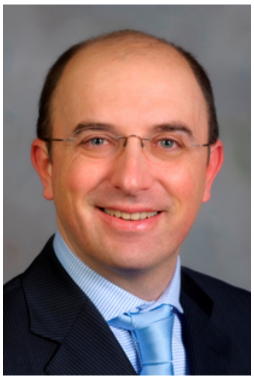
AEIT 2019 Tutorials

Two Tutorials are scheduled in AEIT 2019 on the day preceding the conference, Tuesday, September 17, from 16,00 to 19,00. Attendance is free for AEIT 2019 Delegates.

Tutorial 1
A Power Electronics Control Perspective in AC and Hybrid AC&DC Low-Voltage Smart Microgrids

Small-scale distributed energy sources and storage systems are proliferating in low-voltage grids. Electronic power converters (EPC) are the devices of choice for interfacing such energy resources to the grid and interconnecting different electrical domains. EPCs can process power precisely, promptly, reliably, and efficiently, also giving the possibility of easily scaling the developed solutions by means of modularity and specific control provisions. Thanks to these peculiarities, EPCs can perform a variety of tasks supporting the operation of the electrical systems and even extending the operation of subsections by allowing intentional islanding. Virtually all the advanced functionalities that converters can provide are going to be exploited in smart microgrids, the building blocks of the forthcoming smart grids. To allow this and obtain the expected technical benefits, effective control and monitoring techniques are crucial. The aim of this tutorial is to present the control needs of microgrids and the corresponding functionalities implemented by means of EPCs. After having introduced the microgrid scenario, the problem of coordinating distributed EPCs in low-voltage grids will be discussed, by also illustrating possible solutions at microgrid level. Then, a focus into the implementation of one of the nodes composing the microgrid will be given. Common kinds of nodes in residential low-voltage grids are the smart buildings, which integrate various kinds of loads, sources, and storage devices that can be of ac as well as dc nature. This is one of the most relevant realms of application of hybrid grids. The control challenges relevant to the grid-tied operation, the autonomous operation, and the transitions between the operation modes will be discussed. The second part of the tutorial will look at several control issues related to the EPC control in dc microgrids, including stability monitoring tools, impedance shaping and tuning of control parameters, droop control, resistive output impedance and reduction of the output capacitance. The effects of control delays due to the digital implementations on the closed-loop output impedance will be also discussed.

Instructors: Paolo Mattavelli, Tommaso Caldognetto - Università di Padova, Italy



Paolo Mattavelli (S'95, A'96, M'00, SM'10, F'14) received the MS degree (with honors) and the Ph. D. degree in electrical engineering from the University of Padova (Italy) in 1992 and in 1995, respectively. From 1995 to 2001, he was a researcher at the University of Padova. From 2001 to 2005 he was an associate professor the University of Udine, where he led the Power Electronics Laboratory. In 2005 he joined the University of Padova in Vicenza with the same duties. From 2010 to 2012 he with the Center for Power Electronics Systems (CPES) at Virginia Tech. He is currently a professor with the University of Padova. His major field of interest includes analysis, modeling and analog and digital control of power converters, grid-connected converters for renewable energy systems and micro-grids, high-temperature and high-power density power electronics. In these research fields, he has been leading several industrial and government projects. His current google scholar h-index is 64. From 2003 to 2012 he served as an Associate Editor for IEEE Transactions on Power Electronics. From 2005 to 2010 he was the IPCC (Industrial Power Converter Committee) Technical Review Chair for the IEEE Transactions on Industry Applications. For terms 2003-2006, 2006-2009 and 2013-2015 he has been a member-at-large of the IEEE Power Electronics Society's Administrative Committee. He also received in 2005, 2006, 2011 and 2012 the Prize Paper Award in the IEEE Transactions on Power Electronics and in 2007, the 2nd Prize Paper Award at the IEEE Industry Application Annual Meeting. He is an IEEE Fellow and Co-Editor in Chief for the IEEE Transactions on Power Electronics.

Tommaso Caldognetto (S'10-M'16) received the M.S. (Hons.) degree in Electronic Engineering and the Ph.D. degree in Information Engineering from the University of Padova, Italy, in 2012 and 2016, respectively. In 2014, he was a visiting Ph.D. student with the Institute for Automation of Complex Power Systems, University of Aachen, Germany. He is currently a research fellow with the Department of Technology and Management, University of Padova. His research interests include control of grid-tied converters, dc and ac microgrids and nanogrids, and real-time simulation for power electronics, in which fields Dr. Caldognetto contributed with

more than 50 conference and journal papers in the last seven years. He is a member of the IEEE Power Electronics Society and the IEEE Power and Energy Society.

Tutorial 2

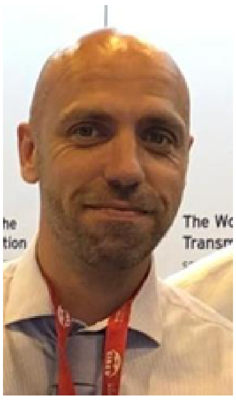
Advances in Protection and Monitoring of HV networks: Time-Domain Protection and Traveling Wave Fault location

In the never-ending search to improve the behavior and benefits of power system protection and monitoring, engineers are constantly improving protective relay safety, speed, security, and dependability. Modern relays are largely phasor-based, which means they can experience delays related to the full-cycle observation window that is required for phasor estimation accuracy. Transients that result from faults occurring on overhead transmission lines travel at lightspeed and spread across the power line as traveling waves. New time-domain line protection operating principles that use incremental quantities and these traveling waves provide ultrahigh- speed tripping, which brings several benefits to the power system and allows for traveling-wave fault location (TWFL). Ultrahigh- speed line protection performs fault detection and line trips in just a couple of milliseconds. On the other end, fast and precise fault location information is critical for the operation and maintenance of electric transmission systems. Knowing the precise fault location reduces the costs of operating and maintaining transmission lines by avoiding long and expensive inspection work on the lines to locate the faulted section. It also allows repairs and transmission line restoration to be carried out quickly, reducing economic losses resulting from the unavailability of the transmission line. Single-end impedance-based fault location is widely used, however, this method is affected by several conditions that can cause fault location inaccuracies, such as zero-sequence mutual coupling, zerosequence modeling errors, system non-homogeneity, system infeeds, current transformer saturation, etc. Nowadays, several methods that are immune to those conditions are available and are easily deployed. Locating faults in real-time on transmission lines with overhead and underground sections (hybrid transmission lines) is very challenging; however, modern technics are capable to locate faults on hybrid lines very accurately and fast, allowing the application of the fault location to release the autoreclose for faults on overhead sections and to block the autoreclose for faults on cable sections.

Outline and Topics:

- How the power system and its assets are affected by the protection tripping time.
- The benefits of fast fault clearing time to the power systems.
- New protection elements based on time-domain and traveling waves.
- Fundamentals and principles of transmission line fault location.
- How the accuracy of traditional impedance based fault location method is affected by different external factors.
- Principles of fault locating based on traveling waves at its application on adaptive autoreclosing control logic to allow or cancel reclosing based on the location of the fault.

Instructor: Giorgio Vielmini - SEL, Italy



Giorgio Vielmini received his degree in electronic engineering from Universita' di Genova, Italy, in 2001. In 2001, he joined Ansaldo Segnalamento Ferroviario as software engineer, in 2004 he joined Sirti as automation Engineer where he was leading a team that developed railway traffic control systems. In 2009, he joined Schweitzer Engineering Laboratories, Inc. (SEL) as a field application engineer, assisting customers in substation protection and automation. In 2017, he was appointed Europe Regional Technical Manager leading the application engineers team.