Workshop on Advanced Power Electronics

Room E-203 (engineering building, Dean's conference room), San Diego State University
5500 Campanile Drive, San Diego, CA 92130
Contact: hzhang@mail.sdsu.edu; Tel: 734-834-3599
Sponsored by IEEE San Diego Section; PES and PELS chapters;
GATE Center for Electric Drive Transportation
Registration fee: $25 members; $35 non-members; $5 for students

Friday, March 25, 2016

Time	Program Chair, Chris Mi, Fellow IEEE, Professor and Chair, ECE department, San Diego State University
08:00-08:15am	Pick up speaker from Marriott Mission Valley and drive to campus
08:15-08:45am	Setup/Networking/Refreshments
08:45-10:00am	**"Effective Design of EMI Filters in Power Electronics Products,"** Toshihisa Shimizu, Professor, Tokyo Metropolitan University
10:00-10:15am	Coffee Break
10:15-11:30am	**"Highly Efficient Microinverter for Photovoltaic Panels,"** Huang-Jen Chiu, National Taiwan University of Science and Technology
11:30-12:30pm	**Tour the DOE GATE Center for Electric Drive Transportation at San Diego State University**
12:30-13:30pm	Lunch
13:30-14:45pm	**"Soft Switching Inverters for Renewable Energy,"** Dehong Mark Xu, Fellow IEEE, Professor, Zhejiang University
14:45-16:00pm	**": Gyrator Based Analyses of Resonant Circuits and Inductive Power Transfer Systems,"** Chun T. Rim, Korea Advanced Institute of Science and Technology (KAIST)
16:00-16:15pm	Coffee Break
16:15-16:45pm	**"Wireless Power Transfer and Its Applications,"** Chris Mi Fellow IEEE, San Diego State University
16:45-18:00pm	Title TBD,
18:15pm	Dinner *

*6:00pm: Dinner for workshop speakers (paid) and attendees (on your own), Venue to be determined. RSVP with Fei Lu.

Workshop Reservation Link: TBD
Driving directions and parking information will be mailed to registered attendees.

Speaker's bio and abstract

Prof. Toshihisa Shimizu

Effective Design of EMI Filters in Power Electronics Products

Bio: Prof. Toshihisa Shimizu graduated from Tokyo Metropolitan University, Tokyo, Japan, and received his B.E., M.E. and Dr.Eng. degrees all in electrical engineering from the same university in 1978, 1980, and 1991, respectively. In 1998, he has been a visiting professor at VPEC, Virginia Polytechnic Institute and State University, Virginia, USA. In 1980, he joined Fuji Electric Corporate Research and Development Ltd, as a research engineer. Since 1993, he joined Tokyo Metropolitan University, Department of Electrical Engineering, as an associate Professor, and now a full professor in the same university. He has been served as vice faculty dean of school of Engineering and Science in Tokyo Metropolitan University from 2009 to 2013, and has been served as department head of Electrical Engineering in the same university. He is currently serving as a visiting researcher of Advanced Institute of Science and Technology in Japan, a technical advisor of intellectual property high-court of Japan, and a chairman of grant committee in Tokyo Metropolitan Small and Medium Enterprise Support Center.

His research interests include high power density converters, characterization of the magnetic materials applied to power converters, high frequency inverters, photovoltaic power generations, EMI filter design in power converters, etc. He published more than 90 journal papers, 400 regional and international conference proceedings, and 5 technical books. He also holds more than 30 patents and 50 patent pending. He honored several national research grants, and has been conducted research projects with more than 30 industrial companies which include Honda Motors, Toyota Motors, Denso, Fuji Electric, Iwatsu Coorporation, LG Electronics, Hitachi Marerials, Mitsubishi Materials, Toho Zinc, etc. Dr. Shimizu is a recipient of the Transactions Paper Awards from IEE Japan in 1999, and 2010, two first prize paper awards from IPEC2010 ECCE-Asia, and first prize paper award from EPE-PEMC2010, and first prise paper award from IPEC2014 ECCE-Asia. He was honored more than 10 awards including outstanding achievement award and special activity award, and awarded 5 awards from IEEE Power Electronics Society and industrial organizations in Japan.

Abstract: Power converters that are used in various products (Industrial applications, home appliances, electric cars, etc.) are required to provide higher specifications such as a high power density, high efficiency, and low cost. High-frequency switching with advanced power devices, such as SiC and GaN, is one effective method used to satisfy the above requirements. On the other hand, electromagnetic interference (EMI) noise emitted from the power converter tends to increase due to a high-frequency switching operation accompanied by high dv/dt or di/dt transients of the SiC and GaN devices. In order to meet EMI regulations, such as CISPR22 and IEC61000, we need to use EMI filters at the AC port or DC port of the power converters. However, it is not easy to optimize the EMI filter design because the inherent EMI noise generated by the power converters cannot be evaluated in advance of the EMI filter design. Hence, a reiterative design process based on trial and error has to be implemented during the design stage. As a consequence, some problems result such as long-duration design and test processes, which increase cost. In order to eliminate the vague process and to achieve an optimum EMI filter design, knowledge of accurate calculation methods for the conducted EMI noise would be essential. In this presentation, basic knowledge of the conducted EMI noise in power electronics systems will be lectured, and state of art technology for mitigating the conducted EMI noise will be discussed. This tutorial consists of the following five content.

(1) Introduction of conducted EMI regulation.
(2) basic theory of conducted EMI in power electronics systems
(3) some practical calculation methods of conducted EMI noise
(4) design procedure of the conducted EMI filter
(5) surve voltage suppression of AC drive systems

Speaker's bio and abstract

Highly Efficient Microinverter for Photovoltaic Panels

Professor Huang-Jen Chiu

Director, Center for Power Electronic Technologies

National Taiwan University of Science and Technology

Bio: Huang-Jen Chiu received the B.E. and Ph.D. degrees in electronic engineering from National Taiwan University of Science and Technology, Taipei, Taiwan, in 1996 and 2000, respectively. From August 2000 to July 2002, he was an Assistant Professor in the Department of Electronic Engineering, I-Shou University, Kaohsiung, Taiwan. From August 2002 to July 2006, he was with the Department of Electrical Engineering, Chung-Yuan Christian University, Chung-Li, Taiwan. Since August 2006, he has been with the Department of Electronic and Computer Engineering, National Taiwan University of Science and Technology, Taipei, Taiwan, where he is a Distinguished Professor and the Director of Center for Power Electronic Technologies, now. Dr. Chiu also serves as the Director/ CEO of some academic-industry co-centers such as FSP-NTUST Research Center, Chroma-NTUST Research Center, ITRI-NTUST EMC Center, and LITEON-NTUST Power Electronics Center (LNPEC). His research interests include high efficiency/ high power density bidirectional DC/DC converters, PFC topologies, and power converter design for renewable energy applications.

His work brought him several distinctive awards including the Young Researcher Award in 2004 from the Ministry of Science and Technology, Taiwan, the Outstanding Teaching Award in 2009 and the Excellent Research Award in 2009 and 2011 from the NTUST, the Y. Z. Hsu Scientific Paper Award in 2010, the Excellent Academic-industry collaboration Award in 2015, and Google Little Box Academic Awards. His student teams won the grand prize of the IEEE International Future Energy Challenge (IFEC) in 2013 and 2015, respectively. Dr. Chiu served as Program Chair of the 2015 IEEE International Future Energy Electronics Conference (IEEE IFEEC 2015). He is an IEEE senior member and serves as an Associate Editor of the IEEE Transactions on Industry Applications and an Associate Editor of the IEEE Transactions on Circuits and Systems Part II: Express Letters (TCAS-II). He is currently the Chair of IEEE Industrial Electronics Society Taipei Chapter and the Industry Committee Chair of Taiwan Power Electronics Association (TaiPEA).

Abstract: While fossil fuels exhaustion and greenhouse effects are widely concerned around the world, one of the most important issues toward to these problems is to find alternative energy for long-term solutions. Green energy offering the promise of clean and abundant energy gathered from self-renewing sources such as solar energy, geothermal energy and wind source are broadly developed. Solar cells are unique in that they directly convert the incident solar irradiation into electricity. Photovoltaic power management concepts are essential to extract as much power as possible from the solar energy. PV energy systems are being extensively studied because of its benefits of environmental friendly and renewable characteristics. Typically, several PV panels are connected in series to provide high-voltage output. However, the PV panels often work in mismatching conditions due to different panel orientations and shadowing effect. This mismatching problem thus reduces the power production of the whole PV string. To overcome the drawback, several literatures have proposed a module integrated converter concept. The individual MPP tracking converters are attached to each PV panel for extracting its maximum power. Such a PV module composed of a PV panel with an individual DC-AC inverter is called solar micro-inverter. This talk initially presents an overview of the speaker's current research and continues by covering trends as well as the latest advances in power electronics field. The talk particularly focuses on a highly efficient micro-inverter for photovoltaic panels, developed at National Taiwan University of Science and Technology. Experimental results of a micro-inverter prototype system will be presented, discussing both challenges and future directions.

Speaker's bio and abstract

Soft Switching Inverters for Renewable Energy

Professor Dehong Mark Xu, Fellow IEEE

Zhejiang University

Bio: Dehong Xu (F'13) received the B.S., M.S., and Ph.D. degrees from the Department of Electrical Engineering, Zhejiang University, Hangzhou, China, in 1983, 1986, and 1989, respectively. Since 1996, He becomes a full professor in College of Electrical Engineering of Zhejiang University, China. He is interested in power electronics topology and control, power conversion for energy saving and renewable energy. He has authored six books and more than 160 IEEE Journal or Conference papers. He owns more than 30 Chinese patents and 3 US patents. He got four IEEE journal or conference paper awards.

From 2013 He is President of China Power Supply Society. He was at-large Adcom member of IEEE power electronics society from 2006 to 2008. He is an associate editor of both IEEE transaction on power electronics and IEEE transaction on Sustainable Energy. He was general chair of IEEE International Symposium on Industrial Electronics(ISIE2012, Hangzhou), IEEE International Symposium on Power Electronics for Distributed Generation Systems (PEDG2013, Arkansas), and IEEE Power Electronics and Applications(PEAC2014, Shanghai). He is IEEE PELS Distinguish Lecturer in 2015. He is IEEE Fellow.

Abstract: Soft switching has been successfully applied in switching supplies, inverter for induction heating etc. However, application of soft switching to three-phase inverters or converters are not so common up to now. Three-phase converters/inverters are widely used in Data Center, UPS, fast EV chargers, PV/Wind power inverter, and drives. In this presentation a revised version of Space Vector Modulation (SVM) known as Zero-Voltage Switching SVM (ZVS-SVM) is proposed. The fundamental and design of ZVS-SVM is explained. It can realize zero voltage switching for all switching including both inverter bridges switches and the added auxiliary switch for Three-Phase inverters. Then The ZVS-SVM is extended to Three-Phase AC/DC converters. Experiment results of 30kW ZVS inverter are introduced.

In addition ZVS-PWM for single phase PV inverter is introduced. The design of ZVS-PWM scheme is explained to optimize the conversion efficiency. Finally the experiment of the 3kW prototype is introduced.

Speaker’s bio and abstract

Developments of Roadway Powered Electric Vehicles

Professor Chun T. Rim

Korea Advanced Institute of Science and Technology (KAIST)

Bio: Chun T. Rim (M’90–SM’11) received the B.S. degree with Honor in electrical engineering from the Kumoh Institute of Technology (KIT), Korea, in 1985, and the M.S. and Ph.D. degrees in electrical engineering from the Korea Advanced Institute of Technology (KAIST), Korea, in 1987 and 1990, respectively. Since 2007, he has been an associate professor of Nuclear and Quantum Engineering, and an adjunct to Aerospace Engineering in Power Electronics at KAIST. He is currently developing various wireless power technologies including inductive power transfer systems for On-Line Electrical Vehicles and leading the Nuclear Power Electronics and Robots Lab (PEARL) at KAIST. His research areas include wireless electric vehicles, wireless power systems for robots and bio-medical applications, and general unified modeling of power electronics. He has authored or coauthored 142 technical papers, written eight books, and holds more than 141 patents (awarded and pending). He won three prizes awarded by the Korean government and the Best Paper Award of IEEE Transactions on Power Electronics (TPEL) in 2015. He has been the chair of the EV charger committee of KIEE since 2011 and was the chair of wireless power committee of KIPE 2010-2015. He is now an associate editor of IEEE TPEL and the Journal of Emerging and Selected Topics in Power Electronics (JESTPE), a guest editor of IEEE TPEL, Transactions on Industrial Electronics, and JESTPE Special Issue on Wireless Power Transfer, the general chair of the 2014 IEEE VTC-Workshop on Wireless power (WoW), 2015 IEEE WoW, and 2016 IEEE WoW, respectively.

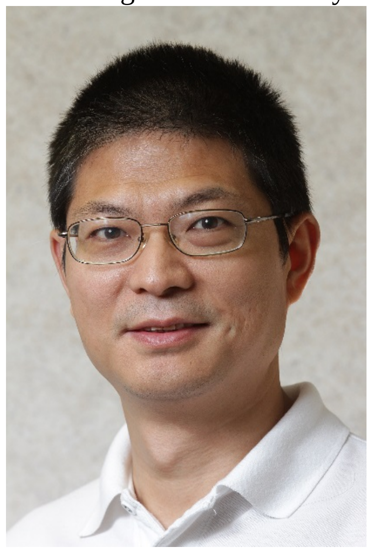
Abstract: As a means of analyzing LC resonant circuits and inductive power transfer (IPT) systems, a gyrator based approach is newly proposed. In most IPT systems, compensation circuits as well as magnetically coupled inductors make the analyses of IPT systems be substantially complicated. A gyrator with an imaginary gain is found to be the equivalent circuit for an LC resonant circuit and a magnetic coupled inductor. Utilizing this fact, the analysis of an IPT system becomes possible based on a circuit analysis without involving lots of cumbersome equations. The application of the proposed gyrator model to a few IPT systems is illustrated, which can be a strong tool for investigating any resonant circuits and IPT systems.

Speaker’s bio and abstract

Capacitive Wireless Power Transfer and Its Applications

Professor Chris Mi, Fellow IEEE

San Diego State University



Bio: Chris Mi is a fellow of IEEE, Professor and Chair of the Department of Electrical and Computer Engineering, and the Director of the US DOE funded GATE Center for Electric Drive Transportation at San Diego State University, San Diego, California, USA. He was previously a professor at the University of Michigan, Dearborn from 2001 to 2015. He received the B.S. and M.S. degrees from Northwestern Polytechnical University, Xi’an, China, and the Ph.D. degree from the University of Toronto, Toronto, Canada, all in electrical engineering. Previously he was an Electrical Engineer with General Electric Canada Inc. He was the President and the Chief Technical Officer of 1Power Solutions, Inc. from 2008 to 2011. He is the Co-Founder of Gannon Motors and Controls LLC and Mia Motors, Inc. His research interests are in electric and hybrid vehicles. Dr. Mi is the recipient of “Distinguished Teaching Award” and “Distinguished Research Award” of University of Michigan Dearborn. He is a recipient of the 2007 IEEE Region 4 “Outstanding Engineer Award,” “IEEE Southeastern Michigan Section Outstanding Professional Award.” and the “SAE Environmental Excellence in Transportation (E2T) Award.” He was also a recipient of the National Innovation Award and the Government Special Allowance Award from the China Central Government. In December 2007, he became a Member of Eta Kappa Nu, which is the Electrical and Computer Engineering Honor Society, for being “a leader in education and an example of good moral character.”

Abstract: Capacitive power transfer (CPT) and inductive power transfer (IPT) are two effective methods to transfer power wirelessly. It has been an established myth that good efficiency and stability of control was only possible in capacitive power transfer (CPT) at low power levels (in the tens of watts) and with low transfer distances (in the millimeter range). Hence, only inductive power transfer (IPT) has been investigated for high power applications, such as charging of electric vehicles (EVs). Dr. Chris Mi and his team have shown that it is possible to achieve excellent efficiencies at the power level and distance applicable to EV charging, breaking the established myth, enabling a paradigm change on EV charging, and making low cost wireless power transfer from science fiction to reality.

The CPT technology utilizes high-frequency alternating electric filed to transfer power without direct electric connection, while the IPT system uses magnetic field to transfer power. The IPT technology has already been widely used in many applications, such as portable electronic devices, biomedical devices, and electric vehicle charging. Compared with the IPT system, the CPT system has many advantages. Magnetic fields are sensitive to nearby metal objects and the system efficiency drops quickly with this interference. It can generate eddy current losses, and hence heats in a conductive object, which creates a potential fire hazard. However, the electric filed in the CPT system does not generate significant losses in the metal objects.