Technical Presentation Session
Sponsored by IAS Chapters and Membership Department (CMD) and CMD DL&PL Committee

DLN Session Series

IAS DISTINGUISHED LECTURERS NOMINATED FOR 2021

SESSION DLN1

Date: Saturday, 21 November 2020
Time:
12:00-13:30 UTC (Coordinated Universal Time)
13:00-14:30 CET (Central European Time, UTC+1)
07:00am-08:30am EST (US Eastern Standard Time, UTC-5)
05:30pm-07:00pm IST (Indian Standard Time, UTC+5:30)
Time converter: https://www.worldtimebuddy.com/

Medium-voltage drive topology design and control

Prof. Yongsug Suh, Jeonbuk National University, South Korea, ysuh@jbnu.ac.kr

Yongsug Suh is a professor at Jeonbuk National University in South Korea. He received the B.E.E. and M.S.E.E. degrees from Yonsei University, Seoul, in 1991 and 1993, respectively, and the Ph.D. degree in electrical engineering from the University of Wisconsin, Madison, WI, USA, in 2004. From 1993 to 1998, he was an Application Engineer in the Power Semiconductor Division, Samsung Electronics Co. From 2004 to 2008, he was a Senior Engineer in the Power Electronics and Medium Voltage Drives Division, ABB, Turgi, Switzerland. Since 2008, he has been with the Department of Electrical Engineering, Jeonbuk National University, Jeonju, South Korea, where he is currently a Professor. His research interests include power conversion systems of high power for renewable energy sources and medium voltage electric drive systems

Abstract:

Medium voltage converters are becoming more important on the market due to high power density, excellent efficiency and high reliability. Today there is a large and still growing application field for adjustable speed drives in medium voltage range such as pumps, fans, rolling mills, wind parks, and energy storage systems. In addition, the electrification of energy conversion units in transportation

systems of a few tens MW tends to adopt this medium voltage drive technology. Because of a relatively large power handling capacity and severe process reliability requirement, these medium-voltage drive systems are characterized by unique and sophisticated power converter topologies and control features as compared to general-purpose low power drive systems.
This lecture covers latest development of medium-voltage drive topology design & control techniques. The various technologies available in the market from different global manufacturers are introduced. The selection of optimal topology and its eligible power semiconductor switches are treated in detail along with its unique switching modulation and control scheme.

Active, Reactive and Harmonic Power Sharing in Islanded Microgrids

Prof. Vinod Khadkikar, Khalifa University, Abu Dhabi, UAE, vinod.khadkikar@ku.ac.ae

Vinod Khadkikar is currently a Professor with the Department of Electrical Engineering and Computer Science, Khalifa University, Abu Dhabi, UAE. His research interests include the applications of power electronics in distribution systems and renewable energy resources, grid interconnection issues, power quality enhancement, active power filters, and electric vehicles. Dr. Khadkikar is currently an Associate Editor for the IEEE Transactions on Industrial Electronics, IEEE Transactions on Industry Applications and IET Power Electronics. He received his M.Tech. degree from the Indian Institute of Technology (IITD), New Delhi, India, in 2002, and the Ph.D. degree in electrical engineering from the École de Technologie Supérieure (E.T.S.), Montréal, QC, Canada, in 2008. From December 2008 to March 2010, he was a Postdoctoral Fellow with the University of Western Ontario, Canada. From April 2010 to December 2010, he was a Visiting Faculty with the Massachusetts Institute of Technology, Cambridge, MA, USA. His research interests include applications of power electronics in distribution systems and renewable energy resources, grid interconnection issues, power quality enhancement, active power filters and electric vehicles

Abstract:
When a distributed generation (DG) or group of DG units operate as single controllable system, it is generally addressed as a Microgrid. These microgrids can be used to supply power to the main grid or can operate as an islanded grid. In an islanded microgrid, the intermittent nature of DG units (such as, photovoltaic and wind) makes the system highly dynamic. This lecture goes into details of islanded microgrids discussing the operation, control and challenges associated with these systems. Special attention will be given to harmonic and unbalance load sharing. Several recent control approaches to deal with the harmonics power sharing will be discussed in detail.

SESSION DLN2

Date: Saturday, 28 November 2020
Time:
12:00-13:30 UTC (Coordinated Universal Time)
13:00-14:30 CET (Central European Time, UTC+1)
07:00am-08:30am EST (US Eastern Standard Time, UTC-5)
05:30pm-07:00pm IST (Indian Standard Time, UTC+5:30)
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The event is organized and hosted by IAS Chapters and Membership Department (CMD)
Co-host is IEEE Region-1 Schenectady Section IAS Chapter

Design of Superconducting Synchronous Machines for Low Speed Applications

Dr. David Torrey, GE Global Research, torrey@ge.com, +1 518-423-7416

David Torrey is a Senior Principal Engineer in the Electric Power organization at GE Global Research. His research interests are in the design and control of electric machines, particularly within the context of integrated energy conversion systems. His application experience ranges from machine design for subsea hydrocarbon pumping, electric submersible pumps, to design of next-generation generators for offshore wind turbines, to design of engine-embedded generators to support hybrid electric aircraft. He holds several awarded and pending patents in the electric machine, power electronics, and control fields related to applications in transportation, renewable energy, oil and gas, and micro-grids. He has authored over 40 journal papers, over 70 conference papers, 3 book chapters, and one textbook in these areas. He supervised 13 doctoral theses while on the faculty at Rensselaer Polytechnic Institute. He is a fellow of IEEE and IET.

Abstract:
Synchronous electric machines with superconducting field windings have been around for a long time but have not gone beyond prototypes and very limited demonstrations. However, magnetic resonance imaging (MRI) systems use superconducting magnets that are made in significant volumes each year and run with high reliability.
This lecture provides a brief review of the technology advances that move superconducting machines toward commercialization and then discusses how one would go about designing a superconducting machine. Review of electric machine fundamentals will be provided to assist those new to the subject.
The notional design of a superconducting synchronous motor rated for 36.5MW of shaft power at 120rpm that would be compatible with a 6kV DC bus is presented as an illustrative example. Such a

machine could serve as a propulsion motor for a large ship. The machine is based on low temperature superconducting field coils and an armature with reduced steel. The large magnetic fields produced by the field coils result in an air gap magnetic field greater than 2T.
Mechanical considerations are also discussed, including the electromagnetic forces that are central to understanding the signatures of the machine.

Applications and Multi-Physics Design of High Speed Permanent Magnet Synchronous Motor

Prof. Jian-Xin SHEN, Zhejiang University, China, J_X_Shen@zju.edu.cn

Jian-Xin Shen received the B.Eng. and M.Sc. degrees from Xi'an Jiaotong University, Xi'an, China in 1991 and 1994, respectively, and the Ph.D. degree from Zhejiang University, Hangzhou, China in 1997, all in electrical engineering.
He was with Nanyang Technological University, Singapore (1997-1999), the University of Sheffield, Sheffield, U.K. (1999-2002), and IMRA Europe SAS, U.K. Research Centre, Brighton, U.K. (2002-2004). Since 2004, he has been a full professor with Zhejiang University.
Prof. Shen has authored more than 270 technical papers, and is the inventor of more than 40 patents. He received 8 paper awards from IEEE and international conferences. He was granted the Nagamori Award with recognition of his contribution to permanent magnet electrical machines and high speed electrical machines. He was the general chair of the ICEMS'2014, IEEE VPPC'2016 and IEEE SCEMS'2018 conferences.

He is a senior member of IEEE, a member-at-large of IEEE Industry Applications Society, a member of IEEE Nikola Tesla Award committee, and a distinguished lecturer of IEEE Vehicular Technologies Society. He is a fellow of IET and a senior member of China Electrotechnical Society (CES).

His main research interests include topologies, control and applications of permanent magnet machines and drives, and renewable energies.

More information about Prof. J. X. Shen can be seen on https://person.zju.edu.cn/en/jxs.

Abstract:

In this speech, some typical applications of high speed permanent magnet synchronous motors (PMSM) are introduced. Optimal design of high speed large PMSM is then presented, taking a 350kW and 13.5krpm non-salient PMSM as an example.

Firstly, it is critical to determine a proper level of PM-excited flux linkage in the armature windings, so that for a given high speed motor the supply voltage can be fully utilized, the motor armature current can be minimized, and the power factor can be enhanced. Of course all of these are associated with proper control strategies, whilst the motor must have sufficient potential capability to cooperate with the control strategies. In other words, the motor itself and the control method should be systematically designed.

Specific considerations on electromagnetic design will presented. For example, PM rotor structure need be designed to provide sufficient strength against centrifugal force and meanwhile to generate the required level of PM flux, whilst stator winding structure should be designed with appropriate inductance, since high operation frequency could cause high armature impedance.

Clearly, high armature impedance may deteriorate the motor power factor, but may also enhance the field modulation capability by armature currents, hence, compromise is essential. On the other hand, during electromagnetic design some special losses such as extra winding ohmic loss and rotor eddy current loss due to high speed operation should be particularly suppressed, as these losses may cause high temperature rise and may even damage the motor.

Rotor stress due to high speed operation need be considered critically. Examples of reducing local over-stress in the rotor will be given, whilst such techniques often harm the motor electromagnetic performance. Therefore, compromise is required again.

Also, design of rotor dynamics is important, in that rotor resonance must be avoided. Basically it is preferable to make a short rotor with a thick shaft to increase the critical resonant frequency. But this will usually enlarge the rotor diameter and consequently increase the rotor stress.

On the other hand, high speed machines enjoy the merit of high power density, but also suffer from the problem of high loss density. Hence, thermal design is particularly required. Winding impregnation or encapsulation can be employed, whilst liquid cooling or forced air cooling can be rather effective, hence, single- or even double-phase fluid dynamics computation is required, coupling with thermal analysis. Furthermore, some measures to enhance the fluid dynamics such as introducing extra air channels in the stator core will affect the motor electromagnetic performance.

Clearly, various physical fields are deeply coupled in the high speed large power motors, thus, compromises must be made. Multi-physics analysis and design are not only essential, but also usually need be iterated, so as to achieve an overall satisfactory performance.