# Master 2 internship

# Optimal 4 quadrants Power Control of prosumer-Grid connected

## Environment

Laboratory : Laboratoire Génie de Production  Supervisor : Mohamed KOUKI/Baptiste TRAJIN

Website : https://www.enit.fr/fr/recherche.html

Research group e-ACE² : https://www.lgp.enit.fr/fr/composition-des-equipes-2/departement-scientifique-systemes.html

## Application deadline : January 15, 2024 0 :00 am

## Keywords

AC Prosumer, Renewable Energy Sources, Hardware in the loop, Advance control, Optimization

## General context

Renewable energy plays an import role for a net-zero emission. According to the latest report by the International Energy Agency (IEA), two third of energy production should be renewable by 2050. To achieve this goal, several challenges should be met, such as controlling the electrical quantities generated from renewable energy sources. Hence the need to design a control strategy that should be robust yet simple enough to be computed on an on-board real-time digital target. To this end, we propose in this project an exhaustive approach start from the modeling of a complex and non-linear system up to its robust control (LQR) strategy based on optimization techniques. This strategy will be compared with other control techniques (vector control, $H_\infty$, etc.). Validation will be performed in simulation under MATLAB. Real-time validation (Hardware in the Loop) will also be provided.

## Expected contribution

The internship can be structured into main complementary activities. These activities consist mainly of:

- Bibliography overview regarding the structure of the prosumer grid-connected, the optimization techniques and the conventional control strategies of converter grid-connected.
- Definition of the system dynamics regulation scheme.
- Formulation of the optimization problem by highlighting the objectives and constraints.
- Computing of LQR control parameters using optimization algorithms. For the validation of the results obtained, other optimization algorithms will be used. Also, other control methods will be used such as vector control and the classic H_∞ control.
- Real-time validation (Hardware in the Loop) of the proposed methodology using STM32 microcontroller.

## Required Skills

The candidate must fit the following requirements:

- Registered in Master 2 in Electrical Engineering.
- Good skills in modeling and control of DERs are mandatory.
- Good skills in MATLAB (Simscape Toolbox) are mandatory.
- Good Skills in optimization techniques.
- Good skills in Embedded systems.

The candidate must also have a good English-speaking level and qualities of written and oral communication and synthesis in English and in French.

## How to apply

All applications must be sent by email (CV + cover letter, optional M1 transcript) at mkouki@enit.fr / baptiste.trajin@enit.fr At the end of the application phase (end of receipt of applications on January 15, 2024, 0 :00 am), an audition will take place between 16/01 and 23/01.

## Internship progress

The internship will last 5 months (6 months possibility). The bonus will be paid monthly and will correspond to the hourly bonus rate of €3.90 per hour of internship. The monthly bonus will be calculated on a pro rata basis of days worked, with the following calculation: 1 day = 7 hours.

The start of the internship is possible from February 2024.

There are three exercise sites located in the same city but approximately 5 km apart :

- Laboratoire Génie de Production (LGP), Ecole Nationale d'Ingénieurs de TARBES, 47 Avenue d'AZEREIX, 65000 TARBES, France.
- Plateforme PRIMES, 67 Boulevard Pierre Renaudet, 65000 Tarbes, France.

## References

[1] Zhao, W., Zhang, Z., Mirjalili, S., Wang, L., Khodadadi, N., & Mirjalili, S. M. (2022). An effective multi-objective artificial hummingbird algorithm with dynamic elimination-based crowding distance for solving engineering design problems. Computer Methods in Applied Mechanics and Engineering, 398, 115223.

[2] Ilchi Ghazaan, M., Ghaderi, P., & Rezaeizadeh, A. (2023). A fast convergence EO-based multi-objective optimization algorithm using archive evolution path and its application to engineering design problems. The Journal of Supercomputing, 1-37.

[3] Kouki, M., Marinescu, B., & Xavier, F. (2020). Exhaustive modal analysis of large-scale interconnected power systems with high power electronics penetration. IEEE Transactions on Power Systems, 35(4), 2759-2768.

[4] W. Borutzky, Bond graph methodology - Development and analysis of multidisciplinary dynamic system models, Springer, 2010