PhD in Information Technology and Electrical Engineering
Università degli Studi di Napoli Federico II

PhD Student: Antonio Di Pasquale

Cycle: XXXVI

Training and Research Activities Report

Year: First

Tutor: prof. Mario Pagano

Date: October 21, 2021

1. Information:

- **PhD student: Antonio Di Pasquale**
- **DR number: DR995136**
- **Date of birth: 13/06/1995**
- **Master Science degree: Electrical Engineering**
- **University: University of Cassino and Southern Lazio**
- **Doctoral Cycle: XXXVI**
- **Scholarship type: UNINA**
- **Tutor: Prof. Mario Pagano**
- **Co-tutor: /**

2. Study and training activities:

Activity	Type[1]	Hours	Credits	Dates	Organizer	Certificate[2]
Probability Calculus and Elements of Stochastic Modelling	**Course**	**24**	**6**	**10/11/2020 – 17/12/2020**	**Prof. Massimiliano Giorgio (MERC)**	**Y**
Numerical Treatment of PDEs	**Course**	**24**	**6**	**11/01/2021 – 17/02/2021**	**Prof. Francesco Calabrò (MERC)**	**Y**
Scientific Programming and Visualization with Python	**Course**	**20**	**2**	**08/03/2021 – 10/03/2021**	**DiSt department - Scuola Politecnica e delle Scienze di Base - UNINA**	**Y**
Matrix Analysis for Signal Processing with MATLAB Examples	**Course**	**8**	**2**	**20/04/2021 – 28/04/2021**	**Proff. Antonio De Maio, Augusto Aubry, Dr. Vincenzo Carotenuto - ITEE-DIETI**	**Y**
Teoria dei Sistemi* (recorded lessons) * Waiting to take the exam	**Course**	**-**	**9**	**01/08/2021 – 15/09/2021**	**Prof. Gianluca Antonelli (UNICAS)**	**N**
European PHD School 2021: Power Electronics, Electrical Machines, Energy Control and Power	**Doctoral School**	**-**	**4**	**12/07/2021 – 16/07/2021**	**Prof. Giuseppe Tomasso (UNICAS)**	**Y**

Systems						
Patent Searching Best Practices with IEEE Xplore	**Seminar**	**1**	**0.2**	**27/11/2020**	**Dr. Eszter Lukacs (IEEE)**	**Y**
How to Get Published with IEEE	**Seminar**	**1.5**	**0.3**	**02/12/2020**	**Dr. Paul Henriques (IEEE)**	**Y**
Modellistica dinamica di una rete elettrica zonale di distribuzione in corrente continua	**Seminar**	**1**	**0.2**	**24/02/2021**	**Prof. Giorgio Sulligoi (AEIT)**	**N**
Introduction to Underwater Robotics	**Seminar**	**2**	**0.4**	**18/06/2021**	**Dr. Fabio Ruggiero - DIETI - Unina**	**Y**
21 MATLAB Features You Need Now	**Seminar**	**1.5**	**0.3**	**28/09/2021**	**Dr. Loren Shure (MathWorks)**	**N**
MATLAB for Analyzing and Visualizing Geospatial Data	**Seminar**	**2**	**0.4**	**29/09/2021**	**Dr. Loren Shure (MathWorks)**	**N**
Deep Learning Overview for Signals and Time Series	**Seminar**	**2**	**0.4**	**30/09/2021**	**Dr. Loren Shure (MathWorks)**	**N**
Qiskit: state of the art and tools for Quantum Computers from IBM	**Seminar**	**2**	**0.4**	**15/10/2021**	**Prof. A. S. Cacciapuoti, DIETI - Unina**	**N**
SAR Polarimetry: Theory, Machine Learning & Applications	**Seminar**	**2**	**0.4**	**19/10/2021**	**Prof. A. Iodice, DIETI - Unina**	**Y**

1) Courses, Seminar, Doctoral School, Research, Tutorship
2) Choose: Y or N

2.1. Study and training activities - credits earned

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	**6**	**0.5**	**5**	**0**	**11.5**
Bimonth 2	**6**	**0.2**	**5**	**0**	**11.2**
Bimonth 3	**4**	**0**	**6**	**0**	**10**
Bimonth 4	**0**	**0.4**	**9.6**	**0**	**10**
Bimonth 5	**4**	**0**	**3**	**0**	**7**
Bimonth 6	**0**	**1.9**	**8.4**	**0**	**10.3**
Total	**20**	**3**	**37**	**0**	**60**
Expected	**30 - 70**	**10 - 30**	**80 - 140**	**0 – 4.8**	

3. Research activity:

Nowadays, environmental pollution represents one of the most pressing problems facing society. Several studies reveal that in urban areas poor air quality has become a major problem. In this context, energy and environmental sustainability in transportation have received a great deal of attention in recent years. According to many studies, the transport sector accounts for 24% of global CO_2 emissions, 29% of global energy demand and 65% of the world total oil consumption [1]. Therefore, electrified railway systems and electrical vehicles play an important role in contributing to the reduction of energy consumption and CO_2 emissions compared with other transport modes.
Hence, the concept of sustainable mobility is increasingly attracting political, economic and scientific interest on a global scale. The goal of sustainable mobility is to reduce the environmental impact of the transportation sector by improving the efficiency across the whole transport system, (i.e., rail, road and waterborne transport).

My research activity fits into this context, focusing the attention on the following main aspects:

i. Optimal strategies for railway systems;
ii. Ultra-fast charging infrastructures for Plug-in Electrical Vehicles (PEV).
iii. Power Forecasting

3.1. Optimal strategies for railway systems

This activity focuses main attention on the Eco-Driving techniques. Eco-driving is the name given to the wide range of train driving techniques intended to reduce economic and environmental impact due to the motion of trains. In other words, these techniques operate to optimize trains speed profile to minimize the traction energy consumption, thus the impact on the primary grid, in the respect of the timetable constraints [2]. The aim of train driving optimization is to find the most effective driving control by coordinating acceleration, cruising, coasting, and braking. Eco-driving approaches are based on analytical or numerical algorithms. Models can be continuous, discrete or hybrid. The numbers of variables and constraints involved in the model can vary (e.g., time, space, acceleration, speed, assigned running time, and maximum acceleration).
Therefore, this activity studied solutions that could provide an improvement of railway systems both in terms of sustainability and efficiency. Solutions not necessarily require huge financial investments, but in some cases they are related to alternative scheduling system.

3.2. Ultra-fast charging infrastructures for Plug-in Electrical Vehicles (PEV)

The growing development of the electric vehicle market places the emphasis on the need to have technologically efficient and widespread charging infrastructures throughout the territory. One of the main topics about electrification of mobility is that the diffusion of Ultra-fast

charging stations (UFCS) must increase in order to make the EVs market more attractive, by reducing EV charging times [3].
Typically, UFCS are equipped with Energy Storage Systems (ESSs) and by Renewable Energy Sources (RESs), in order to reach high power without undue stress on the power grid. Therefore, UFCS looks like a micro-grid where renewable, storage and grid power flows move in a Low Voltage (LV) distribution system in order to supply varying electrical loads.
This activity focused on the management of Ultra-fast charging stations, with particular attention to the scheduling of the recharge of more vehicles simultaneously. The aim is to assess optimal strategies for the recharge of EVs, taking into account more constraints, among which the maximum power available from the UFCS and the residual energy available from the ESS, in order to ensure an optimal management both the infrastructure and the grid.

3.3. Power forecasting

Whilst RESs are the main tool to safeguard the environment, they pose some issues from a technical point of view. Indeed, the uncertainty related to their nature represents a hard challenge for Transmission System Operators (TSOs) and Distribution System Operators (DSOs), in order to manage the electric balance between power demand and supply and to improve the penetration of distributed renewable energy sources [4].
Therefore, in order to deal with the problem of RESs' not predictable nature, Power forecasting methods are drawing more and more attention. The technical literature provides a wide proposal of methods, that are typically classified in the following main classes:

i. Statistical methods, including, for instance, Auto-Regressive (AR), Autoregressive Integrated Moving Average (ARIMA) methods;
ii. Artificial Intelligence (AI) methods, including Artificial Neural Networks (ANNs);
iii. hybrid methods [5].

Whilst statistical methods are the most popular for historical reasons, the Artificial Intelligence ones, thanks to their ability to work with complex non-linear problems, are of increasing interest in the research.
Thus, this activity is studying the effectiveness of AI methods for accurate forecasts in power systems, with special regards to the case of RESs.

***References**:*

[1] S. Solaymani, ‘‘CO2 emissions patterns in 7 top carbon emitter economies: The case of transport sector,’’ Energy, vol. 168, pp. 989–1001, Feb. 2019, doi: 10.1016/j.energy.2018.11.145.
[2] Z. Tian, N. Zhao, S. Hillmansen, C. Roberts, T. Dowens and C. Kerr, “SmartDrive: Traction energy optimization and application in rail systems,” IEEE Transactions on Intelligent Transportation Systems, vol. 20, pp. 2764-2773, 2019.

[3] D. Christen, F. Jauch and J. Biela, "Ultra-fast charging station for electric vehicles with integrated split grid storage," 2015 17th European Conference on Power Electronics and Applications (EPE'15 ECCE-Europe), 2015, pp. 1-11, doi: 10.1109/EPE.2015.7309322.
[4] Grimaccia, F., Leva, S., Mussetta, M., & Ogliari, E. G. C. (2014). Analysis and validation of ANN PV power output forecasting at 24 hours ahead. In ELECTRIMACS 2014 (pp. 1-6).
[5] M. Abdel-Nasser and K. Mahmoud, "Accurate photovoltaic power forecasting models using deep lst-mrnn,"Neural Computing and Ap-plications, vol. 31, no. 7, pp. 2727–2740, 2019.

4. Research products:

- Andreotti, A., Caiazzo, B., Di Pasquale, A., & Pagano, M. (2021). On Comparing Regressive and Artificial Neural Network Methods for Power System Forecast. *In 2021 AEIT International Annual Conference (AEIT).* IEEE. (**Accepted**)

- Franzese, P., Di Pasquale, A., Iannuzzi, D., & Pagano, M. (2021). Electric Ultra Fast Charging Stations: a Real Case Study. *In 2021 AEIT International Annual Conference (AEIT).* IEEE. (**Accepted**)

- Botte, M., D'Acierno, L., Di Pasquale, A., Mottola, F., & Pagano, M. Performance Improvements of Traction Power Systems by Coordinating the Motion of a Fleet of Metro Trains in terms of Layover Time. In *2021 IEEE Vehicle Power and Propulsion Conference (VPPC).* IEEE. (**Accepted**)

- M. Botte, L. D'Acierno, A. Di Pasquale, F. Mottola, M. Pagano, "Optimal Motion of a Fleet of Rolling Stocks in presence of Traction Power System Constraints", *IEEE Transactions on Vehicular Technology*. (**Submitted**)

- C. Attaianese, A. Di Pasquale, P. Franzese, D. Iannuzzi, M. Pagano, "An Optimal Power Scheduling for Multiple EV Parking Slots of Ultra Fast Charging Station", *IEEE Transactions on Smart Grid.* (**Submitted**)

5. Conferences and seminars attended

***2021 AEIT International Annual Conference*, 4-8 October 2021, online conference.**

- Co-author of the paper presented by Ing. Pasquale Franzese: "*Electric Ultra Fast Charging Stations: a Real Case Study*";
- Presenting author of the paper "*On Comparing Regressive and Artificial Neural Network Methods for Power System Forecast*".

Corso per preparazione Esame di Stato 2021 - Periti Industriali (Problematiche di base concernenti la salvaguardia dell'ambiente ed i consumi energetici)

- Author of two short video lessons about sustainability in residential and transportation sectors.

6. Activity abroad:

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7. Tutorship

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