EE 521 Power System Analysis and EE 523 Power System Stability and Control Algorithms

Preamble and Control Inputs

```
systemName =
"ieee11"

powerFlowMethod =
"NRPF"
```

Read CDF file and store the data in neat MATLAB `tables: busData` and `branchData`.

`busData = 11×18 table`

	bus	busName	loadFlowArea	lossZone	busType	vFinal
1	1	"Bus 1 HV"	1	1	3	1.0300
2	2	"Bus 2 HV"	1	1	2	1.0100
3	3	"Bus 3 HV"	2	1	2	1.0300
4	4	"Bus 4 HV"	2	1	2	1.0100
5	5	"Bus 5 HV"	1	1	0	1.0060
6	6	"Bus 6 LV"	1	1	0	0.9780
7	7	"Bus 7 ZV"	1	1	0	0.9610
8	8	"Bus 8 TV"	3	1	0	0.9490
9	9	"Bus 9 LV"	2	1	0	0.9710
10	10	"Bus 10 LV"	2	1	0	0.9840
11	11	"Bus 11 LV"	2	1	0	1.0080

`branchData = 10×15 table`

	i	j	loadFlowArea	lossZone	ckt	type	R
1	1	5	1	1	1	0	0
2	2	6	1	1	1	0	0
3	3	11	2	1	1	0	0
4	4	10	2	1	1	0	0
5	5	6	1	1	1	0	0.0025
6	6	7	1	1	1	0	0.0010
7	7	8	1	1	1	0	0.0055
8	8	9	2	1	1	0	0.0055
9	9	10	2	1	1	0	0.0010
10	10	11	2	1	1	0	0.0025

```
N = 11
numBranch = 10
```

Extract Y_{Bus}, Adjacency List E from the `branchData table`.

```
ybusTable = 11×11 table
```

...

	1	2	3	4	5
1 1	0.0000 -59.9880i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 +59.9880i
2 2	0.0000 + 0.0000i	0.0000 -59.9880i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i
3 3	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 -59.9880i	0.0000 + 0.0000i	0.0000 + 0.0000i
4 4	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 -59.9880i	0.0000 + 0.0000i
5 5	0.0000 +59.9880i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	3.9604 -99.5701i
6 6	0.0000 + 0.0000i	0.0000 +59.9880i	0.0000 + 0.0000i	0.0000 + 0.0000i	-3.9604 +39.6040i
7 7	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i
8 8	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i
9 9	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i
10 10	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 +59.9880i	0.0000 + 0.0000i
11 11	0.0000 + 0.0000i	0.0000 + 0.0000i	0.0000 +59.9880i	0.0000 + 0.0000i	0.0000 + 0.0000i

Run Newton Raphson Power Flow and obtain a steady state snapshot of the system variables $P_i, Q_i, V_i, \delta_i \ \forall$ buses $i \in [1, N], i \in \mathbb{N}$

```
Iteration Number 1 Jacobian:
JTable = 17×17 table
```

...

	$delta_2$	$delta_3$	$delta_4$	$delta_5$	$delta_6$	$delta_7$
1 P_2	60.5879	0	0	0	-60.5879	0
2 P_3	0	61.7876	0	0	0	0
3 P_4	0	0	60.5879	0	0	0
4 P_5	0	0	0	101.3916	-39.6040	0
5 P_6	-60.5879	0	0	-39.6040	199.2017	-99.0099
6 P_7	0	0	0	0	-99.0099	117.0117
7 P_8	0	0	0	0	0	-18.0018
8 P_9	0	0	0	0	0	0
9 P_10	0	0	-60.5879	0	0	0
10 P_11	0	-61.7876	0	0	0	0
11 Q_5	0	0	0	-3.9604	3.9604	0
12 Q_6	-0	0	0	3.9604	-13.8614	9.9010
13 Q_7	0	0	0	0	9.9010	-11.7012

	$delta_2$	$delta_3$	$delta_4$	$delta_5$	$delta_6$	$delta_7$
14 Q_8	0	0	0	0	0	1.8002
15 Q_9	0	0	0	0	0	0
16 Q_10	0	0	-0	0	0	0
17 Q_11	0	-0	0	0	0	0

Iteration Number 2 Jacobian:
JTable = 17×17 table

...

	$delta_2$	$delta_3$	$delta_4$	$delta_5$	$delta_6$	$delta_7$
1 P_2	62.4416	0	0	0	-62.4416	0
2 P_3	0	64.1116	0	0	0	0
3 P_4	0	0	62.9589	0	0	0
4 P_5	0	0	0	106.8334	-42.8853	0
5 P_6	-62.4416	0	0	-41.5654	211.8705	-107.8634
6 P_7	0	0	0	0	-105.0023	125.0538
7 P_8	0	0	0	0	0	-19.2736
8 P_9	0	0	0	0	0	0
9 P_10	0	0	-62.9589	0	0	0
10 P_11	0	-64.1116	0	0	0	0
11 Q_5	0	0	0	-4.0096	-2.3765	0
12 Q_6	7.2464	0	0	10.8216	-14.4060	-3.6620
13 Q_7	0	0	0	0	24.9486	-23.0256
14 Q_8	0	0	0	0	0	5.8554
15 Q_9	0	0	0	0	0	0
16 Q_10	0	0	7.3065	0	0	0
17 Q_11	0	7.4943	0	0	0	0

Iteration Number 3 Jacobian:
JTable = 17×17 table

...

	$delta_2$	$delta_3$	$delta_4$	$delta_5$	$delta_6$	$delta_7$
1 P_2	59.1939	0	0	0	-59.1939	0
2 P_3	0	62.0471	0	0	0	0
3 P_4	0	0	59.5177	0	0	0
4 P_5	0	0	0	101.3844	-39.4132	0
5 P_6	-59.1939	0	0	-38.0634	192.0894	-94.8321
6 P_7	0	0	0	0	-92.1279	108.8595
7 P_8	0	0	0	0	0	-15.9653

	$delta_2$	$delta_3$	$delta_4$	$delta_5$	$delta_6$	$delta_7$
8 P_9	0	0	0	0	0	0
9 P_10	0	0	-59.5177	0	0	0
10 P_11	0	-62.0471	0	0	0	0
11 Q_5	0	0	0	-4.0635	-2.8751	0
12 Q_6	6.9933	0	0	10.6227	-13.4428	-4.1732
13 Q_7	0	0	0	0	22.8692	-20.6724
14 Q_8	0	0	0	0	0	5.4665
15 Q_9	0	0	0	0	0	0
16 Q_10	0	0	6.9950	0	0	0
17 Q_11	0	7.1920	0	0	0	0

Iteration Number 4 Jacobian:

JTable = 17×17 table

...

	$delta_2$	$delta_3$	$delta_4$	$delta_5$	$delta_6$	$delta_7$
1 P_2	58.8549	0	0	0	-58.8549	0
2 P_3	0	61.8842	0	0	0	0
3 P_4	0	0	59.1799	0	0	0
4 P_5	0	0	0	100.8691	-39.0748	0
5 P_6	-58.8549	0	0	-37.7096	190.0235	-93.4590
6 P_7	0	0	0	0	-90.7375	107.0731
7 P_8	0	0	0	0	0	-15.5496
8 P_9	0	0	0	0	0	0
9 P_10	0	0	-59.1799	0	0	0
10 P_11	0	-61.8842	0	0	0	0
11 Q_5	0	0	0	-4.0129	-2.9865	0
12 Q_6	6.9997	0	0	10.6650	-13.2670	-4.3977
13 Q_7	0	0	0	0	22.8173	-20.4812
14 Q_8	0	0	0	0	0	5.5247
15 Q_9	0	0	0	0	0	0
16 Q_10	0	0	6.9998	0	0	0
17 Q_11	0	7.1900	0	0	0	0

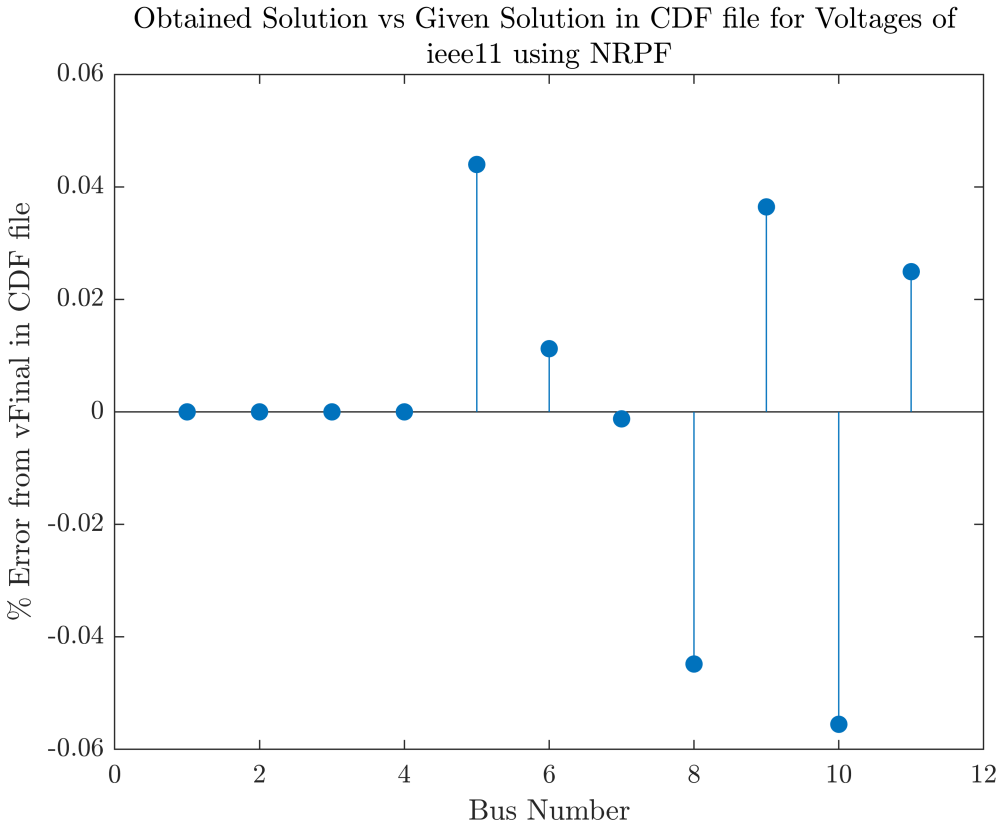
Convergence using NRPF achieved in 4 iterations.

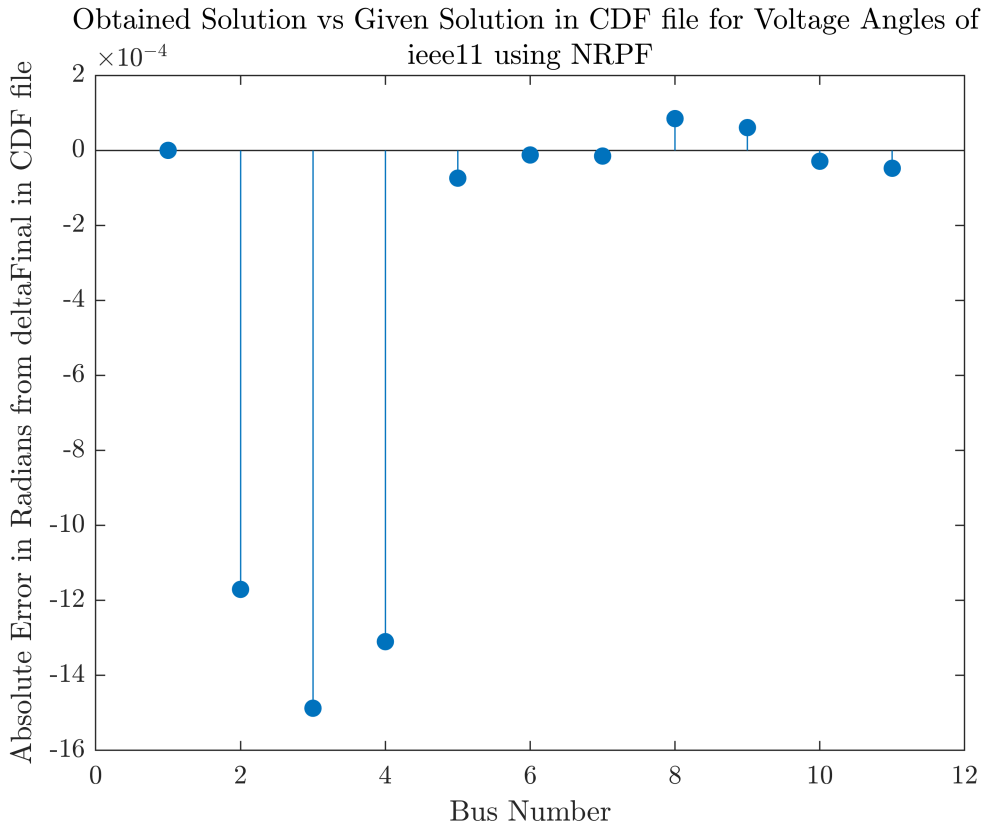
resultTable = 11×4 table

	P	Q	V	delta
1 Bus_1	6.9995	1.8469	1.0300	0
2 Bus_2	6.9997	2.3389	1.0100	-0.1705

	P	Q	V	delta
3 Bus_3	7.1900	1.7571	1.0300	-0.4727
4 Bus_4	6.9998	2.0139	1.0100	-0.6506
5 Bus_5	-0.0009	0.0003	1.0064	-0.1128
6 Bus_6	-0.0023	0.0010	0.9781	-0.2889
7 Bus_7	-9.6703	-0.9983	0.9610	-0.4356
8 Bus_8	0.0003	0.0022	0.9486	-0.6778
9 Bus_9	-17.6648	-0.9988	0.9714	-0.9152
10 Bus_10	-0.0009	0.0007	0.9835	-0.7683
11 Bus_11	-0.0001	0.0001	1.0083	-0.5884

Compare obtained snapshot values of V_i and δ_i against the ones given in the CDF file.





Economic Dispatch and Optimal Power Flow Calculations:

```
Elapsed time is 1.376304 seconds.
```

Have a nice day!

In case you encounter a Java Heap Memory error, delete the above gif, or go to `Preferences->General->Java Heap Memory` and increase the allocated size.