Fundamentals of Power Systems, 2021

**General description of mini-projects**

Every mini-project should cover the items listed with each one.

Each report should have journal paper format (e.g., IEEE) and **the maximum length of 10 pages**.

Recommended software: Julia (+ JuMP), Matlab

2-3 persons should form a group.

Groups should send me an email ([d.pozo@skoltech.ru](mailto:d.pozo@skoltech.ru)) or TA (Telegram) with the list of team members and project chosen **before** **November 14**: first come, first served.

Groups can select their own topic. If so, they should send me an email with title, description of the topics to cover, and reason of why it is relevant with the course before deadline.

Skill under 5 means basic knowledge. Skill over 8 is advance knowledge.

**Requirements for mini project reports and presentations**

For each of the mini projects, you are required to prepare a technical report and a presentation. The total allocated to the miniprojects is 30% of the final mark with 15% for the report and 15% for the presentation. The technical report should be maximum 10 pages long (excluding the list of references). Do not "copy and paste” from the sources - it amounts to plagiarism. You are supposed to read sources and describe what you’ve read using your own words – this engages your brain as opposed to “copy and paste” that engages only your fingers. All reports will be checked using anti-plagiarism software. In literature survey, we expect a minimum of 10-15 papers or reports being referenced.

The presentation must be max 15 mins long followed by 5 mins of discussion. All members of the team are required to present sharing the presentation approximately equally between them. You will be assessed on the quality of the presentation itself (i.e. the quality of slides and delivery) and the content. Please avoid overcrowded slides, with graphs and diagram difficult to read.

What thing should you report:

- **State of the art on your problem**. The closest publications and motivation related to your project.

- **Methodology/algorithm** for dealing with the problem.  What kind of approach are you choosing for dealing with the particular problem that you are addressing?

- **Case study.** You need to validate the proposed methodology. Thus, it is necessary to include a small case study where you provide results and insights on the particular problem that you are working with.

- **Conclusions**.

What thing should not be at the report:

- **Code**. It is very likely that you will need to implement methods or algorithms for solving a case study. Code should not be at the report. If you want to attach, you can use a different file.

- **Numerous figures/tables**. At solving your case study, you may find many possible ways of showing input data/results. Try to be concise and show what are the main outcomes of your study.  If you need to add extra information related to data/results, you can use another companion document with data/results.

How will be evaluated:

- Quality of the report [40%]

- Understanding of the problem and ability to interpret it. [50%]

- Originality [10%].

List of mini-projects

1. **Solving AC-OPF by non-conventional Linear power flow (LPF) models**

Power systems usually are dealing with large optimization problems. Solving them are challenging. At the same time, there are trends on limiting the data shared among participants, such as communities in power grids or different interconnected regions.

1. State-of-the art of the most common linear power flow optimization models.
2. Selection of 2 models.
3. Modeling a small case study

Skills: Modeling [8/10], Programming [7/10], Topics from the course [6/10]

**2) Power Grid in Mars**

What would be the best design? What make it very special? AC/DC Hybrid Microgrids?

a. Problem description. State of the art.

b. Modeling a microgrid in Mars.

c. Implementation.

d. Resolution, analysis and conclusions.

Skills: Optimization [6/10], Programming [6/10], Topics from the course (Electrical E.) [9/10].

**3) Smart charging V1G and V2G. (1 projects)**

a. Classification V1G and V2G solutions

b. Describe the use of batteries for smart charging.

c. Model battery and use for smart charging.

d. Implement a case study.

e. Resolution, analysis and conclusions.

Skills: Simulation [5/10], Optimization [5/10], Programming [6/10], Topics from the course [8/10]

**4) Battery models**

Batteries are a good alternative to conventional generators for providing services for the electric grid. There are some countries that have been implemented mechanisms for compensating batteries that provides regulation services. However, there is a tradeoff between the use of the batteries and its degradation.

a. Classification of batteries degradation according to the charge/discharge profile.

b. Model battery degradation (1- 2 degradation models).

c. Implement a case study.

d. Resolution, analysis and conclusions.

Skills: Simulation [5/10], Optimization [5/10], Programming [6/10], Topics from the course [8/10]

**5) Reliability estimation**

Modern power grids tend to empower their renewable energy penetration due to the state regulations driven by either socal, economical or ecological reasons. Generators that draw energy from renewable sources often bring instability to the whole system: changes in frequency, generation: both active and reactive and other disturbances. It is important that such disturbances can exceed operating limits, e.g., generation limits, phase angle difference and lead a system to a blackout with huge capital losses.

In this project we are to implement an algorithm that will allow one to assess the probability of violating an operating limit for a high-voltage power system.

The outcomes/steps of this project are

1. Make an acquaintance with the [PowerModels.jl](https://lanl-ansi.github.io/PowerModels.jl/stable/) package – developed by a group of researchers from Los Alamos National Laboratory, it is a great package for studying power (and not only power) grids.
2. Learn how to interact with PowerModels.jl, extract information required from the power grid cases
3. Implement an algorithm that estimates the probability of being out of a safe region using Monte-Carlo methods
4. Make an acquaintance with common distributions for fluctuations, analyze the difference in system’s stability with different distributions

**Skills:** Math [8/10], Programming [9/10], Topics from the course [7/10]

Working program

**Week 1. Select two papers/reports. November 19.**

* Why did you choose this paper?
* What is the main connections with your topic?
* Why do you think it is relevant?
* What are the gaps / limitations that authors have rose in this paper?
* Could you state in math form this problem?
* What are the next step that you think that you could work?

**Week 2. Formal definition of the problem (e.g. abstract), and formal definition of the methodology approach. Preliminary results.** **November 26.**

**Week 3. Extended simulations. Analysis of results. December 3.**

**Week 4. Closing your project. Final presentation December 10.**

**Week 5. Reporting. December 15.**