0.0
-28.93	65.08	0.0	-36.16	0.0	0.0	-8.23	18.51	0.0	-10.28	0.0
-72.31	0.0	129.13	-20.66	-36.16	0.0	-20.57	0.0	36.73	-5.88	-10.28
0.0	-36.16	-20.66	129.13	-72.31	0.0	0.0	-10.28	-5.88	36.73	-20.57
0.0	0.0	-36.16	-72.31	127.45	-18.98	0.0	0.0	-10.28	-20.57	32.43
0.0	0.0	0.0	0.0	-18.98	18.98	0.0	0.0	0.0	0.0	-1.58
-30.26	8.23	20.57	-0.0	-0.0	-0.0	115.76	-28.93	-72.31	0.0	0.0
8.23	-18.51	-0.0	10.28	-0.0	-0.0	-28.93	64.93	0.0	-36.16	0.0
20.57	-0.0	-36.73	5.88	10.28	-0.0	-72.31	0.0	128.92	-20.66	-36.16
-0.0	10.28	5.88	-36.73	20.57	-0.0	0.0	-36.16	-20.66	128.92	-72.31
-0.0	-0.0	10.28	20.57	-32.43	1.58	0.0	0.0	-36.16	-72.31	127.35

ΔX Changes in angles of all non slack buses and changes in all voltages of non slack and non PV buses:



Per Unit Bus Voltages after one Iteration:

Bus Voltages for System 1						
1	2	3	4	5	6	7
1	0.946	0.929	0.938	0.936	0.949	1.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0

Below, see that the PowerWorld Outputs align with the results from the code, thus verifying our work so far on this simulator.

Powerworld Output:

Initial Bus Voltages, Flat Start:

	Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)	Angle (Deg)	Load MW	Load Mvar	Gen MW	Gen Mvar
1	1	1	1	20.00	1.00000	20.000	0.00			0.00	0.00
2	2	2	1	230.00	1.00000	230.000	0.00				
3	3	3	1	230.00	1.00000	230.000	0.00	110.00	50.00		
4	4	4	1	230.00	1.00000	230.000	0.00	100.00	70.00		
5	5	5	1	230.00	1.00000	230.000	0.00	100.00	65.00		
6	6	6	1	230.00	1.00000	230.000	0.00				
7	7	7	1	18.00	1.00000	18.000	0.00			200.00	0.00

ΔP *and* ΔQ for all 7 buses, Mismatch

	Number	Name	Area Name	Type	Mismatch MW	Mismatch Mvar	Mismatch MV
1	7	7	1	PV	200.00	0.00	200.00
2	3	3	1	PQ	-110.00	-42.66	117.98
3	4	4	1	PQ	-100.00	-59.40	116.31
4	5	5	1	PQ	-100.00	-54.40	113.84
5	2	2	1	PQ	0.00	5.71	5.71
6	6	6	1	PQ	0.00	4.89	4.89
7	1	1	1	Slack	0.00	0.00	0.00

Jacobian for all Buses:

	Number	Name	Jacobian Equation	Angle Bus 1	Angle Bus 2	Angle Bus 3	Angle Bus 4	Angle Bus 5	Angle Bus 6	Angle Bus 7
1	1	1	Real Power	1.00						
2	2	2	Real Power		115.87	-28.92	-72.31			
3	3	3	Real Power		-28.92	65.08		-36.16		
4	4	4	Real Power		-72.31		129.13	-20.66	-36.16	
5	5	5	Real Power			-36.16	-20.66	129.13	-72.31	
6	6	6	Real Power				-36.16	-72.31	127.45	-18.98
7	7	7	Real Power						-18.98	18.98
8	1	1	Slack							
9	2	2	Reactive Power		-30.26	8.23	20.57			
10	3	3	Reactive Power		8.23	-18.51		10.28		
11	4	4	Reactive Power		20.57		-36.73	5.88	10.28	
12	5	5	Reactive Power			10.28	5.88	-36.73	20.57	
13	6	6	Reactive Power				10.28	20.57	-32.43	1.58
14	7	7	Voltage Magnitude							

Volt Mag Bus 1	Volt Mag Bus 2	Volt Mag Bus 3	Volt Mag Bus 4	Volt Mag Bus 5	Volt Mag Bus 6	Volt Mag Bus 7
	30.26	-8.23	-20.57			
	-8.23	18.51		-10.28		
	-20.57		36.73	-5.88	-10.28	
		-10.28	-5.88	36.73	-20.57	
			-10.28	-20.57	32.43	-1.58
					-1.58	1.58
1.00						
	115.76	-28.92	-72.31			
	-28.92	64.93		-36.16		
	-72.31		128.92	-20.66	-36.16	
		-36.16	-20.66	128.92	-72.31	
			-36.16	-72.31	127.35	-18.98
						1.00

Final Bus Voltages after One Iteration:

	Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)	Angle (Deg)	Load MW	Load Mvar	Gen MW	Gen Mvar
1	1	1	1	20.00	1.00000	20.000	0.00			113.76	71.81
2	2	2	1	230.00	0.94646	217.687	-4.37				
3	3	3	1	230.00	0.93138	214.217	-5.56	110.00	50.00		
4	4	4	1	230.00	0.93953	216.091	-4.68	100.00	70.00		
5	5	5	1	230.00	0.93680	215.463	-4.82	100.00	65.00		
6	6	6	1	230.00	0.94909	218.290	-3.78				
7	7	7	1	18.00	1.00088	18.016	2.40			200.00	92.71