**Analysis of Modern Converter-based power systems** **Activity 0**

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## Session description

This homework deals with the basic understanding of Voltage Source Converters (VSCs). Students will learn the fundamentals of VSC power converters by means of simple simulation models. Base models to process the problems will be provided in Matlab 2022b version.

## Deliverable report

- Prepare a report (preferably in LaTeX) answering the different questions raised in each of the problem sections.
- Please structure the report, so that it is simple to follow the answers to each of the problems.
- Provide graphical evidence or equations to support your answers to each of the problems.
- Deliver the report, together with the models and scripts created during the homework.
- We will work on this Homework in class.

## Problems

- In the following pages you will find the activity problems to address

**Tasks to complete - Model analysis guide**
Please complete the following simulations and study the results.

**Problem 1**
Open the file 'Script_Clarke_3D_Base.m' and proceed with the following tasks:

- Understand the link between abc-$\alpha\beta$ in time domain
- Understand the abc-$\alpha\beta$ in the 3D cubic representation
- Add harmonics and observe the impact both in time domain and in the 3D view

**Problem 2**
Open the file 'Model0_PWM_Base.slx' and proceed with the following tasks:

- Study how the modulation is implemented
- Observe the voltage applied by the converter (without filtering it)
- Observe the voltage applied by the converter (filtering it)
- Apply the phase different and observe the impact on the: grid voltage, converter voltage and network current

**Problem 3**
Open the file 'Model1_Clarke_Park.slx' and proceed with the following tasks:

- Observe the Clarke transformation application in time domain ($\alpha\beta 0$)
- Observe the Park transformation application in time domain ($qd0$)
- Check that Clark is a Park transformation without rotation
- Apply an angle shift and observe the impact

**Problem 4**
Open the file 'Model2_PLL.slx' and proceed with the following tasks:

- Change the phase and amplitude of the grid voltage
- Apply a phase jump to the $abc$ voltage generator and observe how the PLL is tracking the angle
- Apply a phase jump changing the PI controller parameters
- Change the amplitude of one of the phases individually and observe the impact on the $qd0$ magnitudes

**Problem 4**
Open the file 'Model3_CurrentLoop.slx' and proceed with the following tasks:

- Revise how the current control operates
- Change the current step changes in $qd$
- Change the parameters of the current loop (PI controllers)
- Disconnect the decoupling and observe the impact on the currents

**Problem 5**
Open the file 'Model4_Refcalculation1.slx' and 'Model4_Refcalculation2.slx' and proceed with the following tasks:

- Change the active and reactive power set-points
- Change the control parameters of the PQ controllers

**Problem 6**
Create a complete model of a converter including PLL, current control and PQ reference control.