PLENARY SPEAKERS

Title : Power Electronics for Renewable Energy and Power Systems: Opportunities and Challenges

Dr. Jian Sun

Biography : Dr. Jian Sun joined the faculty at Rensselaer Polytechnic Institute (RPI) in 2002, where he is currently a Professor in the Department of Electrical, Computer and Systems Engineering. He is also Director of the Center for Future Energy Systems (CFES) funded by New York State government. His research interests are in the general area of power electronics and energy conversion, with an emphasis on modeling, control, and different applications including renewable energy, power systems and aerospace.Dr. Sun received his doctorate from the University of Paderborn in Germany. Prior to joining RPI, he spent five years at the Advanced Technology Center of Rockwell Collins working on power electronics for aircraft power systems, and was a Post-Doc Fellow at Georgia Tech from 1996 to 1997. His professional services to the power electronics community included serving as Editor-in-Chief of IEEE Power Electronics Letters from 2008 to 2014 and as Treasurer of IEEE Power Electronics Society since 2013. Dr. Sun received the IEEE PELS Modeling and Control Technical Achievements Award in 2013 and the R. David Middlebrook Outstanding Achievement Award in 2017. He is a Fellow of IEEE and also an active consultant to the industry internationally.

Abstract: A major driver for the development of power electronics has been microelectronics and motor drive applications. The success and impact of this development can be seen today in the ubiquitous IT infrastructure which we depend upon for virtually every aspect of our life, and the millions of electric vehicles that will eventually displace vehicles based on internal combustion engines. From power system perspective, however, these applications are on the load side and their impacts on the system are not as prefund as

power electronics that started to proliferate on the generation and transmission side in recent years due to the rapid development of renewable energy and high-voltage dc (HVDC) trans mission.Compared to electromechanical and electromagnetic energy conversion devices such as generators and transformers that use slow (or no) control and can endure large overvoltage and overcurrent for long time, power electronics employ much faster control but have very limited overloading capabilities. These two fundamental characteristics, determined by semiconductor physics, complement each other at the device and converter level, but each is in conflict with certain aspects of how today's power grid is designed and operated. Namely, fast control creates complex dynamics and resonance problems in the high frequency range that don't exist in traditional power systems, while the need to protect a converter itself can be very detrimental to system transient stability. This talk reviews the technology and application of power electronics in renewable energy generation and HVDC transmission systems, and discusses their impacts on grid stability. System modeling and analysis based on a new small-signal sequence impedance theory is also presented as an effective method for the analysis and mitigation of high-frequency resonance problems that have become a major challenge for the development and operation of HVDC and large-scale renewable energy systems in recent years.

Title: Biomass for Fuels and Chemicals – Challenges and Opportunities

Dr. Suchithra Thangalazhy Gopakumar

Biography: Dr. Suchithra Thangalazhy Gopakumar is an Assistant Professor at University of Nottingham Malaysia. She received her Bachelors degree in Chemical Engineering from Government Engineering College Thrissur in 2004. Her Masters degree was in Industrial Pollution Control from National Institute of Technology Karnataka, Surathkal, and Doctoral degree from Auburn University, Alabama, USA in 2012. Dr. Suchithra's research focuses on the development of liquid biofuels or extraction of chemicals from various biomass feedstocks through thermo-chemical conversions and catalytic upgrading. She has co-authored two book chapters and 18 international journal articles. She has presented her findings in various international conferences and exhibitions. Recently her projects have received awards in international exhibitions conducted in Malaysia. She has also secured external research grants for various projects. Dr. Suchithra has achieved the status of 'Fellow of The Higher Education Academy', UK. She is also a member of American Society of Agricultural and Biological Engineers (ASABE) and associate member of Institute of Chemical Engineers (IChemE) and Indian Institute of Chemical Engineers (IIChE).

Abstract: To meet the rise in global energy demand with dwindling fossil fuel reserves, a lot of research is now focusing on different types of renewable energy sources. Solar, hydro, biomass, geothermal and wind are some renewable sources, which provide various forms of energy. Of these, biomass energy is unique since it is the only renewable source for organic carbon. Biomass are organic materials, mainly composed of carbon, hydrogen, oxygen and nitrogen. Sources of biomass include energy crops, algae, animal manure as well as agriculture, municipal and forest waste. As biomass is available in different forms, it is possible to convert biomass into value-added products via various processing technologies. A bio refinery, which is analogous to today's petro refinery, is an integrated approach to convert biomass into a variety of fuels and chemicals. Two major platforms in biorefinery are sugar platform (bio-chemical) and syngas platform (thermos-chemical). Current paper discuss the chemical value of biomass and the potential conversion routes and major chemical processes in a bio-refinery. Biomass is diverse in nature and are distributed widely. Therefore, collecting and processing biomass is still a challenge. In addition, biorefinery products has compact with existing petroleum-derived products. This presentation also includes a view on status of biomass and biofuels.

Title: Role of Power Electronics in Alternate Energy Systems


Ashoka K.S. Bhat

Biography: Ashoka K.S. Bhat obtained the B.Sc. degree in physics and math from Mysore University, in 1972. He received the B.E. degree in electrical technology and electronics and the M.E. degree in electrical engineering, both with distinction from the Indian Institute of Science, Bangalore, in 1975 and 1977, respectively. He also received the M.A.Sc. and Ph.D. degrees in electrical engineering from the University of Toronto, Ontario, Canada, in 1982 and 1985, respectively.

From 1977 to 1981, he worked as a scientist in the Power Electronics Group of the National Aeronautical Laboratory, Bangalore, India. After working as a postdoctoral fellow for a short time, he joined the Department of Electrical Engineering, University of Victoria, B.C., Canada, in 1985, where he is currently a Professor of Electrical Engineering and is engaged in teaching and conducting research in the area of power electronics. He was responsible for the development of the Electromechanical Energy Conversion and Power Electronics courses and laboratories in the Department of Electrical Engineering at the University of Victoria.

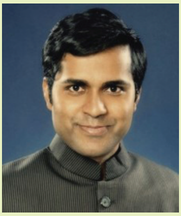
He has more than 40 years of experience in power electronics and authored (or co-authored) many reviewed journal papers and has presented more than 100 reviewed conference papers. He has successfully supervised many Ph.D. and Master's students. He has offered several short term and full-semester courses in the area of Power Electronics.

Dr. Bhat is a *Fellow of IEEE* (USA), Life *Fellow of the IETE* (India), and a registered Professional Engineer in the province of British Columbia, Canada.

Abstract: There is an increased use of alternate energy sources due to energy crisis and environmental concerns. Power electronic converters form an integral part of such energy systems due to the varying nature of the outputs available from various energy sources. In this talk, a brief overview of the application of power electronic converters in such systems will be presented. Some of the topics to be briefly discussed are: Interfacing of alternate energy sources (such as photovoltaic array, fuel cells and wind energy) to the utility line, bidirectional power converters needed for energy storage, power converters for electrolyser application, etc.

KEYNOTE SPEAKERS

Title: Recent Progress in Current-fed Power Converters for High Voltage Gain Applications



Dr. Akshay K. Rathore

Biography: Dr. Akshay K. Rathore received his PhD degree in Power Electronics from University of Victoria, BC, Canada in 2008. He has secured above 3M US $ research funding at Singapore through various industries and government agencies. He has supervised over 25 PhDs, postdoctoral fellows, research engineers, and graduate students. Dr. Rathore is a recipient of 2013 IEEE IAS Andrew W. Smith Outstanding Young Member Award, 2014 Isao Takahashi Power Electronics Award. and 2017 IEEE IES early career award He was a consultant to WEG, Brazil, Crenergy Systems Pte Ltd, Singapore and Robert Bosch (SEA) Pte Ltd, Singapore. He has published over 130 research papers in reputed journals. He is an Associate Editor of IEEE Transactions on Industry Applications, IEEE Transactions on Industrial Electronics, IEEE Transactions on Transportation Electrification, IEEE Transactions on Sustainable Energy, IEEE Journal of Emerging Selected Topics in Power Electronics, and IET Power Electronics. He has one European Patent commercialized by WEG Drives, Brazil. He is presently an associate Professor with department of ECE, Concordia university, Canada.

Abstract: Current-fed power electronic systems have been demonstrated and justified for low voltage high current applications. Major applications include interfacing low voltage dc and high voltage dc grids in a microgrid, renewable energy integration, energy storage, and electric transportation.Current-fed converters offer short circuit protection and voltage amplification due to input inductor. In addition, inductor is reliable and offers higher lifetime (relatively reduced degradation) compared to electrolytic capacitor used in voltage-fed converters. Alternative energy sources output (solar PV, fuel cells) is low voltage and the same is true for energy storage. Current-fed transformer-less converters are able to boost the source voltage up to 10x. In addition, the variability of renewables varies voltage and current (so the power) output. Therefore, the power electronics interface should accommodate such variations with high

performance over entire operating range. The major challenge is to maintain high efficiency with intermittent variability, load profile, and usage. Current-fed converters are superior in performance for such variations and specifications. The major challenge in current-fed is high voltage spike/overshoot across the semiconductor devices at turn-off owing to hard commutation. It needs additional snubber circuits or active-clamping reducing density, efficiency, as well as boost capacity. Advanced current-fed converters with novel modulation and impulse resonance achieve soft-commutation and natural voltage clamping of the devices without external snubber circuit making it snubber-less. Soft-switching of all semiconductor devices is achieved and maintained over wide variation in source voltage and power. Similarly, the attributes of natural device voltage clamping and soft-commutation are also maintained. Conventional current-fed as well as voltage-fed PWM and resonant converters have soft-switching limitations and lose at light load and increased source voltage. However, the proposed current-fed converters maintain their originality owing to proposed modulation. Soft-switching, natural voltage clamping, and soft-switching are inherent and maintained with wide variation in source voltage and output power. As additional measures, proposed topologies report negligible circulating current that results in higher efficiency at partial load and increased source voltage and reduced peak current stress across the components

Title: Autonomous Microgrids: Operation, Control and Challenges

Dr. Vinod Khadkikar

Biography: Dr. Vinod Khadkikar holds a PhD in Electrical Engineering from cole de Technologie Supérieure, Montreal, Canada (2008). He also holds an MTech in Power Electronics, Electrical Machines and Drives, from the Indian Institute of Technology (IIT), Delhi. During 2010, he was a Visiting Faculty at the Massachusetts Institute of Technology, Cambridge, USA. He did his Postdoctoral Fellow at the Department of Electrical and Computer Engineering, the University of Western Ontario, London (ON), Canada. He received a number of scholarships including MHRD (Government of India), Ministry of Education of Quebec (Canada) and scholarship awarded byÉcole de TechnologieSupérieure. Dr. Khadkikar's current research interests include application of power electronics in renewable energy systems and smart grid, grid interconnection issues, electric power quality enhancement, active power filters and static reactive power compensation. He has more than 30 journal papers to his credit. He is an Associate Editor of the IEEE Transactions on Industrial Electronics and IET Power Electronics Journal. Currently, Currently he is an Associate Professor at Masdar Institute, Khalifa University of Science and Technology, Abu Dhabi, UAE.

Abstract: In recent years, the electric power sectors worldwide have seen a gradual penetration of renewable energy based distributed generation (DG) units. When a 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 autonomous grid feeding the local load demand. In an autonomous microgrid, the intermittent nature of DG units (such as, photovoltaic and wind) makes the system highly dynamic. This keynote will go into details of autonomous microgrids and discuss the operation, control and challenges associated with these systems. Some of the research findings and future research scope in this area will also be discussed.

Title:Low order harmonic suppression in induction motor drives with dodecagonal and octadecagonal voltage space vectors for drives

Dr. Gopakumar K.

Biography: Dr. Gopakumar K. did his M. Sc. (Engg.) (E.E.) in 1984 and Ph.D. (E.E.) in 1994 both from the Indian Institute of Science. He is a **Fellow of IEEE** and IETE, and Fellow Indian National academy of Engineers (FNAE). He has guided more than 25 PhD students and has more than 125 international journal publications to his credit. He is Co Editor-in-Chief IEEE Trans. on Industrial Electronics. He received IETE (India)- B.K Bose award for contributions to the area of power electronics and drives for high power applications. He is a distinguished Lecturer of IEEE Industrial Electronics Society. He recently received IISc Alumni award for Excellence in Research in Engineering-2016 and is ABB Chair professor 2016 -2018.

Abstract: Multilevel inverters are preferred for variable speed drives due to its improved output voltage profile , less low order harmonic content and low dv/dt requirements for the devises etc;. But the conventional multilevel voltage space vector structure has a hexagonal profile and it introduces the low order 5th and seventh harmonics especially in the overmodulation region. Recently, numerous interesting multilevel topologies have been reported for motor drive applications. However, to date, the most popular topology is the neutral-point clamped (NPC) three-level topology, especially for medium-voltage drives applications. This shows that the industry is still looking for viable alternative to this topology, with reduced power circuit complexity and increased reliability for medium-voltage drives applications. This specific lecture will focus on some of the recent work from my lab on five-level and nine-level inverter topologies, with reduced DC-link voltages along with common-mode voltage reduction for conventional as well as open-ended winding induction motor drives. This is followed by the new interesting concept of dodecagonal voltage space vector structure generation with fifth and seventh order harmonics as a viable alternative for the conventional hexagonal structure for the voltage space vector structure, for PWM control. The dodecagonal voltage space vector structure generation for an induction motor drive with open-end structure

will be introduced in the first part of the lecture and then it will be extended to the normal three phase IM drive using a switched capacitive H-bridge acting as a 5th and 7th order harmonics, throughout the modulation range. The switched capacitive filter with a capacitve fed H-bridge will only supply reactive energy and the capacitor voltage can be balanced during the PWM control without any complexity. The same concept will be extended for octadecagonal voltage space vector generation using the basic inverter modules, in this lecture.