



Program

Monday, February 1, 2016

Polo Scientifico e Tecnologico "Fabio Ferrari", Room A103

13.00 **Registration**

14.00 **School opening**

14.30 **Reliability and safety assessment: fundamentals and application to energy systems**

Lecturers: Marcantonio Catelani, Lorenzo Ciani, University of Firenze (Italy)

Modern technologies and related business requirements lead to a significant growth in manufacturing product complexity and, at the same, more severe reliability and safety requirements. For these reasons the interest in RAMS (Reliability, Availability, Maintainability, Safety) and diagnostics measurements and evaluation is growing in many different manufacturing fields, in particular to avoid unexpected failure occurrences in the most critical components and so to optimize system's availability. The first part of the lecture deals with the fundamentals of reliability theory. The second part focuses on the application of some reliability and safety analysis techniques applied to energy systems.

19.00 **Welcome event**

Welcome event at the S.A.S.S., Spazio archeologico sotterraneo del Sas (piazza Cesare Battisti, Trento)

Tuesday, February 2, 2016

Polo Scientifico e Tecnologico "Fabio Ferrari", Room A103

8.30 **Overview of electrical diagnostics techniques for medium/high voltage industrial induction machines**

Lecturer: Sang Bin Lee, Korea University (Seoul, Korea)

Induction machines are undoubtedly the most dominant and important type of electrical apparatus used in industrial facilities in the power generation, petroleum and chemical, metals, pulp and paper, cement, and mining industries, etc. Continued operation of induction machines is critical for maintaining the productivity, efficiency, and reliability of the industrial facility. The objective of this lecture is to present an overview of electrical diagnostic techniques used in the field for off-line testing and on-line condition monitoring of medium~high voltage induction machines.

The subjects covered in this lecture include:

1. overview of motor testing and diagnostics
2. high resistance connections
3. rotor cage testing
4. airgap eccentricity / bearing testing
5. stator magnetic wedge testing
6. stator core testing
7. stator winding insulation testing

A description of the fault, root causes and consequences of failure are given for each type of fault component, and the advantages and disadvantages of commercially available on-line and off-line technologies are presented. The typical causes of false positive and negative fault indications encountered in the field produced by commercial motor inspection methods such as steady state on-line spectrum analysis and off-line standstill testing are also given. The target audience is practicing engineers and



researchers in the area of reliability, diagnostics, and prognostics for electrical machines in industrial environments. This course can also serve as an introduction/overview of electric machine diagnostics for attendees with undergraduate level knowledge of electric machines.

14.00 ***Condition monitoring of electric machines and drives: towards fault tolerant processes***

Lecturer: Alberto Bellini, University of Bologna (Italy)

Condition monitoring of electric machine and drives has a considerable influence on the operational continuation of many industrial processes. Correct diagnosis and early detection of incipient faults result in fast unscheduled maintenance and short downtime for the process under consideration. They also avoid harmful, sometimes devastating, consequences and reduce financial loss. An ideal diagnostic procedure should take the minimum measurements necessary from a machine and by analysis extract a diagnosis, so that its condition can be inferred to give a clear indication of incipient failure modes in a minimum time. The lecture will cover the following topics:

1. modeling and physical insight of main faults for induction machines: stator faults which are defined by stator winding open or short circuited; rotor electrical faults which include rotor winding open or short circuited for wound rotor machines and broken bar(s) or cracked end-ring for squirrel-cage machines; rotor mechanical faults such as bearing damage, eccentricity, bent shaft, and misalignment
2. diagnosis of electric drives: pitfall and fallacies, failure of one or more power electronic components of the drive system
3. signal processing of electric quantities for early diagnosis of fault under on-line operation
4. from diagnosis to fault tolerant system; perspectives of a system approach to increase the reliability of electric drives

The target audience is practicing engineers and researchers in the area of reliability, diagnostics and fault tolerant electric drives; system designers of industrial applications with electric drives. This course can also serve as an introduction/overview of electric machine diagnostics for attendees with undergraduate level knowledge of electric machines.

Wednesday, February 3, 2016

Polo Scientifico e Tecnologico "Fabio Ferrari", Room A103

8.30 ***Classification in Iso-Attention classes of HV transformer fleets***

Lecturer: Massimo Pompili, Sapienza Università di Roma (Italy)

The largest electrical Operators (TSO) may have in service some hundreds of HV power transformers. It means that failures are to be expected along their operational times with possible heavy consequences in case of fire or explosion or other negative events. The traditional approach for preventing failures and their consequences is normally based on periodical evaluations of some physical, chemical and electrical parameters of the insulating oil and/or of the equipment but these data do not give any information on the overall "state of health" of the units when the observed properties are below the values assumed by the different existing Standards as acceptable limits. Also these data are not related to failure consequence. With this aim, a more complete risk evaluation has started to be applied as an innovative powerful tool for preventing negative situation due to transformer failures and for classifying these electrical units in iso-attention classes. This risk is formed by three partial components, which are: 1) causes of the failure, 2) probability that a failure may provoke a damage and 3) type and entity of damages (magnitudo). This approach may be an useful tool for supporting decisions and addressing periodical investments of electrical operators and utilities having in service transformer fleets. With this aim, approximately 700 different HV transformers of one of the biggest electrical operator have been examined, evaluating the single components forming their risks. This analyses has permitted to establish which transformers may be considered more critical with possibility to better address the successive maintenance strategies.



14.00 **Information theoretic modeling in power systems**

Lecturer: Vladimiro Miranda, University of Porto (Portugal)

The adoption of Information Theoretic concepts allows a finer extraction of information from data, leading to the construction of better models. Although not currently usual in Power Systems, these concepts have already proven valuable in several domains.

The lecture will digress through basic concepts of Information Theory and focus on concepts of Entropy, Correntropy and Mutual Information. Then, applications of these concepts will be discussed, touching the following topics:

1. training of autoassociative neural networks (autoencoders)
2. designing missing sensor signal restoration systems
3. clustering, information theoretic mean-shift algorithms, and application to transformer fault diagnosis systems
4. reliability assessment of power systems via Monte Carlo - acceleration with neural networks and with entropy methods

These topics will be adequately linked with the smart grid paradigm whenever appropriate.

19.30 **Social dinner**

Social dinner at the Ristorante Due Mori - Antica Trattoria (via San Marco 11, Trento)

■ **Thursday, February 4, 2016**

Polo Scientifico e Tecnologico "Fabio Ferrari", Room A103

8.30 **A power electronics perspective on system stability in microgrids**

Lecturer: Paolo Mattavelli, University of Padova (Italy)

The increasing number of renewable energy sources and energy storage devices connected to the grid has the potential to progressively increase the network performance in terms of efficiency, stability and demand response, while allowing full exploitation of any kind of Distributed Energy Resources (DERs). For this purpose the electronic power processors (EPPs) interfacing the power sources or storage elements with the distribution grid must be driven properly, controlling their active and reactive currents and harmonic distortion so as to improve power sharing, voltage stability and distribution losses. This lecture is aimed to give the fundamental knowledge of stability of electronic power processors used in Distributed Energy Resources in future microgrids, including basic operation of EPP and the analysis of stability based on the impedance concept.

14.00 **No energy autonomy without increased energy efficiency**

Lecturer: Wolfgang Streicher, University of Innsbruck (Austria)

The background of the lecture is a work for the Austrian Minister of Environment conducted in 2011. It tried to give answer to the questions: Is energy autarky technically possible in Austria, what part takes energy efficiency and what part renewable energies? After an introduction of the background and the boundary conditions for the scenarios, available technologies are described. Then the potential of renewable energy carriers in Austria are derived and the current energy demand of the sectors buildings, production and transportation are given. Two scenarios based on constant or growing energy services demand are discussed. Finally the needed efficiency increase for the two scenarios and possible energy flows for the two scenarios are presented, the impacts on the energy system and political decisions are discussed and conclusions are drawn.



16.00 ***Electrical machines for high efficiency and reliable application***

Lecturer: Luigi Alberti, Free University of Bozen - Bolzano (Italy)

Electrical machines are more and more used in many applications such as renewable energy systems, more electrical vehicles and variable speed applications. This is thanks to their high efficiency and control flexibility which allow to obtain significant developments in various fields. The talk will present the main sizing criteria of the electrical machines for high efficiency and reliable systems. After a recall of the basic theory, the specific aspects of the design are introduced considering various application examples and case studies. Various aspects (electromagnetic, thermal and mechanical) will be considered and discussed.

■ **Friday, February 5, 2016, Room A103**

Polo Scientifico e Tecnologico "Fabio Ferrari"

8.30 ***On-line monitoring and diagnosis of photovoltaic modules***

Lecturer: Giovanni Spagnuolo, University of Salerno (Italy)

On line monitoring and diagnosis techniques, especially if embedded into photovoltaic (PV) module-dedicated electronics, allow to check the state-of-health of the module and also of its power processing system. Some data are acquired during the normal operation of the PV generator and feed the prognostic algorithms in order to program the plant maintenance for minimizing the impact on the power production. An overview of the state-of-the-art and some novel approaches presented in the current literature are given in the lecture.

12.30 ***School closing***