

Remus Teodorescu received the Dipl.Ing. degree in electrical engineering from Polytechnical University of Bucharest, Romania in 1989, and Ph.D. degree in power electronics from University of Galati, Romania, in 1994. In 1998, he joined Aalborg University, Department of Energy Technology, power electronics section where he currently works as a professor. He has more than 130 papers published, 1 book and 3 patents. He is a Senior Member of IEEE, Associate Editor for IEEE Power Electronics Trans. and chair of IEEE Danish joint IES/PELS/IAS chapter.

He is the founder and coordinator of the Green Power Laboratory at Aalborg University focusing on the development and testing of grid converters for renewable energy systems. He is the coordinator of Vestas Power Program, involving 10 PhD students, 2 Post Doc and guest professors. His areas of interests are: design and control of power converters used in renewable energy systems.

Marco Liserre, received the MSc and PhD degree in Electrical Engineering from the Bari Polytechnic, respectively in 1998 and 2002. From January 2004 he is an assistant professor of the Bari Polytechnic teaching courses of power electronics, industrial electronics and electrical machines. He has worked towards several projects funded by the Italian Minister of Research and by private companies. His research interests are in the control of power converters. He has published 127 technical papers, 28 of them in international peer-reviewed journals, and three chapters of a book. These works have received more than 800 citations. He has been visiting Professor at Aalborg University (Denmark) at Alcala de Henares University (Spain) and Christian-Albrechts University of Kiel, Germany. Dr. Liserre is a senior member of IEEE. He is an Associate Editor of the IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS. He is the Founder and the Editor-in-Chief of the IEEE INDUSTRIAL ELECTRONICS MAGAZINE. He is the Founder and the Chairman of the Technical Committee on Renewable Energy Systems of the IEEE Industrial Electronics Society. He is Associate Editor of the new journal IEEE TRANSACTIONS ON SUSTAINABLE ENERGY starting in 2010. He has received the IES 2009 Early Career Award.

Dr. Liserre will be the Co-Chairman of the International Symposium on Industrial Electronics (ISIE 2010), that will be held in Bari 4-7 July 2010.

Pedro Rodriguez, received the MSc and PhD degree in Electrical Engineering from the Technical University of Catalonia (UPC), Spain in 1994 and 2004, respectively. In 1990, he joined the Electrical Engineering Department, at the UPC, where he is currently an associate professor. Since 1998, he focused his interest on Power Electronics applied to Power Quality Conditioning and Distributed

Energy Systems Integration. Currently, he is leading the Renewable Electrical Energy Systems (REES) research group at the UPC. He stayed as a researcher in the Center for Power Electronics Systems CPES, at Virginia Polytechnic Institute and State University, Blacksburg, VA, USA, and in the IET, Aalborg University, in 2005 and 2006. He has 3 patents about active filtering and authored more than 50 technical papers published in international prestigious journals and conferences

Josep M. Guerrero received the B.S. degree in telecommunications engineering, the M.S. degree in electronics engineering, and the Ph.D. degree in power electronics from the Technical University of Catalonia (UPC), Barcelona, Spain, in 1997, 2000, and 2003, respectively. He is an Associate Professor with the Department of Automatic Control Systems, UPC, where he currently teaches courses on digital signal processing, control theory, microprocessors, DSP/FPGA devices, and renewable energy. Since 2004, he has been responsible for the Renewable Energy Lab, Escola Industrial de Barcelona, UPC. His research interests include photovoltaics, wind energy conversion, uninterruptible power supplies, storage energy systems, and Microgrids. He is a Senior Member of IEEE, Editor of the International Journal of Integrated Energy Systems, and Associate Editor of the IEEE Transactions on Industrial Electronics and the IEEE Transactions on Power Electronics.

Fee

The fee is 12000 DKK for industrial people and 8000 DKK for PhD students from outside Denmark (free for Danish PhD students). The fee includes coffee, lunch for all four days and copy of slides and articles.

Credits 4.0 ECTS (for PhD students)

Registration

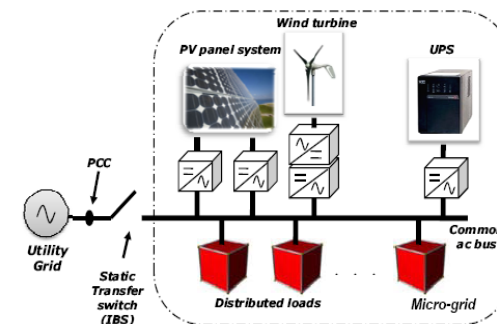
Preferably now and no later than April 18, 2010 by email to: Maria Hald: mha@iet.aau.dk. **25% registration fee reduction** can be achieved in case of registering both Power Electronics for Renewable Energy Systems course 3-6 May 2010 and Photovoltaic Power Systems course 10-13 May 2010 as a package.

Accommodation

For hotel information and booking please check www.iet.aau.dk/phd/phd-courses

Further information

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Industrial/Ph.D. Course in Power Electronics for Renewable Energy Systems – in theory and practice

May 3- 6, 2010



**Department of Energy Technology
Aalborg, Denmark**

Background of the course

There is a rapid development in the area of Distributed Power Generation Systems (DPGS) based on Renewable Energy Sources (RES) like Photovoltaics (PV) and Wind Turbines (WT). Especially for grid-connected DPGS an exponential growth in terms of installation power can be observed mainly due to the subventions given by governmental policies around the world for clean “green” electricity production. Countries like Germany, Denmark, Japan, Spain, Italy, UK and USA have the highest penetration of RES.

The objectives of this course are to learn about the grid converters structure and control for both single-phase and three-phase systems both in power generation like PV and wind turbines connected to the grid. Synchronization and monitoring in both single-phase systems will be covered in details and advanced methods able to cope with distorted grid or grid faults are introduced.

Practical issues related to the design of the control of the converter, grid filter and grid interaction are addressed with experimental validations.

There will be increased focus on the compliance with the new grid codes standards for DGPS that impose stringent requirements in terms of power quality, ride-through, fast P-Q control, grid monitoring and islanding detection.

Other functionalities for grid converters as STATCOM and Active Filtering will be also investigated.

The DG concept is growing in importance, pointing out that the future utility line will be formed by distributed energy resources and interconnected microgrids. In fact, the responsibility of the final user is to produce and storage part of the electrical power of the whole system. This change of paradigm let the, microgrid export and import energy to the utility through the point of common coupling (PCC). And, when there is a utility failure, the microgrid still can work as an autonomous grid. As a consequence, these two classical applications: grid-connected and islanded operations can be used in the same application, under the concept of flexible microgrid. Examples of microgrid systems are given and analyzed in detail. Cases of islanded and flexible microgrid hierarchical control are described. Stability analysis and decentralized control issues are presented.

Control design experience will be gained by using advanced simulation models in Matlab-Simulink for both single-phase and three-phase grid converters. Hands-on experience will be provided in the state-of-the-art Green Power Laboratory where all the students will do experiments including control implementation for single-phase and three-phase grid converters including current control, harmonic compensation, grid synchronization, sag detection and STATCOM on setups controlled by dSPACE (DS1103). No less than 40% of the course time will be spent in the lab.

Keep yourselves updated at www.iet.aau.dk

Place

Aalborg University, Department of Energy Technology
Pontoppidanstraede 101, Room 23
DK-9220 Aalborg East, Denmark

Language

English

Prerequisites

A degree in electrical engineering or control engineering and Matlab/Simulink knowledge is strongly recommended.

Literature

A number of related articles and copy of slides are included in the course documentation (included in fee).

Day 1, 08.30-16.30

- L1 PV and WT Systems Overview
- L2 PV Inverters structure and control
- L3 Grid synchronization and monitoring for single-phase grid converters. PLL Basics.
- L4 Grid synchronization and monitoring for three-phase grid converters.
- L5 Grid connection requirements for RES-DGPS
- Lab I Introduction to Green Power Lab.
- Lab II Design and simulation of PLL (Matlab/Simulink)
- Lab III Experimental evaluation of PLL for single-phase systems. Accuracy and dynamics.
- Lab IV Experimental evaluation of 3-phase synchronization under distorted grid

Day 2, 08.30-16.30

- L6 Modulation and current/voltage control of the grid converter

- L7 Harmonic compensation
- L8 Grid filter design and stability of the current control
- L9 Grid converter control and future functions
- Lab V Design of current control for grid conv.
- Lab VI Design of harmonic compensation
- Lab VII Experimental testing of single-phase grid converter. Current control. PQ control. Harmonic compensation.
- Lab VIII Experimental testing of three-phase grid converter. Current control. dq control. Harmonic compensation.

Day 3, 08.30-15.40

- L10 Instantaneous Power Theory. STATCOM. Active Filtering.
- L11 Grid converter control under faulty grid. Low-voltage ride-through capability
- Lab IX Design and simulation of control strategy for three-phase STATCOM.
- Lab X Experimental testing of STATCOM
- Lab XI Design and simulation of grid converter control under grid faults. LVRT.
- Lab XII Experimental testing of grid converter control under grid faults.

Day 4, 08.30-15.40

- L12 Microgrid configurations
- L13 Distributed energy storage systems
- L14 Control of DC-coupled Microgrids
- L15 Control of AC Microgrids
- Lab XIII Control of an standalone inverter
- Lab XIV Control of an inverter able to operate in both grid-connected islanding modes.

Lecturers

Professor, Remus Teodorescu, Aalborg University, Denmark

Assistant Professor, Marco Liserre, Bari Polytechnic, Italy

Associate Professor, Pedro Rodriguez, Technical University of Catalonia, Spain.

Associate Professor, Josep M. Guerrero, Technical University of Catalonia, Spain.