



NATIONAL PH.D. PROGRAM IN AUTONOMOUS SYSTEMS

Modelling, control, and optimisation of electrical smart grids

Ph.D. candidate

Sajjad Miralizadeh Jalalat

Cycle

XXXIX

Tutors

Prof. Alberto Cavallo

Dr. Antonio Russo

1. Description of the research program

This Ph.D. research project aims at the study, design and development of nonlinear control and optimization strategies, possibly coupled with AI/Machine Learning techniques, aimed at power management of electrical smart grids. The smart grids, comprising of multiple agents acting as power sources and/or loads, will be modeled according to the framework of switched and hybrid dynamical systems. Control algorithms will be designed to regulate the power flow both on the local level of the single agent and on the hierarchically higher level to allow the implementation of desired power management policies. A possible applicative scenario is that of the so-called “More Electric Aircraft”, that aims at traditional aircraft electrification through replacement of hydraulic and pneumatic devices with their electric counterpart. The increased number of electric and electronic devices onboard calls for the need of automated control algorithms aimed at achieving specific power management policies. Hence, innovative, possibly optimal, power management algorithms need to be implemented to contemporarily guarantee the achievement of the control goal and the safety of the aircraft micro grid.

2. Schedule of the research activities

First academic year (planned)

	Description	Period	Activity abroad
Background study	Individual Research and literature review on Machine Learning techniques, aimed at power management of electrical smart grids.	23/24 T1-T6	NO
Problem Statement	Problem formulation and evaluation of the methodologies, techniques, and theoretical tools to be adopted and developed for future research activities.	23/24 T7-T12	NO

Second academic year (planned)

	Description	Period	Activity abroad
Further background study and proposed solutions.	Individual Research and literature review on Machine Learning techniques, aimed at power management of electrical smart grids. Development of ad-hoc control algorithm for power management of smart grids.	24/25 T1-T6	NO
Simulation and experimental tests	Abroad research period at the Institute for Aerospace Technology of the University of Nottingham (UK). Design of simulation environment. Experimental tests and validation of the theoretical results.	24/25 T7-T12	YES

Third academic year (planned)

	Description	Period	Activity abroad
Simulation and experimental data evaluation	Evaluation of the obtained simulation and experimental results. Participation to conferences and seminars.	25/26 T1-T6	NO

Thesis writing	Drafting of conference and journal articles. Drafting of the Ph.D. thesis.	25/26 T7-T12	NO
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3. Training and research activities plan

First academic year (planned)

	Description	Period	Final Exam	ECTS
A. Ph.D. courses	Course 08: Introduction to Optimal Linear Quadratic Control	Second Semester 23/24	Yes	2
	Course 02: Control for Optimization	November-December 2023	Yes	1
	SIDRA Summer School	July 24	Yes	3
B. Master's degree courses	Multivariable Feedback Control	First Semester 23/24	Yes	6
	Robust Control	Second Semester 23/24	Yes	6
C. Soft skill courses				
D. Participation to seminars				
E. Participation to international congresses or workshops				
F. Presentation of research products at international congresses or workshops	AUTOMATICA.IT SIDRA 2024	September 2024		5
	TOTAL OF ECTS FOR TRAINING ACTIVITIES			23
G. Individual research activity	Individual Research and literature review on Machine Learning techniques, aimed at power management of electrical smart grids			27
H. Supervision of students				
I. Integrative teaching activities				
J. Preparation of manuscripts for conferences or journals	Preparation of manuscripts for conferences or journals			10
	TOTAL OF ECTS FOR RESEARCH ACTIVITIES			37
	TOTAL OF ECTS			60

Second academic year (planned)

	Description	Period	Final Exam	ECTS
A. Ph.D. courses	EECI M18 DUBROVNIK, Control and Machine Learning Enrique Zuazua		Yes	3
	Course 04: Intelligent Control Systems		Yes	2

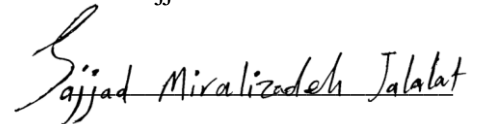
B. Master's degree courses	Identificazione e Controllo dei Processi	First Semester 24/25	Yes	9
C. Soft skill courses				
D. Participation to seminars				
E. Participation to international congresses or workshops				
F. Presentation of research products at international congresses or workshops	AUTOMATICA.IT SIDRA 2025	September 2025		5
	TOTAL OF ECTS FOR TRAINING ACTIVITIES			22
G. Individual research activity	Individual research activity on Machine Learning techniques, aimed at power management of electrical smart grids			19
H. Supervision of students				
I. Integrative teaching activities				
J. Preparation of manuscripts for conferences or journals	Preparation of manuscripts for conferences or journals			19
	TOTAL OF ECTS FOR RESEARCH ACTIVITIES			38
	TOTAL OF ECTS			60

Third academic year (planned)

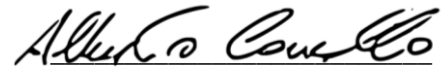
	Description	Period	Final Exam	ECTS
A. Ph.D. courses				
B. Master's degree courses				
C. Soft skill courses				
D. Participation to seminars				
E. Participation to international congresses or workshops				
F. Presentation of research products at international congresses or workshops	AUTOMATICA.IT SIDRA 2026	September 2026		5
	European Control Conference 2026	June/July 2026		5
	TOTAL OF ECTS FOR TRAINING ACTIVITIES			10
G. Individual research activity	Individual research activity on Machine Learning techniques, aimed at power management of electrical smart grids			25
H. Supervision of students				

I. Integrative teaching activities				
J. Preparation of manuscripts for conferences or journals	Preparation of manuscripts for conferences or journals			25
TOTAL OF ECTS FOR RESEARCH ACTIVITIES				50
TOTAL OF ECTS				60

Sajjad Miralizadeh Jalalat



Alberto Cavallo, Full Professor



Antonio Russo, RTD-A

