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JUPYTER NOTEBOOK: A TOOL FOR RESEARCHING AND DESIGNING POWER SYSTEMS

In the context of rapidly evolving demands for reliability, efficiency, and sustainability in power systems, researchers and engineers need an integrated tool for modeling, analysis, and data visualization. Such a tool should enable the resolution of tasks like distributing loads and voltages across electrical networks; analyzing power losses in lines; assessing system stability under various operating conditions; and simulating emergency situations to identify critical nodes in the system.

This tool can be Jupyter Notebook—an open and flexible environment that not only performs calculations but also documents the research process.

Jupyter Notebook has several features that make it an appealing instrument for researching and designing power systems.

Interactivity and Instant Feedback:

- it allows code to be executed by cells, enabling users to immediately observe the results of numerical computations.
- provides dynamic adjustment of model parameters, which is important for modeling transient processes and analyzing network stability.

Users can write and execute code in segments, experimenting with data and algorithms in real time. This approach facilitates the prompt testing of it and rapid feedback from the model.

Integration of Research in a single document:

- combining mathematical models with the implementation of computational code deepens the understanding of the decisions made;
- the use of LaTeX for formatting formulas and Markdown for structuring text makes the content easy to read and ideal for creating presentations;

Integration with Python Libraries, among the most important of these libraries is Pandapower – a specialized library for the analysis, modeling, and optimization of electrical networks. Pandapower enables the modeling of network components such as buses, lines, transformers, generators, loads, and power sources. All components are defined through a user-friendly API, allowing for flexible formation of the network topology. It performs calculations of voltage distribution, currents, active and reactive power throughout the network, and evaluates network performance under steady conditions. Pandapower is capable of executing short-circuit current calculations, applying optimization tools, power loss compute, and determining economically efficient operating modes by it.

Pandapower also provide visualization of the electrical network. Its pandapower.plotting subsystem can quickly display network schematics, simplifying the analysis of network design and simplified comparisons of various alternatives.

Furthermore, libraries such as NumPy, Pandas, and Matplotlib solve a broad range of additional tasks related to the research and design of power systems. These tasks include solving mathematical problems using numerical methods, processing statistical data and data from external sensors, and visualizing data.

Thus, the combination in Jupyter Notebook of the extensive capabilities of Pandapower, NumPy, Pandas, Matplotlib, and the Python programming language itself opens up vast opportunities for:

- laboratory work and research projects, interactive analysis, visualization, and scenario-based studies;
- collaborative research through the joint editing of Jupyter Notebook documents, data sharing among students, postgraduates, and engineers, with fully documented experiments that foster creative and interdisciplinary projects;
- enhanced professional training by mastering modern modeling tools for applied engineers, thereby developing skills for designing and maintaining high-tech power infrastructure;
- pursuing innovative solutions by applying machine learning and optimization algorithms;
- creating intelligent control systems that ensure the network operates stably in real time.

As a result, utilizing Jupyter Notebook for the research and design of power systems, with the incorporation of the Pandapower library – represents a powerful means for conducting both analytical and experimental studies, integrating theoretical formulations, programming code, and visual interpretations into one document.