ECCE 2023 Program Will Feature Extensive Lineup Of Tutorials

This year's IEEE Energy Conversion Congress & Expo (ECCE 2023), which will be held Sunday, Oct. 29 through Thursday, November 2 in Nashville, Tennessee, will feature 24 tutorials, including both half-day and 1.5-hour sessions, on a wide array of topics relating to power electronics, electric machines, and their applications. Most of these tutorials will be presented on Sunday, with the exception of two 1.5-hour tutorials that will be given on Thursday afternoon. This article presents abstracts for each of the tutorials. For information on tutorial cost and how to register for these sessions, see the Rates & Registration page.

Sunday Morning Sessions (October 29, 2023)

The following three-hour tutorials will be presented on Sunday morning, from 8:30 am to 11:50 am with a 20-minute break from 10:00 am to 10:20 am. In the following descriptions, tutorial ID numbers are shown in parentheses after the title.

Grid Forming Power Converters: Concepts, Implementation And Analysis (Tutorial ID: #318)

Authors: Pedro Rodriguez, Xiongfei Wang, Rolando Burgos and Heng Wu (Academia – Faculty)

Abstract: As the penetration of renewable energy sources driven by grid-connected power converters monotonously increases, unusual interactions between innovative and legacy generation systems become more concerning since they threaten the system's stability and reliability. To address this issue, the hierarchical control of power converters in electrical grids should be revised, and the modelling and analysis methods should be adapted to the new requirements from systems operators.

This tutorial reviews the role of grid-connected power converters, focusing on their critical aspects when working as grid-following converters and grid-forming converters. The tutorial presents the operating principle and controllers of grid-forming converters, analyzes their performance, and discusses relevant implementation approaches. The tutorial also discusses preferred implementations, assessing grid services (inertia emulation, power oscillations damping, voltage/frequency regulation, power quality improvement, island operation, black-start, etc.) under different conditions and applications. Finally, analysis techniques are presented to evaluate the impact of grid-forming converters on grid performance, focusing on dynamic analysis and stability.

Shallow Neural Networks And Deep Learning Applications In Power Electronics And Electrical Drives (#385)

Authors: Giansalvo Cirrincione and Rahul Kumar (Academia – Staff)

Abstract: This tutorial aims to provide an overview of the application of shallow- and deep-neural-based approaches in the field of power electronics and electrical drives. Power electronics and electrical drives have traditionally relied on conventional control methods, however, with advancements in machine learning, shallow- and deep-neural-based strategies have shown great potential to improve the performance and efficiency of these systems.

Shallow neural architectures are often preferred for power electronics and electrical drives due to their simplicity and real-time processing capabilities. On the other hand, deep learning techniques provide a more sophisticated approach to modeling and controlling these systems as well as explain-ability, which can lead to better performance and accuracy. In this tutorial, the recent advances and applications of shallow- and deep-neural-based approaches will be discussed in various domains within power electronics and electrical drives. Additionally, the highlights of the challenges and opportunities for further research in this field will be covered.

GaN FETs And GaN Integrated Circuits for DC-DC And Motor Drives Applications (#443)

Authors: Marco Palma and Michael de Rooij (Industry, EPC)

Abstract: Gallium nitride (GaN) power semiconductors have seen increased adoption in many power-electronic applications. Recently GaN devices have made inroads into compact and efficient dc-dc converters and BLDC motor drives with surprising benefits that include ultra-low audible emissions, small size, high dc to mechanical

efficiency, reduced component count, and improved precision control when compared to MOSFET-based inverters.

The tutorial aims to provide engineers with the tools and understanding needed to fully utilize the potential of GaN FETs and emerging GaN integrated circuits and be able to implement them in advanced dc-dc converters and in BLDC motor drive applications. Additional details on the characteristics of GaN FETs, designing their applications, and future developments of the GaN FETs will be covered in the tutorial.

SiC Unleashed: Are SiC Technology High Performances Reliable Enough For Your Application? (#368)

Authors: Xuning Zhang, Cesare Bocchiola and Zhiyu Shen (Industry, Microchip Technology)

Abstract: Silicon carbide (SiC) devices enhance power density and efficiency in converters by shrinking passive components. Proper SiC device design ensures reliability in professional, industrial, or high-reliability applications. This seminar presents an in-depth summary of SiC devices and their applications, to help converter designers at different levels to get the full benefits and face the challenges found when using SiC devices; proper design guidelines are also needed to extract the maximum benefit from using SiC devices.

The tutorial covers the device structure and its operation, gate driving design, power stage design, and converter-level optimization aspects. Real-world applications, such as EV chargers and dc solid-state circuit breakers, will be presented, demonstrating the benefits of using SiC devices in system size, weight, and cost reduction compared to Si devices.

Aviation Class Propulsion Solution: Additively Manufactured Motor Coils, Integrated With Modular Motor Drive & Advanced Cooling (#1452)

Authors: Nathan Weise, Ayman EL-Refaie, Armin Ebrahimian, Seyed Iman Hosseini Sabzevari, A. Khan Waqar, Sina Vahid, Ali Al-Qarni, Salar Koushan and Chowdhury Towhid (Academia – Faculty)

Abstract: Transportation electrification has been a focus in academia and industry, particularly in aerospace electrification. Considering the power density and efficiency requirements for aerospace electrification, conventional machine/drive systems might not be feasible for such an application. The Integrated Modular Motor Drive (IMMD) concept, which combines the machine, drive, and cooling systems as a single structure has been investigated.

In this tutorial, the design considerations and requirements for IMMD, as a solution for aviation electrification, are presented. The challenges of designing and characterizing additively manufactured motor coils and paralleling GaN switches are presented, and test results are demonstrated. The advanced cooling system design for both motor and drive systems is described. Finally, the overall integrated system is demonstrated, and the test results are presented.

Integrated Motor Drives, State Of The Art, Challenges, And Emerging Technologies (#1436)

Authors: Lee Empringham, Liliana de Lillo, Xu Deng, Thomas Jahns and Daniel Kernan (Academia – Faculty)

Abstract: The energy savings that can be achieved by driving electrical motors at the desired speed rather than maximum speed using variable frequency converter technologies is clear and accepted within industry. There can be however a general reluctance to retrofit VFDs due to increased infrastructure and installation costs. The integration of power electronic converters into electrical motors to create variable speed integrated motor drives offers many benefits over traditional separated VSDs in terms of installation costs, environmental requirements, and raw material costs.

This tutorial will introduce the concept of the integrated motor drive and summarize the challenges involved with their design and manufacture. The tutorial also discusses the areas of integrated drive topologies and distributed control, wide-bandgap semiconductors and implications for their use in IMDs, systems-based thermal management solutions and emerging technologies. Integrated motor drives from an industrial point of view will be highlighted with a discussion of the constraints and commercial factors in addition to real-world examples of industrial deployment.

Advances In Wireless Power Technology For Electric Vehicles And Smart Devices (#55)

Authors: Chun Rim (Academia – Faculty)

Abstract: Recent advances in wireless power transfer (WPT) technologies offer consumers and industries more convenient, efficient, and intelligent charging of electric vehicles (EVs) and smart devices (SDs) such as smart phones, drones, robots, and IoTs. WPT has been adopted to get free from frequent plug in and out of charging by hand. Heavy and bulky batteries alone cannot solve the energy hungry problem of all mobile things, which should be eventually recharged.

In this tutorial, fundamental principles of WPT including inductive power transfer (IPT) are briefly introduced, and major WPT theories such as coupled-coil model, gyrator circuit model, magnetic mirror model, and general unified dynamic phasor model are explained. Additionally, advances in WPT for EVs are covered for both stationary charging electric vehicles (SCEVs) and roadway-powered electric vehicles (RPEVs).

For the SCEVs, the coil design, large tolerance charging, compensation circuit, and foreign object detection (FOD) issues are addressed in detail. The recent advances in WPT for RPEVs and WPT for SDs will also be covered. Finally, future WPT issues are addressed, which includes interoperable wireless EVs, longer distance IPT, 3D wireless chargers, and synthesized magnetic field focusing (SMF).

Electromagnetic Compatibility Of Switched-Mode Power Supplies (#320)

Authors: Guenter Keller (Academia – Faculty)

Abstract: The tutorial on electromagnetic compatibility of switched-mode power supplies covers various aspects, including legal regulations, emission and immunity standards, test setups, and test parameters. It also discusses four coupling mechanisms (impedance, capacitive, magnetic, and radiated) and basic countermeasures. Signals and characteristics are discussed, including common-mode and differential-mode interferences, Fourier transforms, and the origin of electromagnetic interferences.

The presentation also focuses on EMC design, evaluating efficiency and control issues. Discussions on factor correction, EMC filters, problem-solving approaches, active EMI filters, magnetic components, suitable components, shielding basics, and PCB layout structures will be provided. The tutorial also addresses grounding, component placement, and component selection. The tutorial provides practical examples and basic physics of Maxwell product for a better understanding of electromagnetic compatibility and its impact on efficiency, lifetime, and costs of power supplies.

HVDC Transmission Systems And DC Grids: Developments And Challenges (#856)

Authors: Khaled Ahmed (Academia – Faculty)

Abstract: Large renewable power plants are often located far from consumption centers, making integration challenging. Power electronic interfacing is needed to decouple ac grids, control active and power exchange, and assist renewable power plants to ride-through different ac and dc network faults. Current high-voltage direct current (HVDC) link technologies rely on voltage source converters, but thyristor line-commutated current source converters have limitations. Self-commutated voltage-source-converter HVDC transmission systems were developed to address the shortcomings associated with the line-commutated current-source-converter-based HVDC transmission systems.

The tutorial will cover the integration of large renewable energy plants, including operation, control, and interactions with ac grids. The interactions between current source converter (CSC) and voltage source converter (VSC) based HVDC with ac systems will be analyzed. Ac and dc faults analysis for different HVDC technologies will be discussed. Finally, dc grids will be reviewed and discussed including the theoretical concepts, technology, control, faults, dc-dc embedded, and protection with particular emphasis on practical implementation aspects and on reported operational issues.

In addition to the above three-hour tutorials, the following 1.5-hour tutorials will be presented on Sunday morning.

Gallium Nitride: Device Technologies And Applications (#359, 8:30 am to 10:00 am)

Authors: Davide Bisi (Industry, Transphorm)

Abstract: Gallium nitride (GaN) is gaining popularity in power conversion markets, such as mobile device chargers, power supplies, data centers, renewable energy, and automotive, due to its superior switching performance. This tutorial covers key parameters of power devices, such as on-state resistance, breakdown voltage, and parasitic capacitances, and their impact on conversion losses.

GaN material properties are compared to silicon and silicon carbide, and GaN transistors are discussed for normally-off operations, high current, and voltage ratings (up to 1200 V). Good practices for driving GaN devices fast and reliably are discussed, along with industrial and automotive qualification standards, lifetime tests, transient reliability, and short-circuit capability. The tutorial concludes with a review of main GaN applications, circuit topologies, and design recommendations for efficient and reliable GaN devices.

Z-Source DC Solid-State Circuit Breakers (#980, 10:20 am – 11:50 am)

Authors: Fang Peng, Keith Corzine and Jinyeong Moon (Academia – Faculty)

Abstract: The utilization of dc interconnection in power systems is becoming increasingly prevalent for various reasons, such as the potential for significant savings in power conversion stages and the ease of interconnecting inherently dc-natured components, such as solar panels, fuel cells, and batteries. However, research is still being conducted on circuit breakers, as there is no zero crossing in the current, creating a sustained arc that can potentially damage the switch or cause a fire. Solutions include oversized ac breaker, hybrid breakers, and fully solid-state circuit breaker (SSCB).

The Z-source circuit breaker is a unique type of SSCB based on fundamental Z-source LC circuits. It operates by deactivating the current path in response to a fault without requiring detection circuitry and technique. The Z-source breaker has a rapid turn-off due to its solid-state operation, usually in the microsecond range. It also offers independent operation of multiple breakers in a dc microgrid, allowing only the breaker nearest the fault to be disengaged.

This tutorial will review fundamental Z-source circuits, including coupled-inductor Z-source circuits and utilization in Z-source inverters, and present various variations on the Z-source breaker, including bi-directional topologies. Select examples of Z-source breakers will be utilized throughout the tutorial to illustrate various practical concepts, with simulations of these examples being made available to the tutorial participants.

Sunday Afternoon Sessions (October 29, 2023)

The following three-hour tutorials will be presented on Sunday afternoon, from 1:00 pm to 4:20 pm with a 20-minute break from 2:30 pm to 2:50 pm.

Model Predictive Control: From Theory To Industrial Applications (#165)

Authors: Tobias Geyer and Petros Karamanakos (Industry and Academia, ABB System Drives and Tampere University)

Abstract: Conventional control methods fail to operate the power electronic systems in an optimal manner, causing the underutilization of the existing hardware. An attractive control alternative is model predictive control (MPC) due to its numerous advantages, such as explicit inclusion of design criteria and restrictions, design versatility, and inherent robustness. Due to these features, MPC can bring significant benefits by improving performance metrics (e.g., current distortion, power losses, settling time), and/or reducing the hardware requirements (or, equivalently, by fully utilizing the existing hardware).

The objective of this tutorial is to show MPC-based approaches that improve the performance of power electronic systems. To this aim, different algorithms will be discussed and analyzed, while design guidelines that maximize the performance benefits of MPC will be provided. Moreover, to clearly demonstrate the tangible improvements that MPC brings, it will be shown how MPC paved its way in industry by increasing the rated power of high-power converters, lowering their cost, and guaranteeing their safe operation in the presence of adverse operating conditions. Finally, a critical assessment of the existing MPC methods will be provided, and the tutorial will close with an outlook for MPC in power electronics and possible future research directions.

Power Electronics Intensive Power Systems: Dynamic Modeling And Control, Hardware Testing, And Standardization (#695)

Authors: Xiaonan Lu, Wei Du, Mariko Shirazi, Jing Wang and Christopher Rowe (Academia – Faculty)

Abstract: Research and industry practices are focusing on enhancing grid resilience and stability with increasing inverter-based resources. This includes grid-forming and grid-following inverters, localized and network-interconnected microgrids, and advanced substation modeling and control. The increasing penetration of inverter-based resources in modern power grids requires a paradigm shift towards power-electronics-intensive power systems.

This tutorial will introduce the latest research advances and industry practices on grid-interactive power electronic inverters, focusing on dynamic modeling, control, large-scale hardware-in-the-loop validation, full-scale hardware testing, and industrial standardization. The tutorial covers individual inverters, inverter clusters, 1-MW full-scale hardware test-beds, and very-large-scale power systems with high inverter penetration. The interactive session will encourage audience participation and interest in real-world scenarios and applications.

Artificial Neural Networks For Power Electronics - A Hands-On Approach (#1148)

Authors: Joao Pinto, Burak Ozpineci and Marcio Kimpara (Government, Oak Ridge National Laboratory)

Abstract: Power electronics systems involve various components and applications, including switching devices, digital circuits, microprocessors, and electromagnetic devices. These systems face various problems, including converter design, control, modulation, energy management, system integration, parameter estimation, diagnostics, prognostics, and fault tolerance operation. Data-driven modeling, such as artificial neural network (ANN), is becoming increasingly important for solving these problems.

This tutorial will provide a background in the ANN principles and a practical and detailed description of all phases for using this technique. Then, a discussion of the most common power type of problems in power electronics will be provided. In the sequence, three power electronics problems will be described and the use of ANN to solve them will be addressed in a hands-on approach, i.e., each attendee will design, train, test, validate, software implement, and deploy them during the tutorial, acquiring the knowledge to develop research in ANN applications aimed at power electronics.

Design For Reliability: The Origin Of Aging And Degradation In Advanced Power Modules And Emerging State Of Health (SOH) Estimation Techniques (#574)

Authors: Douglas DeVoto and Faisal Khan (Government, NREL)

Abstract: Designing modern power modules and power converters involves optimizing for a variety of performance metrics including switching efficiency, power density, maximum operating temperature, junction-to-coolant thermal resistance, lifetime, and cost. Many of these targets directly conflict with each other and require a multi-objective optimization strategy. While balancing electrical and thermal requirements is well understood, this tutorial will focus on strategies to introduce reliability optimization earlier in the design process and the failure modes in modern power converters.

Common failure locations (e.g., wire bonds, solder interface) and mechanisms within traditional automotive power electronics package designs and reliability concerns associated with packaging at higher temperatures and higher heat fluxes will be discussed. Novel materials, manufacturing methods, and packaging solutions will be presented that increase overall power module package reliability. Modeling procedures will demonstrate optimization strategies for thermomechanical performance and validation methods to accelerated test profiles and operation profiles will be reviewed.

Cryogenic Power Electronics Design For Electrified Aircraft Propulsion (#332)

Authors: Fei (Fred) Wang, Zhang Zheyu, Cheng Ruirui and Dam Shimul (Academia – Faculty)

Abstract: Cryogenic power electronics offer numerous game-changing benefits, including 1) improved performance of power semiconductor devices, such as silicon (Si)- and gallium nitride (GaN)-based, offering decreased specific on-state resistance and increased switching speed; 2) faster switching frequency operation at cryogenic temperature, greatly reducing the need for passives (e.g. EMI filtering); thereby reducing filter weight; 3) less cooling requirement at extremely low ambient temperatures, and 4) light and/or efficient busbar designs due to the low resistivity of conductors at cryogenic temperature.

This tutorial will provide several key perspectives for the cryogenic power electronics design from the component up to the converter level. First, the characteristics of critical components, including power semiconductors and magnetics, at cryogenic temperature are introduced. Second, special considerations, trade, and design studies of cryogenic power stage and filter are discussed. Then, two examples of a 40-kW Si-based and a 1-MW SiC-based cryogenically cooled inverter system for electric aircraft propulsion are illustrated, with cooling design, safety considerations, and the protection scheme highlighted.

Reliability Requirements And Qualification Of Automotive Power Semiconductor (#1161)

Authors: Layi Alatise, Jose Ortiz-Gonzalez and Don Gajewski (Academia – Staff)

Abstract: Wide bandgap devices (WBG) are becoming increasingly popular in automotive applications, particularly in traction inverters and battery chargers. The mission profile of the traction inverter is a particularly aggressive one since the electrothermal stresses on the power devices vary significantly in amplitude and frequency as the motor drive goes through various stages of the drive cycle including acceleration, deceleration, stalling etc.

The traction converter has been implemented using silicon devices where the performance and reliability is well known and understood. Application of WBG devices like SiC MOSFETs and GaN power devices in automotive applications requires understanding of the reliability and qualification procedures especially according to the automotive standard.

This tutorial aims to introduce subjects related to WBG device physics, operation, reliability, application-specific requirements, and test methodologies and specifications. The tutorial is a joint lecture delivered by power device experts from academia (University of Warwick) and industry (Wolfspeed). Attendees will gain a better understanding of the reliability and robustness requirements of power devices used in automotive applications.

Advanced Data-Driven And Digital-Twin Enabled Power-Electronics-Intensive Battery Management Systems And Fast Charging (#75)

Authors: Sheldon Williamson, Uday Deshpande and Akash Samanta (Academia – Faculty)

Abstract: Lithium-ion batteries (LIBs) are crucial for the technical and commercial success of electrified transport systems. Understanding battery technology is essential for both technical and user aspects. Range anxiety and reliability are bottlenecks in the widespread adoption of EVs, and intelligent safety frameworks and smart battery management systems (BMSs) are essential for safe, reliable, and longer battery life. Ineffective BMS, particularly poor thermal management control, contributes to frequent fire incidents in EVs.

Intellectual state estimation techniques, such as artificial intelligence, machine learning, and deep learning, are used to ensure reliable operation of BMSs. High-resolution data is collected and processed using IoT platforms, such as cloud computing and data storage. All these aspects will be discussed with examples in this tutorial. Furthermore, the application of microcomputers and new-gen computing platforms, such as edge-computing and fog-computing will also be discussed.

Fast charging has reduced range anxiety but increased thermal runaway risks. Recent developments, such as constant temperature constant voltage (CTCV) charging and modular multilevel converter (MMC)-based cell balancing and protection techniques, are discussed in the tutorial. Health-conscious BMS and ways to extend battery useful life are also covered. The application of higher-order cell electrical and thermal modeling is also discussed in battery emulator development. Finally, recent R&D issues, challenges, and case studies of existing BMS methods and thermal management systems will be explained.

Next-Generation Medium- And High-Voltage High-Power All Silicon Carbide Modules: Design, Characterization, And Applications (#544)

Authors: Kraig Olejniczak, Ashish Kumar, Ahmed Ismail, Yue Zhao and Juan Balda (Industry, Wolfspeed; Academia, University of Arkansas)

Abstract: The medium-voltage (MV) applications, such as railway traction and industrial motor drive systems and renewable energy systems, have traditionally utilized MV silicon IGBTs based power modules. These and many other applications can benefit from the recent advancements in MV and high-voltage (HV) silicon carbide (SiC) technology to increase the converter efficiency and the power density. In this seminar, the presenters

from industry and academia will present the latest advancement in MV/HV high power SiC power module technology, from the latest package design to their real-world applications.

This presentation starts with a comprehensive review of packaging technology and state-of-the-art for MV/HV SiC power modules, including 3.3 kV, 6.5 kV, 10 kV and beyond. Then the application-specific characterization, power cycling and lifetime prediction methods will be presented, followed by the session of reference designs on gate drivers and converters. In addition, various case studies, e.g., isolated power converters for data center applications and MV dc chargers, will be presented to highlight the system-level benefits brought by these SiC MV/HV power modules.

General Airgap Field Modulation Theory For Electrical Machines And Its Applications In Automotive And Aerospace Industries (#64)

Authors: Ming Cheng, Peng Han and Le Sun (Academia – Faculty)

Abstract: The demand for high-performance electrical machines is increasing due to the rapid development of the social economy. Application areas of electrical machines have extended from conventional industrial drive to aerospace, transportation, numerical control machine tools, robots, and other high-tech fields. This tutorial will provide an overview of airgap magnetic field modulation phenomena observed in electrical machines and the general airgap field modulation theory.

The theory unifies analysis of various electrical machines, including conventional dc machines, induction machines, and synchronous machines, and enables the creation of new electrical machine topologies. The tutorial covers key concepts in electrical machine engineering, specialized analysis, and applications, including the stator-PM variable reluctance resolver and dual-rotor power-split machine for hybrid electric vehicles.

By the end of the tutorial, attendees will understand the historical development of electrical machines, the general airgap field modulation theory framework for design, analysis, and innovation, and be able to apply the theory in qualitative and quantitative analysis of machine performance and inventing emerging machine topologies to meet various application needs.

In addition to the above three-hour tutorials, the following 1.5-hour tutorials will be presented on Sunday afternoon.

Wide Bandgap Device Based Power Electronics For Aerospace Applications (#1280, 1 pm – 2:30 pm)

Authors: Jin Wang (Academia – Faculty)

Abstract: Aerospace applications are potentially the final frontiers for power electronics research and developments. In aviation, electric aircraft including unmanned aerial vehicles (UAVs), and electric vertical take-off and landing (e-VTOLs) require a new generation of power converters, motor drives, and circuit breakers with unprecedented power density, efficiency, and reliability. On the space side, lunar, Mars, and deep space expeditions require lightweight, highly efficient power electronics systems.

Wide bandgap (WBG) power devices, such as silicon carbide diodes, MOSFETs, and GaN HEMTs, are considered as candidates for aerospace applications. Challenges for WBG devices include radiation hardness, extreme operating temperature, high altitude, voltage, and di/dt operation induced issues such as lower partial discharge inception voltage and higher EMI noises.

The tutorial will introduce the state-of-the-art of power electronics devices and circuits for aerospace applications, then will dive into detailed discussions on the challenges. Design examples for both electric propulsion and lunar surface power distribution will be introduced in detail. This tutorial is designed for intermediate-level professionals interested in recent developments in power electronics devices and circuits.

Understanding Of Observed Switching Waveform For High-Speed SiC Devices: From Application Perspectives With Analytical Insights (#330, 2:50 pm – 4:20 pm)

Authors: Xu She and Zheyu Zhang (Industry, Lunar Energy)

Abstract: SiC power devices are revolutionizing next-generation power electronics, with high-speed switching being a key feature for many applications such as electric vehicles, photovoltaics, and energy storage systems. High-speed switching is one of the key features, enabling SiC-based power electronics to be highly efficient and

ultra-dense. Therefore, high-fidelity switching data based on switching testing has become an essential step for high-precision device datasheets, product design optimization, and SiC-based R&D activities.

However, measured SiC switching waveforms are non-ideal and sensitive to test circuit design, measurement system, and operator. These discrepancies can be confusing due to circuit parasitics, load high-frequency characteristics, measurement setup, probing, and other factors. This tutorial aims to understand the observed switching waveforms for high-speed SiC devices by focusing on parasitics, load, and measurement.

The tutorial will cover the overview and impacts of parasitics in the switching loop considering the physical implementation in the actual circuit. The comparative analysis with load will also be provided starting from the load modeling considering the high-frequency characteristics, its impact on switching behavior will be quantified based on the circuit. The measurement, including grounding loop effects due to probing and the probe location-induced measurement error will be discussed.

The tutorial will cover both the industry SiC products and laboratory engineering prototypes. The theoretical analysis will be demonstrated using simulation, enhancing understanding, and introducing interactive instructor-audience approaches.

Thursday Afternoon Sessions (November 2, 2023)

Supplementing the many tutorials presented on Sunday, the following 1.5-hour tutorials will be presented on Thursday afternoon from 4:00 pm to 5:20 pm.

Advancements In Digital Design And Manufacture Of Electric Propulsion Motors (#663)

Authors: Phil Mellor, Nick Simpson, Mircea Popescu, Melanie Michon and Josh Hoole (Academia – Faculty)

Abstract: Electric propulsion is a crucial solution for improving energy efficiency and reducing CO_2 emissions in transportation. Industry-led technology roadmaps aim to reduce the volume and cost of active materials in propulsion motor technologies. Potential solutions include increased motor speeds and higher pole numbers and/or topologies such as reluctance and induction machines with reduced dependence on rare-earth materials.

In high-performance, weight-critical applications such as aircraft the limitations of conventional electrical machine construction, comprising laminated iron and organic polymer insulated magnet wire coils, is becoming a major barrier to future performance improvement. Reliability and longevity are also important considerations particularly in understanding the impact of the adoption of new designs, materials and manufacture. Design software needs to become sophisticated to cater to new technological developments and provide valuable experience for non-specialist users.

The tutorial will explore the prospects of advancements in new materials and net shaped manufacture alongside computational intelligence in addressing the challenges of an increasingly digital design environment in automotive and aerospace applications. The tutorial will also discuss the potential of metal additive manufacture, composites with directional thermal, mechanical, and electromagnetic properties, and X-ray tomography for assessing manufacturing variability and degradation in electrical machine windings.

New Advances And Trends On Model Predictive Control For Power Electronics And Electrical Drives (#72)

Authors: Marco Rivera and Patrick Wheeler (Academia – Faculty)

Abstract: In the last decades, the application of fast, modern microcontrollers have been continuously growing, allowing the development and implementation of new and more-intelligent control strategies as an alternative to conventional techniques for power converters. Model Predictive Control is one of these powerful and attractive alternatives that has received a lot of attention in recent years.

The use of predictive control offers several interesting advantages: it is an intuitive control approach, it does not need linear controllers and modulators, and it is possible to easily include nonlinearities and restrictions in the control law. It is expected that the advantages of predictive control will lead to industrial applications in the very near future. In this tutorial new advances and trends in the application of model predictive control for power electronics and electrical drives will be presented.