

Numerical Stability of Power Flow Analysis

Lab 1

EEEN50100 - Stability Analysis of Nonlinear Systems

Exercises

1. Solve the power flow analysis of the IEEE 14-bus system without enforcing reactive power limits of PV and slack generators for different loading levels and determine the maximum loading level at which a solution can be obtained.
2. Solve the power flow analysis of the IEEE 14-bus system (enforcing reactive power limits of PV and slack generators) for different loading levels and determine the maximum loading level at which a solution can be obtained.
3. Discuss whether the maximum loading conditions obtained in the previous exercises correspond to a numerical issue or are actually related to saddle-node or limit-induced bifurcations.

Data File

Use the file `ieee14_static.dm` that can be found in the collection of data files on the module website.

Hints

- To modify the loading level use the macro `ALTER` in the input file. For example:

```
ALTER, PQ, MUL, *, p, 1.2
ALTER, PQ, MUL, *, q, 1.2
ALTER, PV, MUL, *, pg, 1.2
```

In the example above, all load power consumption as well as all PV generator active power productions are scaled by a factor 1.2.

- Use `Settings.forcepq = True` and `Settings.distrsw = False` for all exercises.

- While solving Exercise 1, be sure that no reactive power limit of the static generators is enforced. With this aim, either enlarge `qmax` of PV and Slack generators or be sure that the option `PF.pv2pq` is set to `False`.
- While solving Exercise 2, be aware that enforcing reactive power limits using the option `PF.pv2pq = True` may lead to numerical issues or may provide “sub-optimal” solutions depending on the value of the option `PF.invpq`. Try different values of `PF.invpq` (e.g., 1, 2, 3) to define the best solution (i.e., the one that shows minimum losses).
- A conclusive answer to the question posed in Exercise 3 can be obtained only by means of a continuation power flow analysis. However, one can try different power flow solution methods close to the maximum loading condition point to see whether more robust power flow solver are able to find solutions with higher loading conditions. Among available options of the power flow solver (option `PF.solver`), try to use standard Newton-Raphson’s method `"NR"` (default), continuous Newton’s method `"RK6"`, robust Newton-Raphson’s method `"Robust"` and Optimal Newton-Raphson’s method for polar coordinates `"Braz"`.