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PROGRAM

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2023

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Welcome

It is our great pleasure to welcome you to the 14th IEEE International Electric Machines and Drives Conference (IEMDC 2023) in San Francisco, CA. IEMDC is one of the major conferences in the area of electric machines and drives and is co-sponsored by four IEEE societies: the Industry Application Society (IAS), the Industrial Electronics Society (IES), the Power Electronics Society (PELS), and the Power and Energy Society (PES). The conference was established in 1997 and has taken place every two years thereafter. IEMDC brings together researchers, engineers, industry experts, and practitioners to share their innovative concepts and research outcomes related to electric machines, drives and their emerging applications.

The conference program includes exceptional tutorials, thought-provoking technical sessions, and an interesting exhibition. Plenary talks will be delivered by renowned experts from ZeroAvia, the U.S Navy, Tesla, and Joby Aviation.

While in San Francisco, we hope you find time to visit the city's several iconic sights and landmarks as well as beautiful scenery. The city also has charming neighborhoods, spectacular parks and interesting museums.

We would like to express our sincere gratitude to the IEMDC 2023 Organizing Committee, technical track chairs, special session organizers and reviewers for their hard work. We are also very thankful to all attendees including speakers, authors, presenters, session chairs, exhibitors, sponsors and all volunteers who were involved in the conference.

We hope you have a great time at IEMDC 2023 and thank you for your support and participation.

Leila Parsa
Gerard- Andre Capolino
IEMDC 2023 General Chairs

Organizing Committee

Organizing Committee Chairs

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TT-1 – Rotating Electric Machines
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> Antonio Cardoso
> Mircea Popescu
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TT-2 – Electric Drives
> Marko Hinkkanen
> Di Zhang
> Fabio Mandrile
> Di Pan

TT-3 – Special Machines, Electromagnetic Actuators and Sensors
> Ronghai Qu
> Alireza Siadatan
> Matthew Gardner

TT-4 – Thermal, Materials and Efficiency Issues
> Michael Galea
> Luca Ferraris
> Sandro Rubino
> Jose E. Ruiz Sarrió

TT-5 – Design Optimization, Modelling and Simulation
> Maarten Kamper
> Juan Tapia
> Simone Ferrari
> Ebrahim Amiri

TT-6 – Condition Monitoring, Fault Diagnosis and Prognosis
> Thomas Wolbank
> Jose Antonino Daviu
> Lucia Frosini

TT-7 – Transportation Applications
> Paolo Pescetto
> Jiangbiao He
> Jahirul Islam

TT-8 – Energy and Grid-Connected Applications
> Radu Bojoi
> Yilmaz Sozer
> Pinjia Zhang

Special Session Chairs

SS-1 – Measurement and Self-Commissioning Techniques for AC Motor Drives
> Pescetto Paolo
> Ludovico Ortombina

SS-2 – Novel Multi-Torque Component Machines
> Shaofeng Jia
> Lijian Wu

SS-3 – NVH Mitigation Techniques for High Power Density Electric Machines
> Haiyang Fang
> Tianjie Zou

SS-4 – Learning-based Electric Machine Design & Optimization
> Bingnan Wang

SS-5 – Open Science for Advancing Research and Education of Electric Machines and Drives
> Oliver Wallscheid
> Marko Hinkkanen

SS-7 – Additive Manufacturing of Electric Machines
> Toomas Vaimann
> Ants Kallaste

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Agenda
PROGRAM AT A GLANCE

Monday, May 15, 2023

7:30 AM – 6:00 PM	**Registration** CYRIL MAGNIN FOYER		
8:00 AM – 11:30 AM	**Tutorials** *(Note there will be a Coffee Break from 9:30 AM – 10:00 AM in the Cyril Magnin Foyer)*		
	ROOM: CYRIL MAGNIN I	ROOM: POWELL	ROOM: MISSION
	Tutorial 1: General Airgap Field Modulation Theory for Electrical Machines and Its Applications in Automotive and Aerospace Industries	**Tutorial 2: High Power Density Motor Equipped with Additively Manufactured Windings Integrated with Advanced Cooling & Modular Integrated Power Electronics**	**Tutorial 3: Self-bearing Linear-Rotary Actuators with Wireless Power Transfer for High-Purity and Precision Applications**
11:30 AM – 1:00 PM	**Lunch On Your Own**		
1:00 PM – 4:30 PM	**Tutorials** *(Note there will be a Coffee Break from 2:30 PM – 3:00 PM in the Cyril Magnin Foyer)*		
	ROOM: CYRIL MAGNIN I	ROOM: POWELL	ROOM: MISSION
	Tutorial 4: Overview of Recent Research Development of Novel DC Biased Current Flux Modulated Machines	**Tutorial 5: Design and Implementation of Decoupled Torque Controllers for Multi-Three-Phase Motor Drives**	**Tutorial 6: Advanced Hairpin Winding Technology: Design, Manufacturing, and Thermal Management**
6:00 PM – 8:00 PM	**Welcome Reception** CYRIL MAGNIN BALLROOM		

Tuesday, May 16, 2023 *Expo Open 12:00 PM – 5:00 PM*

7:30 AM – 6:00 PM	**Registration** CYRIL MAGNIN FOYER			
8:00 AM – 8:15 AM	**Opening Remarks** CYRIL MAGNIN BALLROOM			
8:15 AM – 9:35 AM	**Plenary Session I** CYRIL MAGNIN BALLROOM			
8:15 AM – 8:55 AM	**Keynote – Dr. Youcef Abdelli**			
8:55 AM – 9:35 AM	**Keynote – CAPT Lynn "LJ" Petersen, USN (Ret)**			
9:40 AM – 10:00 AM	**Coffee Break** CYRIL MAGNIN FOYER			
10:00 AM – 12:00 PM	**Oral Sessions**			
	ROOM: CYRIL MAGNIN I	ROOM: CYRIL MAGNIN III	ROOM: POWELL	ROOM: MISSION
	Session 1: Rotating Electric Machines 1	**Session 2: Electrical Drives 1**	**Session 3: Design Optimization, Modelling and Simulation 1**	**Special Session 1: Measurement and Self-Commission Techniques for AC Motor Drives 1**
12:00 PM – 1:30 PM	**Lunch** CYRIL MAGNIN FOYER			
1:30 PM – 3:30 PM	**Oral Sessions**			
	ROOM: CYRIL MAGNIN I	ROOM: CYRIL MAGNIN III	ROOM: POWELL	ROOM: MISSION
	Session 4: Rotating Electric Machines 2	**Session 5: Electrical Drives 2**	**Session 6: Thermal, Materials and Efficiency Issues 1**	**Session 7: Transportation Applications**
3:30 PM – 4:00 PM	**Coffee Break** CYRIL MAGNIN FOYER			
4:00 PM – 6:00 PM	**Oral Sessions**			
	ROOM: CYRIL MAGNIN I	ROOM: CYRIL MAGNIN III	ROOM: POWELL	ROOM: MISSION
	Session 8: Rotating Electric Machines 3	**Session 9: Electrical Drives 3**	**Session 10: Thermal, Materials and Efficiency Issues 2**	**Session 11: Special Machines, Electromagnetic Actuators and Sensors 1**

Wednesday, May 17, 2023 *Expo Open 9:00 AM – 5:00 PM*

7:30 AM – 6:00 PM	**Registration** CYRIL MAGNIN FOYER			
8:10 AM – 9:30 AM	**Plenary Session II** CYRIL MAGNIN BALLROOM			
8:10 AM – 8:50 AM	**Keynote – Dr. Konstantinos Laskaris**			
8:50 AM – 9:30 AM	**Keynote – Jon Wagner**			
9:40 AM – 10:00 AM	**Coffee Break** CYRIL MAGNIN FOYER			
10:00 AM – 12:00 PM	**Oral Sessions**			
	ROOM: CYRIL MAGNIN I	ROOM: CYRIL MAGNIN III	ROOM: POWELL	ROOM: MISSION
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12:00 PM – 1:30 PM	**Lunch On Own**			
1:30 PM – 3:30 PM	**Oral Sessions**			
	ROOM: CYRIL MAGNIN I	ROOM: CYRIL MAGNIN III	ROOM: POWELL	ROOM: MISSION
	Session 15: Rotating Electric Machines 5	**Session 16: Electrical Drives 5**	**Session 17: Special Machines, Electromagnetic Actuators and Sensors 3**	**Session 18: Energy and Grid-Connected Applications**
3:30 PM – 4:00 PM	**Coffee Break** CYRIL MAGNIN FOYER			
4:00 PM – 5:30 PM	**Poster Session 1** CYRIL MAGNIN FOYER			
6:00 PM – 8:00 PM	**Banquet** CYRIL MAGNIN BALLROOM			

Thursday, May 18, 2023 *Expo Open 9:00 AM – 3:00 PM*

7:30 AM – 12:00 PM	**Registration** CYRIL MAGNIN FOYER			
8:00 AM – 10:00 AM	**Oral Sessions**			
	ROOM: CYRIL MAGNIN I	ROOM: CYRIL MAGNIN III	ROOM: POWELL	ROOM: MISSION
	Session 19: Rotating Electric Machines 6	**Session 20: Design Optimization, Modelling and Simulation 2**	**Session 21: Condition Monitoring, Fault Diagnosis and Prognosis 1**	**Special Session 4: Learning-based Electric Machine Design & Optimization**
10:00 AM – 10:20 AM	**Coffee Break** CYRIL MAGNIN FOYER			
10:20 AM – 12:20 PM	**Oral Sessions**			
	ROOM: CYRIL MAGNIN I	ROOM: CYRIL MAGNIN III	ROOM: POWELL	ROOM: MISSION
	Session 22: Rotating Electric Machines 7	**Session 23: Design Optimization, Modelling and Simulation 3**	**Session 24: Condition Monitoring, Fault Diagnosis and Prognosis 2**	**Special Session 5: Open Science for Advancing Research and Education of Electric Machines and Drives**
12:20 PM – 1:30 PM	**Lunch On Own**			
1:30 PM – 3:00 PM	**Poster Session 2** CYRIL MAGNIN FOYER			
3:00 PM – 3:20 PM	**Coffee Break** CYRIL MAGNIN FOYER			
3:20 PM – 5:20 PM	**Oral Sessions**			
	ROOM: CYRIL MAGNIN I	ROOM: CYRIL MAGNIN III	ROOM: POWELL	ROOM: MISSION
	Session 25: Rotating Electric Machines 8	**Session 26: Condition Monitoring, Fault Diagnosis and Prognosis 3**	**Special Session 2: Novel Multi-Torque Component Machines**	**Special Session 3: NVH Mitigation Techniques for High Density Electric Machines**

Plenary Sessions
KEYNOTE SPEAKERS

Tuesday, May 16 | 8:15 AM – 8:55 AM
CYRIL MAGNIN BALLROOM

How Hydrogen eDrive System Will Enable Sustainability and Zero Emission of Air Transportation/*Challenges, Trends and Road Map*

Dr.Youcef Abdelli

CTO and Chief Engineer Propulsion at ZeroAvia

BIO: Dr. Youcef Abdelli comes from an extensive aerospace background in electric aircraft programs (Amazon Prime Air, MagniX , Liebherr, Airbus, Safran). His expertise in aircraft electrical systems, generation and distribution , power electronics hardware, software and propulsion systems. Before ZeroAvia , he worked for Amazon Prime Air, where he was the principal and chief engineer leading the propulsion and battery systems department for the drone division. Prior to Amazon, he worked for magniX where he led electric propulsion system development for current product lines and head of the power electronics department. He developed an industrial aerospace-grade power electronics system that was integrated in a successful test flight of a Beaver in Dec 2019 with Harbour Air and with a Caravan in Moses lack on 2020 .He was one of the key members of Propulsion special conditions establishment with the FAA. Prior to that, he worked for Liebherr aerospace, where he was the chief engineer and power electronics senior expert fellow, working on different successful aerospace (Civil and military) and automotive (Fuel cell electric compressors) projects. At ZeroAvia, he is the CTO and chief engineer for propulsion system, he is in charge of the development of an industry-leading aerospace-grade electric propulsion system , technology road map and strategy - Youcef Abdelli earned his PhD in Electrical Engineering and Electronics from the Polytechnic School of Nantes University.

Tuesday, May 16 | 8:55 AM – 9:35 AM
CYRIL MAGNIN BALLROOM

A History of Silicon Carbide (SiC) Wide Bandgap (WBG) Advancement through Power Electronic Building Blocks (PEBB) and Implications for the Future

CAPT Lynn "LJ" Petersen, USN (Ret)

Ret US Navy

BIO: Mr. Petersen graduated from the United States Naval Academy, Annapolis, MD with a BS in Mathematics in 1986 and commissioned an Ensign in the US Navy. Selected as an Engineering Duty Officer, he received a MS in Mechanical Engineering from the Naval Postgraduate School, 1994. Following Active Duty, he was an Electrical Engineer at NSWC, Carderock Division, Annapolis, MD. Hired by ONR in May 2006, he served as S&T rep to the Electric Ships Office (ESO), PMS 320. Recalled to Active Duty, in 2008, with assignment as the Deputy Director, PMS 320, from 2008-2012. Promoted to Captain in 2009, he retired from the Navy in 2016 following 30 years of service. From 2012-2014, he was the Navy's Director for Systems Engineering, assigned in Deputy Assistant Secretary of the Navy for Research, Development, Test and Evaluation (DASN RDT&E.) Mr. Petersen returned to ONR in 2014 and leads basic research in power electronics, electromagnetism, and adaptive controls and applied research in machinery controls, wide bandgap (WBG) semiconductor applications, Medium Voltage Direct Current (MVDC) power distribution systems, and Power Electronic Power Distribution Systems (PEPDS.) Married to Alena, they have two adult children. Senior member of IEEE, member of ASNE and the MRS. He and Alena are active in their church and singing.

Wednesday, May 17 | 8:10 AM – 8:50 AM
CYRIL MAGNIN BALLROOM

The Evolving Design Target of Drive Systems as EVs Are Becoming Mainstream

Dr. Konstantinos Laskaris

Tesla – Principal Motor Designer

BIO: Dr. Konstantinos Laskaris was born in Athens, Greece. He received his diploma in Electrical and Computer Engineering from the National Technological University of Athens (NTUA), his master's degree in Signal Processing from the Imperial College London, UK, and his PhD in Electric Motor geometry optimization for variable speed drives from the NTUA, Greece. Dr Laskaris joined Tesla in 2012 and is currently Director of Motor engineering and humanoid robot actuator systems . Some of his most significant projects at Tesla include the drive unit system design and optimization for Model S, Model X, Model 3, Model Y, Semi-Truck and Cybertruck as well as the actuator systems for the Tesla humanoid robot. His research interests include parametric design, loss modeling and optimization of rotating machines and drive systems, using supercomputers.

Wednesday, May 17 | 8:50 AM – 9:30 AM
CYRIL MAGNIN BALLROOM

Motors and Drives for Electric Flight

Jon Wagner

Joby Aviation

BIO: Jon leads Powertrain and Electronics design engineering at Joby Aviation, a California-based company developing and manufacturing electric vertical take-off and landing (eVTOL) aircraft for commercial passenger use. After undergraduate and graduate studies in Mechanical Engineering at Stanford University, he designed robotics and automation systems for life sciences with roles at Velocity11 and Agilent Technologies. He then drove the strategic direction for technology development as the CTO for Mission Motors, an electric vehicle powertrain development company. Jon then joined Tesla as the Senior Director of Battery Engineering and helped commercialize Model S/X, oversaw the battery development for home and grid scale battery systems, and led the development of the low cost battery pack for Model 3 and Y. For the past 5 years at Joby Aviation, Jon has led the in-house design and commercialization effort for propulsion motors, servo motors, motor drives, batteries, low voltage controllers, and power distribution.

Tutorials

Monday, May 15 | 8:00 AM – 4:30 PM

More information may be found at **IEMDC.org**

Monday, May 15 | 8:00 AM – 11:30 AM

Tutorial 1: General Airgap Field Modulation Theory for Electrical Machines and Its Applications in Automotive and Aerospace Industries

CYRIL MAGNIN I

Instructors:
Ming Cheng, *Southeast University*
Peng Han, *Ansys, Inc.*
Le Sun, *Nanjing University of Science and Technology*

Electrical machines are devices that convert mechanical energy into electrical energy or vice versa. They were invented in the 1800s and have a history of nearly 200 years. Other inventions of similar ages, such as the Watt steam engine, telegraph, incandescent light bulb, etc., have been outdated by emerging technologies. By contrast, the electrical machine shows great tenacity and vitality, becoming a living fossil of the Industrial Revolution.

Demand for high-performance electrical machines is increasing day by day with the rapid development of our 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, ranging from deep below the surface of the earth to deep space, from the furthest depths of the ocean to the surfaces of land and sea.

Tutorial 2: High Power Density Motor Equipped with Additively Manufactured Windings Integrated with Advanced Cooling & Modular Integrated Power Electronics

POWELL

Lead Instructors:
Nathan Weise, Ayman EL-Refaie, *Marquette University*

Co Instructors:
Armin Ebrahimian,Waqar A. Khan, Iman Hosseini, Sina Vahid, Ali Al-Qarni, Salar Koushan, Towhid Chowdhury, *Marquette University*

Transportation electrification has been the center of many research projects in both academia and industry over the past decade. There has been special focus on aerospace electrification over the past few years. As the core of hybrid/electric propulsion systems, electric machines and their drive systems have been at the center of these research efforts. Considering the power density and efficiency requirements for aerospace electrification, conventional machine/drive systems might be not feasible for such an application. To that end, the concept of integration of the machine, drive system, and cooling system has been investigated. Such a concept is known as Integrated Modular Motor Drive (IMMD) in which the machine, drive and cooling system are integrated and considered as a single structure.

On the drive side, the possibility of achieving high power density and efficiency is increased by the emergence of the wide band gap devices (WBGDs). Their intrinsic benefits like, low on-state resistance, and fast turn on/off speed contribute to lower conduction and switching losses which in turn lead to higher efficiency. Furthermore, their ability to function at higher junction temperature relative to their Silicon (Si) counterparts, reduce the cooling system requirements. Optimal design, including board layout, and component selection, is of high importance while using the WBGD, due to the effect of parasitics on the overall performance.

On the machine side, the focus is typically on increasing the machine electric and magnetic loading as well as the mechanical tip speed. This can be achieved via novel machine topologies, advanced materials, advanced manufacturing as well as integrated systems with shared advanced cooling.

In this tutorial, the step by step design of a motor and its integrated derive system is presented. The advanced cooling system design for both motor and drive system is described. Finally, the overall integrated system is demonstrated and some test results are presented.

Tutorial 3: Self-bearing Linear-Rotary Actuators with Wireless Power Transfer for High-Purity and Precision Applications

MISSION

Instructor:
Dr. Spasoje Miric, *ETH Zurich & University of Innsbruck*

Linear and rotary actuators (LiRAs) are used in high-end applications, such as pick-and place robots in the semiconductor/pharmaceutical industry or implantable blood pumps, with incredibly high hygiene and high-precision requirements (sub-µm range). Self bearing actuators should be employed to accomplish such high demands. The self bearing feature is enabled by integrating magnetic bearings (MBs) into a LiRA or by incorporating a pump into a

LiRA where hydraulic bearings (HBs) are realized. Both self bearing enablers, MBs and HBs, feature high purity since there is no wear-and-tear, and MBs allow for high precision. Finally, the actuator's supply must comply with high hygiene requirements and, therefore, moving cables and cable carriers are replaced by wireless power transfer (WPT) technology enclosed in conductive stainless steel. The WPT system achieves exceptionally high efficiency when the coupling magnetic field is parallel to the stainless steel enclosure sheets.

This Tutorial will first discuss the applications of the LiRAs and highlight the challenges arising from the application requirements and explain how these challenges are overcome with self-bearing LiRAs. We will then focus on the self-bearing LiRAs with MBs, where we will first explain how to incorporate MBs into a linear actuator (LA) and, thereby, within the same volume as the original LA. We will show how the phase currents of such a newly conceived actuator are decoupled for the combined windings to control the linear drive force and the MB radial force. We will then focus on integrating MBs into a LiRA and show what integration options exist. We will compare these options using scaling laws specially derived for this purpose and clarify which should be chosen regarding the application. We will explain the automatized geometry optimization for the actuator design, which couples analytic thermal models and numerical magnetic FEM models. Next, we will discuss the implantable LiRA blood pump, where the pumping feature ensures hydraulic bearings of the mover and, therefore, enables self-bearing characteristics. The pump is intended to be used as a total artificial heart, requiring an extremely compact and efficient design of the LiRA. Finally, we will show WPT through stainless steel (SS) technology that is used for supplying moving equipment in environments with high hygiene requirements, e.g., clean rooms in the semiconductor industry.

For the discussed topics, hardware demonstrators and measurements that verify newly proposed self-bearing LiRAs and WPT technology will be shown. They highlight the current research on advanced mechatronics at the Power Electronics Systems Laboratory of ETH Zurich.

Monday, May 15 | 1:00 PM – 4:30 PM

Tutorial 4: Overview of Recent Research Development of Novel DC Biased Current Flux Modulated Machines

CYRIL MAGNIN I

Instructors:

Shaofeng Jia, Deliang Liang, *Xi'an Jiaotong University*

With the rapid development of rail transit, ship electrification, multi-electric/all electric aircraft, robots, and new energy vehicles, etc., electric machines play a more and more important role nowadays. In recent decades, in the field of electric machines, in addition to the popular permanent magnet machines (PMSMs) which are characterized with high power density, high efficiency, etc. benefiting from the use of high magnetic energy magnet materials, a family of flux-modulated machines (FMM) have been gaining more and more research attention thanks to their extremely super-high torque density. The most remarkable feature of FMMs is that the number of the stator pole pairs and the rotor pole pairs are not equal. With the permeance modulation effect of the iron poles, the mechanical speed of the machine is reduced, and the output torque is increased. It is also found that vernier machine

(VM), flux switching machine (FSM), etc. have been proven to follow the same principle of flux modulation and can therefore be considered as parts of the FMM family.

Flux modulated machines have evolved from traditional synchronous machines. In conventional synchronous machines, pure sinusoidal AC current is usually supplied to the armature winding. Therefore, the research on flux modulation machine is mainly focused on topological structure and optimization design, while in the aspect of its control, although some control strategies have been studied, the phase current is still with pure sinusoidal current. However, the advancement of power electronics, control theory, and microprocessor technology make great contribution to the realization of complex current control.

Over the past several years, some researchers have published the research achievements about DC-biased current vernier or flux modulation-based machines. The so-called DC-biased current superimposes a dc component in addition to the traditional pure sinusoidal current in the phase winding. These research show that the performance of the flux modulated machines is improved by using DC-biased current, and the most significant benefit is that the output torque is greatly enhanced. In summary, a new kind of machine family has been formed.

This tutorial makes a comprehensive overview of the related research of the DC biased current flux modulated machine family, and makes some analogies with typical traditional machines (including rotor electrically excited synchronous machine, switched reluctance machine, etc). The tutorial contains six parts, Part I is the introduction of relevant research background, and Part VI is about the conclusions and prospects. The main contents are Part II to Part V, in which four novel flux modulated machines with DC or DC-biased current are illustrated. Part II introduces stator electrically excited vernier machine. Part III mainly presents the dc-biased current vernier reluctance machines. Part IV displays the dc-biased current vernier PM machines, and Part V introduces dc-biased current dual stator/rotor winding vernier machines. These four types of machines were essentially proposed in succession through a progressive process. Their basic structure, theoretical analysis, electromagnetic characteristics, drive and control issues, prototype and experimental results are analyzed and introduced in detail, and the feasible applications of these machines are also introduced. This tutorial will make the academics and researchers have a clearer understanding of this novel machine, and also help to enrich the research domains of the flux modulated machine.

Tutorial 5: Design and Implementation of Decoupled Torque Controllers for Multi-Three-Phase Motor Drives

POWELL

Instructors:

Prof. Radu Bojoi, Dr. Sandro Rubino, *Politecnico di Torino*

Multiphase motor drives are experiencing significant development in the industry due to the current electrification processes involving transports and wind energy production. However, among the multi-phase solutions, multi-three-phase motors are becoming more and more widespread in practice as the stator consists of multiple three-phase winding sets operating in parallel, thus allowing the use of conventional three-phase inverter modules to yield full modularity.

This way, several advantages are obtained. For instance, the fault-tolerance capability is implemented according to the three-phase modularity, avoiding low-order harmonic content on both the dc-link current and torque. Besides, power-sharing strategies can be implemented, resulting in useful for the series of parallel connections of the dc-links belonging to the three-phase units. Application examples of such dc-links configurations can be found in wind energy production or smart grids.

The literature reports several modeling approaches to deal with multi-three-phase motors, such as Vector Space Decomposition (VSD), Multi-Stator (MS), and the more recent Decoupled Multi-Stator (DMS). These approaches model a multi-three-phase motor differently, thus leading to several pros and cons that directly impact the advantages and drawbacks of torque controllers based on them. For instance, VSD-based torque controllers perform torque regulation of a multi-three-phase machine similar to a three phase one, simplifying the control structure. However, power-sharing strategies and fault tolerance are not straightforward to implement. On the other hand, MS-based torque controllers allow for the independent regulation of flux and torque contributions of each winding set, thus getting inherent fault tolerance capability. However, MS-based control schemes need the implementation of complex decoupling algorithms to avoid underdamped or instability phenomena caused by the magnetic coupling between the winding sets. Therefore, the DMS approach has been recently developed to solve this issue and combine the advantages of VSD and MS-based torque controllers.

According to this scenario, this tutorial will present rigorous methodologies for designing and implementing decoupled torque controllers for multi-three-phase drives. The guidelines for selecting the most suitable modeling approach from those previously mentioned will be reported, starting from the features required for the torque controller. Moreover, several control structures will be presented, focusing on those able to perform high-performance and accurate torque regulation in Flux Weakening (FW) operation with Maximum Torque per Volt (MTPV). Finally, experimental results validating the presented methodologies will be shown, considering a 12-phase induction- and 6-phase wound-field synchronous motor for aircraft and a 9-phase permanent magnet synchronous motor (PMSM) prototype.

Tutorial 6: Advanced Hairpin Winding Technology: Design, Manufacturing, and Thermal Management

MISSION

Instructors:

Chris Gerada, Tianjie Zou, Mauro Di Nardo,
University of Nottingham

With the global drive of pursuing "Net Zero" to deal with climate change, ambitious roadmaps are being made, which translate to significantly improved performance requirements on power trains in pure/hybrid electric vehicles (xEVs), at the very heart of which there is the electrical machine. Windings housed within stators of electrical machines are the "central pivot" of electromechanical energy conversion, operating at inherently higher temperatures due to DC and AC power losses, which to a large extent determine the motor's power density level. The ever increasing requirements on power density and efficiency of traction motors have prompted a revolution of winding technologies. Hairpin windings with rectangular conductor bars are gradually replacing random windings in xEV industry and are also being extensively investigated in academia.

The instructors in this tutorial will first of all provide a comprehensive introduction in hairpin winding technology in terms of its design guideline. The flexibility and limitation of winding layout patterns will be thoroughly explained in terms of basic hairpin conductor connections, special jumpers, transposition, parallel branches, terminal positions, phase shift, winding pitches as well as slot-pole combinations, from a practical manufacturing feasibility point of view. Case studies will be provided to highlight how the challenges in high manufacturing cost and high frequency AC losses could be mitigated by novel design ideas to achieve overall balanced efficiency behaviour of EV traction motor.

In addition to the design guideline, the manufacturing process of hairpin windings will also be introduced interactively based on samples and videos made from the highly flexible hairpin winding production line located in Power Electronics, Machines and Control Group within University of Nottingham. The instructors will illustrate step by step how the state-of-the-art hairpin windings are automatically made based on two case studies developed for 160kW and 350kW EV traction motors, respectively. It has been widely accepted that to further improve the power density and the efficiency of electrical machines with hairpin windings, thermal management plays a critical role. Direct oil cooling has become one of the most effective cooling designs that have been found on many commercial products. The distinctive geometric nature of hairpin windings presents new challenges and new opportunities to the thermal management of electrical machines. This tutorial will also dive into this topic, by looking into experimental data and simulation results, to provide guidelines on designing more effective cooling for machines with hairpin windings, and potential options of thermal modelling.

Technical Program
ORAL SESSIONS

Tuesday, May 16 | 10:00 AM – 12:00 PM

Oral Session 1: Rotating Electric Machines 1

CYRIL MAGNIN I

Session Chairs:
Matthew Gardner, Silvio Vaschetto

IEMDC23-000315 – Low-Cost Axial Flux PCB Motor with Ferrite Core and Ferrite Magnet Topology for Fan Applications
Shahin Asgari, Nejat Saed, Annette Muetze, *Austria*

IEMDC23-000449 – Comparative Analysis of Doubly Salient Special Machine and Flux Switching Machine with PMs in Stator
Chandra Sekhar Goli, Maryam Salehi, Somasundaram Essakiappan, Madhav Manjrekar, Dan M Ionel, James Gafford, *United States*

IEMDC23-000304 – Fast Sizing Procedure for Salient-Pole Wound Field Synchronous Motors for Transportation Electrification
Federica Graffeo, Silvio Vaschetto, Alberto Tenconi, Andrea Cavagnino, *Italy*

IEMDC23-000208 – Torque Ripple Minimization in Wound Field Synchronous Machine using Asymmetric Rotor Pole Spacing
Ritvik Chattopadhyay, Md Sariful Islam, Iqbal Husain, *United States*

IEMDC23-000067 – Generator Design Improvements: Case Study of 2.3 MW Wind Generators
Henk de Swardt, *United States*

IEMDC23-000103 – Estimation of Torque Components of a Salient Pole Synchronous Machine
Amir Ebrahimi, *Germany*

Oral Session 2: Electrical Drives 1

CYRIL MAGNIN III

Session Chairs:
Eddy Aeloiza , Thomas Wolbank

IEMDC23-000322 – Flying Start of Sensorless Synchronous Machines with Reactive Power Injection
Anantaram Varatharajan, Yebin Wang, Abraham Goldsmith, United States

IEMDC23-000267 – Sensorless Estimation of Rotor Current and Rotor Position for Inductive Electrically Excited Synchronous Machines
Andreas Gneiting, Samuel Mueller, Nejila Parspour, *Germany*

IEMDC23-000094 – Modelling of a Rotating Signal Injection Based Position Observer for Sensorless Synchronous Electric Drives
Giuseppe Galati, Luigi Alberti, Ludovico Ortombina, *Italy*

IEMDC23-000037 – A Novel Inductance Asymmetry Compensation Method for High Frequency Signal Injection Sensorless Control of Dual Three-Phase IPMSMs
Yang Chen, Zi-Qiang Zhu, Ximeng Wu, Chao Hui Liu, *United Kingdom*

IEMDC23-000269 – Seamless Start-up of Loaded PMSM Drive from Open-Loop Id/F to Sensorless Control
Pengwei Li, Hao Lin, Ali Bazzi, *United States*

IEMDC23-000169 – Analysis and Compensation of Saliency Harmonic Components in Multi-Salient Induction Motors for Encoderless Speed Control
Eduardo Rodriguez Montero, Markus Vogelsberger, Thomas Wolbank, *Austria*

Oral Session 3: Design Optimization, Modelling and Simulation 1

POWELL

Session Chairs:
Xu Yang, Iqbal Husain

IEMDC23-000070 – Robustness of Dynamic FEA-based Demagnetization Calculation in the Multi-Objective Optimization of PM-assisted Synchronous Reluctance Motor with Blended Magnets
Robin Wilson, Praveen Kumar, Ali Al-Qarni, Qingqing Ma, Ayman EL-Refaie, *United States*

IEMDC23-000345 – High Accuracy Real-Time Simulation of Synchronous Reluctance Motor Drive Using Parallel Processing
Marco Tursini, Davide Angrilli, Andrea Credo, Giuseppe Fabri, *Italy*

IEMDC23-000046 – Optimization of the Magnetization Direction of Magnets in a PM-Assisted Synchronous Reluctance Machine to Minimize Demagnetization
Praveen Kumar, Robin Wilson, Ayman EL-Refaie, *United States*

IEMDC23-000246 – Magnetic Equivalent Circuit Modelling of Synchronous Reluctance Machines
O?uz Korman, Mauro Di Nardo, Michele Degano, Chris Gerada, Mukhammed Murataliyev, *United Kingdom*

IEMDC23-000307 – Free-Form Rotor Optimization for Synchronous Reluctance Machines used in X-ray Tubes
Christiane Mellak, Peter Gangl, Alessio Cesarano, Josef Deuringer, Annette Muetze, *Austria*

IEMDC23-000172 – Analytical Modelling Technique of Oil-cooled Electric Machine Using Empirical Correlation and LPTN
Yew Chuan Chong, Saeed Jahangirian, Husain Adam, Melanie Michon, Chuan Liu, Zeyuan Xu, David Gerada, Chris Gerada, *China*

* Special Session 1: Measurement and Self-Commissioning Techniques for AC Motor Drives

MISSION

Session Chairs:
Pescetto Paolo, Ludovico Ortombina

IEMDC23-000382 – Standstill Self-Commissioning Procedure for Synchronous Reluctance Motors based on Coenergy Model
Ludovico Ortombina, Nicola Bianchi, Luigi Alberti, *Italy*

IEMDC23-000414 – Improved Short Time Thermal Transient Model and Testing Procedure for High Power Density Motors
Paolo Pescetto, Gaetano Dilevrano, Gianmario Pellegrino, Aldo Boglietti, *Italy*

IEMDC23-000407 – An Experimental Test Procedure for Magnetic Model Identification of Multi-Three-Phase Induction Motors
Sandro Rubino, Fabio Mandrile, Luisa Tolosano, Eric Giacomo Armando, Radu Bojoi, *Italy*

IEMDC23-000421 – Experimental Fast Mapping of Synchronous Reluctance Motors Considering the Cross-Saturation
Lino Di Leonardo, Matteo Carbonieri, Nicola Bianchi, Marco Tursini, *Italy*

IEMDC23-000225 – Estimation of Equivalent Circuit Parameters of Multiphase Induction Machines by Exploitation of Space Harmonic Relations
Omer Ikram ul Haq, Luca Peretti, Marko Hinkkanen, *Sweden*

IEMDC23-000250 – A Robust Method for Estimation of Inductances at Standstill Considering Magnetic Saturation
Akshay Vijayrao Deshmukh, Bilal Akin, *United States*

Tuesday, May 16 | 1:30 PM – 3:30 PM

Oral Session 4: Rotating Electric Machines 2

CYRIL MAGNIN I

Session Chairs:
Nick J. Baker, Alireza Fatemi

IEMDC23-000163 – Investigation of Slot Shape and Associated Winding Configuration for Aerospace Actuator Motor
Liya Tom, Muhammad Khowja, Gaurang Vakil, Chris Gerada, *United Kingdom*

IEMDC23-000260 – Analysis of Magnet Eddy Current Loss for Four-Pole High Speed PM Machines with Various Stator Winding Configurations
Yu Wang, Zi-Qiang Zhu, *United Kingdom*

IEMDC23-000001 – Testing and Cleaning Synchronous Motors and Generators of 5000 to 30000 hp
Henk de Swardt, *United States*

IEMDC23-000236 – A Reconfigurable Multi-Three-Phase PM Motor: Nominal, Overload and Post-Fault Operations
Nicola Bianchi, Ludovico Ortombina, Paolo Gherardo Carlet, *Italy*

IEMDC23-000085 – Time Efficient Modeling of the Vibrational Behaviour of Permanent-Magnet Synchronous Machines with Non-uniform Air Gap Shape
Kevin Jansen, Sebastian Mönninghoff, Marius Franck, Kay Hameyer, *Germany*

IEMDC23-000349 – Synthesis of a Series-Hybrid Permanent-Magnet Variable Flux Motor
Bassam S. Abdel-Mageed, Akrem Mohamed Aljehaimi, Pragasen Pillay, *Canada*

Oral Session 5: Electrical Drives 2

CYRIL MAGNIN III

Session Chairs:
Thomas Wolbank, Eddy Aeloiza

IEMDC23-000389 – Identification of Mechanical Impedance of an Electric Machine Drive for Drivetrain Design
Hannu Hartikainen, Lauri Tiitinen, Sampo Laine, Marko Hinkkanen, *Finland*

IEMDC23-000114 – Experimental Investigation of the Impact of Soft Switching on Capacitive Bearing Currents in SiC Based Motor Drives
Felix Schulte, Martin Pfost, *Germany*

IEMDC23-000187 – Voltage and Current Harmonics Evaluation of Reduced Common-mode Voltage PWM Methods in Adjustable Speed Drives
Zhe Zhang, Kevin Lee, *United States*

IEMDC23-000076 – Variation in Motor Cable Dieletric Properties Caused by Temperature and the Effect of Variation on Active Motor Overvoltage Mitigation Methods
Juhamatti Korhonen, Juha-Pekka Ström, Juho Tyster, Pertti Silventoinen, *Finland*

IEMDC23-000432 – Quadruple-three-phase Drive Systems and Related Operating Methods for Common-mode Noise Cancellation and DC Ripple Reduction
Boran Fan, Rolando Burgos, Junming Liang, Jagadeesh Tangudu, *United States*

IEMDC23-000453 – Enhanced Volts-per-Hertz Starting of Permanent Magnet Motor with Heavy Loads in Long Cable Subsea Applications
Virendra Singh, Kaushik Rajashekara, Goutham Selvaraj, *United States*

Oral Session 6: Thermal, Materials and Efficiency Issues 1

POWELL

Session Chairs:
Simone Ferrari , Matthew Gardner

IEMDC23-000385 – Specimen Shape Optimization for a Novel Test Setup to Study the Impact of Mechanical Stress on Soft Magnetic Material Properties
Gereon Goldbeck, Daniel Wöckinger, Christoph Dobler, Gerd Bramerdorfer, *Austria*

IEMDC23-000403 – Impedance-Based Estimation Method of PWM-Induced Losses for Traction Motors
Radu Bojoi, Fabio Mandrile, Sandro Rubino, Eric Giacomo Armando, Aldo Boglietti, Andreas Carlsson, Shafigh Nategh, *Italy*

IEMDC23-000249 – Magnetic Behavior and Loss Assessment of Additively Manufactured Fe-Si alloys
Andrea Cavagnino, Silvio Vaschetto, Emir Poskovic, Erica Liverani, Alessandro Fortunato, *Italy*

IEMDC23-000436 – Statistical Assessment of the Core Losses in Ring Cores Due to Geometrical Properties
Leonardo Colombo, Sima Soltanipour, Francisco Marquez-Fernandez, Mats Alaküla, *Sweden*

IEMDC23-000043 – Characterization of the Permittivity of Enameled Wires in Inverter-Driven Low-Voltage Electrical Machines
Niklas Driendl, Aladin Othman, Kay Hameyer, *Germany*

IEMDC23-000295 – Lumped Parameter Thermal Network Model Investigations for an Electric Machine Stator with Flux Barriers
Andres Felipe Sanchez Porras, Daniel Alban Leguizamo, Lars Zigan, *Germany*

Oral Session 7: Transportation Applications

MISSION

Session Chairs:
Pescetto Paolo, Weiqiang Chen

IEMDC23-000383 – Development of Direct Oil Cooling Solutions for E-mobility Traction Motors, Part I: Stator Cooling Concept
Gabriele Puccio, Shafigh Nategh, Davide Barater, Michele Merelli, Philippe Farah, Michelangelo Raimondo, *Sweden*

IEMDC23-000384 – Development of Direct Oil Cooling Solutions for E-mobility Traction Motors, Part II: Rotor Cooling Concept
Gabriele Puccio, Shafigh Nategh, Davide Barater, Andreas Carlsson, Michelangelo Raimondo, *Sweden*

IEMDC23-000299 – Optimum Rotor Design for Rare-Earth Free High Performance Traction Applications Interior Permanent Magnet Motors
Ali Al-Qarni, Ayman EL-Refaie, *United States*

IEMDC23-000446 – A High Power Density Flux Switching Machine with Superconducting Field Coils and Shields for Aircraft Applications
Saeid Saeidabadi, Leila Parsa, Keith Corzine, Christopher Kovacs, Timothy Haugan, *United States*

IEMDC23-000268 – A High Saliency Ratio Segmented Rotor Wound Field Synchronous Machine for Traction Applications
Ritvik Chattopadhyay, Iqbal Husain, *United States*

IEMDC23-000442 – Analysis of Circulating Current in Hairpin Windings Due to Manufacturing Deviation
Danielly Lima Bezerra, Tianjie Zou, Antonino La Rocca, Mengmeng Cui, Hailin Huang, Alasdair Cairns, Chris Gerada, *United Kingdom*

Tuesday, May 16 | 4:00 PM – 6:00 PM

Oral Session 8: Rotating Electric Machines 3

CYRIL MAGNIN I

Session Chairs:
Alireza Fatemi, Ayman El-Refaie

IEMDC23-000408 – Synchronous Reluctance Machines with and without Ferrite Assistance for Lifting Systems
Paolo Ragazzo, Simone Ferrari, Gaetano Dilevrano, Lorenzo Beatrici, Christian Girardi, Gianmario Pellegrino

IEMDC23-000332 – Hybrid FE-Analytical Procedure for Fast Flux Map Computation of Synchronous Reluctance Machines
Gianvito Gallicchio, Mauro Di Nardo, Michele Degano, Chris Gerada, Francesco Cupertino

IEMDC23-000256 – Comparison of Synchronous Reluctance Motors and Permanent Magnet Synchronous Motors with Direct Liquid Cooling Arrangement
Andrea Credo, Pia Lindh, Francesco Parasiliti, Ilya Petrov, Juha Pyrhönen

IEMDC23-000232 – Assessment of Three Different Rotor Constructions for a High-Speed Axially Laminated Synchronous Reluctance Machine
Eero Scherman, Andrea Credo, Emil Kurvinen, Ilya Petrov, Juha Pyrhönen, Jussi Sopanen

IEMDC23-000023 – Permanent Magnet-Assisted Synchronous Reluctance Machine with Auxiliary Barriers
Seyyed Morteza Mousavi Bafrouei, Aliakbar Damaki Aliabad, Ebrahim Amiri

IEMDC23-000215 – Permanent Magnet-Assisted Synchronous Reluctance Machine with MnAl Magnetic Material
Seyyed Morteza Mousavi Bafrouei, Aliakbar Damaki Aliabad, Ebrahim Amiri, Mostafa Shakouri Dehaghani

Oral Session 9: Electrical Drives 3

CYRIL MAGNIN III

Session Chairs:
Luigi Alberti, Ludovico Ortombina

IEMDC23-000106 – Dynamic Model for HEPM Motors Including the Nonlinear Magnetic Characteristics
Paolo Gherardo Carlet, Luca Cinti, Ludovico Ortombina, Nicola Bianchi, *Italy*

IEMDC23-000305 – Effect of Coupling Stiffness on High-speed Electric Machine Driveline
Juuso Narsakka, Tuhin Choudhury, Emil Kurvinen, Jussi Sopanen, Juha Pyrhönen, *Finland*

IEMDC23-000170 – Adaptive Hysteresis Current Control for Improved EMI Performance in Fast Switching Motor Drives
Tabish Mir, Xu Deng, Barrie Mecrow, Daniel Smith, Mingfei Wu, Sana Ullah, Muhammad Ikhlaq, *United Kingdom*

IEMDC23-000316 – An Alternative to Determine IM Parameters Trends Affected by Magnetic Saturation Using Two-Stage Flux-Decay Test by FEM
Meng-Ju Hsieh, Torbjörn Thiringer, *Sweden*

IEMDC23-000366 – Reducing Traction Motor Drive Losses in Electric Vehicle using Advanced Torque Modulation
Md Zakirul Islam, Matthew Younkins, *United States*

IEMDC23-000025 – Genetic Algorithm Based Approach of SRM Current Profiling for Torque Control and Minimal Copper Losses
Euan Macrae, Ali Abdel-Aziz, Khaled Ahmed, Richard Pollock, Barry Williams, *United Kingdom*

Oral Session 10: Thermal, Materials and Efficiency Issues 2

POWELL

Session Chairs:
Ants Kallaste, Nick J. Baker

IEMDC23-000028 – Preliminary Study on the Applicability of Water-Based Lubricant as a Direct Cooling Medium in Rotating Electrical Machines
Liguo Yang, Yu Cao, Shimin Zhang, Hakim el Bahi, Kay Hameyer, *Germany*

IEMDC23-000080 – Local Heat Transfer Coefficient Measurements on Shaft Spray Cooled End Windings
Felix Hoffmann, Mattis Parche, Jonas Bender, Thomas Wetzel, Martin Doppelbauer, *Germany*

IEMDC23-000398 – Thermal Modelling and Validation of a Direct Rotor Cooled Permanent Magnet Electric Machine
Jasper Nonneman, Ilya T'Jollyn, Steven Vanhee, Michel De Paepe, *Belgium*

IEMDC23-000093 – Combined Star-Delta Windings in Small Induction Machines for Reducing No-Load and Additional Losses
Tobias Knapp, Wilfried Hofmann, *Germany*

IEMDC23-000323 – Aviation Mission Profile Performance Evaluation in a High Specific Power SPM Machine with Additively Manufactured Coils and Integrated Heat Pipes
Salar Koushan, Xuhui Feng, Sreekant Narumanchi, Ayman EL-Refaie, *United States of America*

IEMDC23-000240 – Comparative Study of Stator-mounted PM Machines Focusing on Thermal Performance
Guanbo Zhang, Guangjin Li, *United Kingdom*

Oral Session 11: Special Machines, Electromagnetic Actuators and Sensors 1

MISSION

Session Chairs:
Wolfgang Gruber, Jagadeesh Tangudu

IEMDC23-000186 – Damping of Oscillation in Permanent Magnet Torque Limiter
Shahjahan Ahmad Syed, Gaurang Vakil, Christopher Gerada, Maamar Benarous, *United Kingdom*

IEMDC23-000155 – Bearingless Axial-Force/Torque Motor with Reduced Number of Power Switches
Wolfgang Gruber, Simon Hell, *Austria*

IEMDC23-000113 – A New Winding Configuration for High Pole Number, Bearingless Machines
Sumaira Ahmed, Barrie Mecrow, Xu Deng, Daniel Smith, *United Kingdom*

IEMDC23-000374 – Variable Passive Radial Stiffness in Single-Drive Bearingless Motors for Changing Rotor Natural Frequency
Minoru Watanabe, Hiroya Sugimoto, *Japan*

IEMDC23-000034 – Sensorless Axial Vibration Damping Control of Two-Axis Actively Positioned Bearingless Motors with Adaptive Flux Observer
Yuichiro Nakamura, Shinichi Furutani, Keita Kajino, Hiroya Sugimoto, Masahito Miyoshi, *Japan*

IEMDC23-000072 – Investigation on the Pole-pair Number Combinations of Two Degree-of-Freedom Rotary-Linear Machine with Hybrid Permanent Magnet
Yaojie He, Shuangchun XIE, Christopher H. T. Lee, *Singapore*

Wednesday, May 17 | 10:00 AM – 12:00 PM

Oral Session 12: Rotating Electric Machines 4

CYRIL MAGNIN I

Session Chairs:
Xu Yang , Ali Bazzi

IEMDC23-000112 – Rotor Reinforcement of Interior PM Machines Using Structural Inserts
Derek Lahr, Alireza Fatemi, Anthony Coppola, *United States*

IEMDC23-000233 – Comparison Study of Different FSCWs with Flux Barrier Stator
Gurakuq Dajaku, *Germany*

IEMDC23-000431 – Design and Analysis of a Triple-Rotor Integrated with a Gearbox for a High Power Density Motor
Jagadeesh Tangudu, Huan Zhang, Andrzej Kuczek, Zaffir Chaudhry, Wenping Zhao, *United States*

IEMDC23-000119 – Ultra-Compact Design of Additively Manufactured Variable Cross Section Profile Bar Winding for Traction Motor
Wenbo Liu, Franco Leonardi, Wanfeng Li, Becky Morris, Leyi Zhu, Jakob Jung, *United States*

IEMDC23-000297 – Design and Analysis of High-Speed Induction Machines for Submerged Cryogenic Pumps
Marco Biasion, Gianluca Carena, Silvio Vaschetto, Alberto Tenconi, Andrea Cavagnino, *Italy*

IEMDC23-000388 – Optimized Rewinding of Oversized Induction Motors
Fernando J. T. E. Ferreira, *Portugal*

Oral Session 13: Electrical Drives 4

CYRIL MAGNIN III

Session Chairs:
Luigi Alberti, Sandro Rubino

IEMDC23-000254 – Constrained Model Predictive Control for Hybrid Excited Permanent Magnet Synchronous Motors
Luca Cinti, Ludovico Ortombina, Petros Karamanakos, Nicola Bianchi, *Italy*

IEMDC23-000441 – Rotor Vibration Control using Multi-Three Phase Permanent Magnet Synchronous Machine
Mauro Di Nardo, Mohammad Ilkhani, Meiqi Wang, Michele Degano, Chris Gerada, Giacomo Sala, Tiberio Spadi, Marcus Gaertner, Christian Brecher, Maik Hoppert, *United Kingdom*

IEMDC23-000183 – Active Damping for Soft-switching Motor Drive
Weiqiang Chen, Eddy Aeloiza, Veli-Matti Leppänen, Tero Viitanen, *United States*

IEMDC23-000222 – Fuzzy Variable Structure Control of a Six-Phase Induction Generator
Omar Bouyahia, Yazidi Amine, Franck Betin, Gerard-Andre Capolino, *France*

IEMDC23-000134 – Approximate Protocol for Optimal Induction Motor Drive Cycle Efficiency
Thomas Krause, Steven Leeb, James Kirtley, *United States*

IEMDC23-000036, – Modeling of a High Speed High Inertia Outrunner Reluctance Synchronous Machine Using Trivariate Polynomial Approximation of Flux Surfaces
Ivan Kliasheu, Daniel Weil, Gerd Griepentrog, Mario Carroccia, *Germany*

Oral Session 14: Special Machines, Electromagnetic Actuators and Sensors 2

POWELL

Session Chairs:
Silvio Vaschetto, Iqbal Husain

IEMDC23-000391 – Design Optimization of a Direct-drive Wind Generator with Non-rare-earth PM Flux Intensifying Stator and Reluctance Rotor
Ali Mohammadi, Oluwaseun A. Badewa, Yaser Chulaee, Somasundaram Essakiappan, Madhav Manjrekar, Dan M. Ionel, *United States*

IEMDC23-000133 – Designing an Integrated Generator for a Wave Energy Converter
Lewis Chambers,Nick Baker, *United Kingdom*

IEMDC23-000356 – Quick Prediction of Losses During Magnetization State Changes in Variable Flux Machines
Julius Kesten, Martin Doppelbauer, *Germany*

IEMDC23-000397 – Comparative Study of Axial-Flux Switched Reluctance Machines with Different Core Materials
Yangye Ji, Guangjin Li, *United Kingdom*

IEMDC23-000129 – Operating Principle and Characterisation of a Novel Contrarotating Dual-Rotor Switched Reluctance Machine
Ruben De Croo, Frederik De Belie, *Belgium*

IEMDC23-000062 – Design of a Dual DC-Bus Homopolar Generator Implementing a Direct-Cooled Excitation Coil
Amedeo Vannini, Antonino La Rocca, Matthew Cooper, Alessandro Marfoli, Luca Papini, Paolo Bolognesi, Chris Gerada, *United Kingdom*

✻ Special Session 7: Additive Manufacturing of Electric Machines

MISSION

Session Chairs:
Toomas Vaimann, Ants Kallaste

IEMDC23-000344 – Litzpins: Hybrid Solid-Transposed Hairpin Conductors Enabled By Additive Manufacturing
Nick Simpson, Dominic North, Harry Felton, Sai Priya Munagala, Phil Mellor, Axel Helm, *United Kingdom*

IEMDC23-000194 – Axially Asymmetric Design for Additive Manufacturing of Synchronous Reluctance Machines
Muhammad Usman Naseer, Ants Kallaste, Bilal Asad, Toomas Vaimann, Anton Rassõlkin, *Estonia*

IEMDC23-000045 – Additively Manufactured Air-cooled Lightweight Rotor for an Automotive Electric Motor
Maximilian Bieber, Bernd Ponick, Michael Haase, Frederik Tasche, *Germany*

IEMDC23-000164 – An Assessment of Using State-of-the-Art Additively Manufactured Permanent Magnets for a Distributed Wind Generator
Casper Labuschagne, Latha Sethuraman, Parans Paranthaman, Tod Hanley, Lee Jay Fingersh, *United States*

IEMDC23-000171 – Novel 3D Printed Coils for High Power Density Electrical Machine and Traction Applications
Ahmed Selema, Joffrey Van Den Abbeele, Mohamed Ibrahim, Peter Sergeant, *Belgium*

IEMDC23-000303 – A Scalable Analytical Model for Printed Multi-Barrier Reluctance Rotor
Daniele Michieletto, Luigi Alberti, *Italy*

Wednesday, May 17 | 1:30 PM – 3:30 PM

Oral Session 15: Rotating Electric Machines 5

CYRIL MAGNIN I

Session Chairs:
Ali Bazzi, Simone Ferrari

IEMDC23-000271 – A Review on Electrical Submersible Pumping System
Sara Ismaeel, Mohamed Ibrahim, Essam Rashad, Peter Sergeant, *Belgium*

IEMDC23-000244 – Determination of Parameters of Symmetrical Six-Phase Permanent Magnet Synchronous Machines
Partha Pratim Das, Subhransu Satpathy, Subhashish Bhattacharya, *United States*

IEMDC23-000399 – Modeling and Characterization of Permanent Magnet DC Motors for High Performance Applications
Vidit Pandya, Siddharth Mehta, Prerit Pramod, *United States*

IEMDC23-000321 – Design Methodologies of High Speed Surface Permanent Magnet Synchronous Machines
Francesco Cupertino, Gianvito Gallicchio, Mauro Di Nardo, Mohammad Reza Ilkhani, Chris Gerada, *Italy*

IEMDC23-000061 – A New Hybrid Permanent Magnet Synchronous Machine with V-shape Spokes
Zi-Qiang Zhu, Seyedmilad Kazemisangdehi, Yanjian Zhou, Hailong Liu, *United Kingdom*

IEMDC23-000167 – High Efficiency Hybrid Synchronous Motor Design with Loss Analysis for a Two-Speed e-Powertrain System in Electric Vehicle
Shun Feng, Ronghai Qu, *China*

Oral Session 16: Electrical Drives 5

CYRIL MAGNIN III

Session Chairs:
Sandro Rubino, Ludovico Ortombina

IEMDC23-000336 – Comparative Study Between Finite Control Set Model Predictive Control and Digital Sliding-Mode Control for the Reduction of Current Harmonics in Six-Phase PMSM Drives
Pedro Filipe da Costa Goncalves, Sumedh Dhale, Battur Batkhishig, Jingru Yang, Babak Nahid-Mobarakeh, *Canada*

IEMDC23-000074 – Fade-over Strategy for Use of Model Predictive Direct Self-Control with Field Oriented Control
Mario Pena, Michael Meyer, Oliver Wallscheid, Joachim Böcker, *Germany*

IEMDC23-000005 – Current Harmonics Control Algorithm for inverter-fed Nonlinear Synchronous Electrical Machines
Stefan Haehnlein, Jan Philipp Degel, Christian Kloeffer, Martin Doppelbauer, *Germany*

IEMDC23-000068 – Comparison Study of Rotor Field-Oriented Control and Stator Field-Oriented Control in Permanent Magnet Synchronous Motors
Rashad Ghassani, Maurice Fadel, Zohra Kader, Mohamad Koteich, Pascal Combes, *France*

IEMDC23-000367 – Initial Rotor Position Detection for Surface Mounted PMSM
Mahshid Khoshlessan, Benjamin Jessie, Mohammad Rastegar, Babak Fahimi, *United States*

IEMDC23-000230 – Reliability and Fault-Tolerance Assessment of PMSM Drive for Electric Aircraft Applications
Alireza Siadatan, Ali Kalantarikhalilabad, Afshin Rezaei-Zare, *Canada*

Oral Session 17: Special Machines, Electromagnetic Actuators and Sensors 3

POWELL

Session Chairs:
Weiqiang Chen, Alireza Fatemi

IEMDC23-000390 – Torque and Power Capabilities of Coreless Axial Flux Machines with Surface PMs and Halbach Array Rotors
Yaser Chulaee, Donovin Lewis, Matin Vatani, John F. Eastham, Dan M. Ionel, *United States*

IEMDC23-000086 – Design of an Axial-Flux Synchronous Reluctance Machine with 3D-Printed Rotor
You Zhou, Junyao Liu, Fanbo Meng, Guanghui Yang, Christopher H. T. Lee, *Singapore*

IEMDC23-000021 – Development and Analysis of a Homopolar Consequent Pole Transverse Flux Magnetic Gear
Salek Khan, Matthew Gardner, *United States*

IEMDC23-000179 – Variable Reluctance Resolver With a Modular Stator
Valerii Abramenko, Ilya Petrov, Juha Pyrhönen, *Finland*

IEMDC23-000274 – Microscale Electromagnetic Actuation of Ferrofluid for Enhanced Cooling Efficiency
Patrick Luk, Jiawei tang, *United Kingdom*

IEMDC23-000203 – Torque Production in Triply-Excited Magnetic Gears
Sri Vignesh Sankarraman, Matthew Gardner, Ahmad Daniar, *United States*

Oral Session 18: Energy and Grid-Connected Applications

MISSION

Session Chairs:
Oliver Wallscheid, Baoyun Ge

IEMDC23-000081 – Doubly Fed Induction Generator in a Flywheel Energy Storage with Stator Harmonic Compensation
Jonas Kienast, Gino Sturm, Steffen Bernet, Wilfried Hofmann, *Germany*

IEMDC23-000419 – Acoustic Noise Analysis of an External Rotor Ferrite Permanent Magnet Airborne Wind Generator
Daniel Heide, Bernd Ponick, *Germany*

IEMDC23-000325 – Active and Passive Control of Nine-Phase Wind Turbine Conversion Systems: A Comparison
Mahdi Homaeinezhad, Omid Beik, *United States*

IEMDC23-000195 – Real-time Controller Hardware-in-the-Loop Testing of an Electric Vehicle Powertrain for Optimal Delivery of Energy Sources
Hamed Nademi, Edward Grunloh, *United States*

IEMDC23-000350 – Sensorless Speed and Position Estimation of a Rotor-tied Doubly Fed Induction Generator
Alford Sibanda, Nkosinathi Gule, *South Africa*

IEMDC23-000048 – A Novel Rotary Frequency Multiplier Using the Third-Order Harmonic of Air-Gap Flux
Yuliang Liu, Shaofeng JIA, Deliang Liang, *China*

Thursday, May 18 | 8:00 AM – 10:00 AM

Oral Session 19: Rotating Electric Machines 6

CYRIL MAGNIN I

Session Chairs:
Ayman El-Refaie, Ebrahim Amiri

IEMDC23-000078 – Investigation on Axial-Flux Switched Reluctance Machine With Different Winding Configurations
Yangye Ji, Guangjin Li, *United Kingdom*

IEMDC23-000059 – Development of an Electrically Excited Axial Flux Machine with Stabilized Disk Rotor
Patrick Schwarz, Andreas Möckel, Tobias Heidrich, *Germany*

IEMDC23-000340 – A Comparison of Outer Rotor Radial and Axial Flux Machines for Application in Electric Vehicles
Vandana Rallabandi, Burak Ozpineci, Dan Ionel, *United States*

IEMDC23-000136 – Performance Analysis of a Novel Consequent-Pole Dual-Layer Axial Flux Magnetic Gear with Halbach Array
Soheil Yousefnejad, Ebrahim Amiri, *United States*

IEMDC23-000234 – Comparison of Rotor Arrangements of Transverse Flux Machines for a Robotic Direct Drive Optimized by Genetic Algorithm and Regression Tree Method
Benedikt Kaiser, Martin Schmid, Nejila Parspour, *Germany*

IEMDC23-000138 – Equivalent Circuit Extraction for Hybrid Stepper Motor based on Electromagnetic Finite Element Analysis
Jingchen Liang, Ryan Magargle, Pavani Gottipati, *United States*

Oral Session 20: Design Optimization, Modelling and Simulation 2

CYRIL MAGNIN III

Session Chairs:
Alexander Kuhl, Tianjie Zou

IEMDC23-000189 – Computationally Efficient Analytical Model of Permanent Magnet Vernier Machines
Vahid Zamani Faradonbeh, Ghazal Mirzavand, Akbar Rahideh, Ebrahim Amiri, *United States*

IEMDC23-000309 – Optimal Design, Simulation, and Sensitivity Analysis of a C-Shaped Axial Flux Synchronous Motor
Alireza Siadatan, Ali Kalantarikhalilabad, Afshin Rezaei-Zare, Maryam Sepehrinour, *Canada*

IEMDC23-000369 – System-Level Optimization of Electric Machines for Aircraft Propulsion
Anubhav Bose, Kiruba Haran, *United States*

IEMDC23-000263 – Optimization of Induction Machine Design for Electric Vehicle Powertrain
Meng Lu, Gabriel Domingues, Francisco Marquez-Fernandez, Mats Alaküla, *Sweden*

IEMDC23-000175 – Optimization and Comparison of Modern Offshore Wind Turbine Generators Using GeneratorSE 2.0
Latha Sethuraman, Garrett Barter, Pietro Bortolotti, Jonathan Keller, David Torrey, *United States*

IEMDC23-000210 – An Optimisation Tool for Hybrid-Electric Aircraft Propulsion Systems
Bob Walmsley, *United Kingdom*

Oral Session 21: Condition Monitoring, Fault Diagnosis and Prognosis 1

POWELL

Session Chairs:
Taner Goktas, Toomas Vaimann

IEMDC23-000140 – A Novel Approach towards Detection and Classification of Electric Machines' Stator Winding Insulation Degradation Using Wavelet Decomposition
Ashutosh Patel, Chunyan Lai, K. Lakshmi Varaha Iyer, *Canada*

IEMDC23-000096 – Locus-Based Fault Indicators and a Cumulative Sum Algorithm to Detect Induction Machine Stator Interturn Short-Circuit Faults
Geoffrey Postal, Frederik De Belie, Hendrik Vansompel, Johan Gyselinck, *Belgium*

IEMDC23-000042 – A Novel High Frequency Voltage Injection Method for Inter-Turn Short-Circuit Fault Detection and Location in Electrical Machines
Ying Qin, Guangjin Li, Chunjiang Jia, Paul McKeever, *United Kingdom*

IEMDC23-000063 – Asymmetric Parameter Influence Analysis in PMSM Position Sensor Offset Error Diagnosis
Brycen Halfmann, Sandun Kuruppu, *United States*

IEMDC23-000117 – Fault Detection and Classification of Inter-Turn Short Circuit Faults for Electrical Machines with Wavelet Transform and Convolutional Neural Networks
Duc Pham, Pablo Soler Garcia, Xinyi Yu, Rik W. De Doncker, *Germany*

IEMDC23-000022 – Multi-stage Fault Diagnosis of Partial Demagnetization Faults in PMSMs with Low Labelled Data
Mahmoud Eid, Khang Huynh, Jagath Senanayaka, Kjell Robbersmyr, Ruben Panadero, *Norway*

* Special Session 4: Learning-based Electric Machine Design & Optimization

MISSION

Session Chairs:
Bingnan Wang, Yusuke Sakamoto

IEMDC23-000196 – Piecewise and Physics-Enhanced Topology Optimization for the Design of Electric Machines
Baoyun Ge, *United States*

IEMDC23-000226 – Tandem Neural Networks for Electric Machine Inverse Design
Yihao Xu, Bingnan Wang, Yusuke Sakamoto, Tatsuya Yamamoto, Yuki Nishimura, Toshiaki Koike-Akino, Ye Wang, *United States*

IEMDC23-000438 – Multi-Objective Motor Design Optimization with Physics-Assisted Neural Network Model
Yusuke Sakamoto, Yihao Xu, Bingnan Wang, Tatsuya Yamamoto, Yuki Nishimura, *United States*

IEMDC23-000273 – Neuronal Networks to Determine Air Gap Flux Densities for High-Speed Electric Motors
Benedict Jux, Roman Dabrowski, D a Subramani, Martin Doppelbauer, *Germany*

IEMDC23-000329 – Drive Cycle Temperature Prediction for PSM using Recurrent Neuronal Networks
Christian Digel, Felix Hoffmann, Martin Doppelbauer, *Germany*

IEMDC23-000275 – Metamodel Based Electric Vehicle Powertrain Optimization A Drive Cycle Approach
Mehdi Djami, Claude Marchand, Maya Hage Hassan, Guillaume Krebs, Philippe Dessante, Lamya Abdeljalil Belhaj, *France*

Thursday, May 18 | 10:20 AM – 12:20 PM

Oral Session 22: Rotating Electric Machines 7

CYRIL MAGNIN I

Session Chairs:
Maher AlBadri, Alexander Kuhl

IEMDC23-000258 – Partial Discharge Investigation of Electric Machine Winding Due to Thermo-Mechanical Stresses for Electric Aircraft Propulsion
Anjana Samarakoon, Brian Wolhaupter, Thomas Tallerico, Thanatheepan Balachandran, Kiruba Haran, *United States*

IEMDC23-000008 – Stray-Load Loss Approximation for Partial Loads
Maher Al-Badri, United *States*

IEMDC23-000092 – Impact of Temperature Dependency of Ferromagnetic Material Properties on the Performance of Reduced Critical Rare Earth Electrical Traction Machines
Sigrid Jacobs, Johan Rens, *Belgium*

IEMDC23-000013 – Optimized Cutting Process of Flat Wires for Electric Motors with Hairpin Technology
Alexander Kühl, *Germany*

IEMDC23-000020 – Performance of Electric Motor with Integrated Magnetic Spring under Rotor Eccentricity
Mohamed Ibrahim, Peter Sergeant, *Belgium*

IEMDC23-000379 – Multiple Objective Co-Optimization and Experimental Evaluation of Switched Reluctance Machine Design and Controls
Timothy Burress, Leon Tolbert, *United States*

Oral Session 23: Design Optimization, Modelling and Simulation 3

CYRIL MAGNIN III

Session Chairs:
Baoyun Ge, Jose Enrique Ruiz-Sarrio

IEMDC23-000011 – Improved Core Loss Calculations in Soft Magnetic Composites Considering 3-D Magnetic Flux Density Vectors and Geometry Dependent Eddy Currents
Mehmet Kulan, Nick Baker, Konstantinos Liogas, Oliver Davis, John Taylor, *United Kingdom*

IEMDC23-000044 – Rapid Electromagnetic Scaling Methodology for the Electric Propulsion of a Hybrid-electric Aircraft
Norman Blanken, Vivien Boe, Bernd Ponick, *Germany*

IEMDC23-000346 – Demagnetization Analysis of a High-Speed PMSM for an Aerospace Application
Srikanth Pillai, Alexander Forsyth, Jeffrey Doan, Mohamed Abdalmagid, Giorgio Pietrini, Piranavan Suntharalingam, Mikhail Goykhman, Ali Emadi, *Canada*

IEMDC23-000118 – Image-Based Optimization of Electrical Machines Using Generative Adversarial Networks
Michael Heroth, Helmut Schmid, Rainer Herrler, Wilfried Hofmann, *Germany*

IEMDC23-000058 – Physical Limits of Power Density Improvements of Electric Machines
Sebastian Mönninghoff, Kevin Jansen, Kay Hameyer, *Germany*

IEMDC23-000207 – High-Fidelity Nonlinear Modeling of an Asymmetrical Dual Three-Phase PMSM
Sodiq Agoro, Iqbal Husain, *United States*

Oral Session 24: Condition Monitoring, Fault Diagnosis and Prognosis 2

POWELL

Session Chairs:
Bingnan Wang, Yusuke Sakamoto

IEMDC23-000148 – The Influence of Voltage Form on the Insulation Resilience of Inverter-fed Low Voltage Traction Machines with Hairpin Windings
Timo Petri, Marina Keller, Nejila Parspour, *Germany*

IEMDC23-000047 – Development of a Bearing Test Bench to Investigate Root Causes of Bearing Current Damages
Silvan Scheuermann, Martin Doppelbauer, Björn Hagemann, Antoine Jarosz, Johannes Stoß, Jürgen Kett, *Germany*

IEMDC23-000124 – Preliminary Analysis of Bearing Current Faults for Predictive Maintenance
Karolina Kudelina, Hadi Ashraf Raja, Toomas Vaimann, Bilal Asad, Ants Kallaste, Anton Rassõlkin, *Estonia*

IEMDC23-000415 – Rotor Fault Diagnosis in a Hydrogenerator based on the Stator Vibration and the Variational Autoencoder
Rony Ibrahim, Ryad Zemouri, Bachir Kedjar, Antoine Tahan, Kamal Al-Haddad, Arezki Merkhouf, *Canada*

IEMDC23-000159 – Digital Twin Service Unit Development for An EV Induction Motor Fault Detection
Viktor Rjabtsikov, Mahmoud Ibrahim, Bilal Asad, Anton Rassõlkin, Toomas Vaimann, Ants Kallaste, Vladimir Kuts, Mariusz Stepien, Mateusz Krawczyk, *Estonia*

IEMDC23-000202 – Ground Fault Monitoring for Motor-Drive Systems with High Resistance Grounding
Jiangang Hu, Yujia Cui, Andrew Roberts, Jeff McGuire, *United States*

* Special Session 5: Open Science for Advancing Research and Education of Electric Machines and Drives

MISSION

Session Chairs:
Oliver Wallscheid, Lauri Tiitinen

IEMDC23-000238 – Motulator: A Motor Drive Simulator in Python
Lauri Tiitinen, Hannu Hartikainen, Luca Peretti, Marko Hinkkanen, *Finland*

IEMDC23-000091 – Deep Reinforcement Learning Current Control of Permanent Magnet Synchronous Machines
Tobias Schindler, Lara Broghammer, Petros Karamanakos, Armin Dietz, Ralph Kennel, *Germany*

IEMDC23-000333 – AMDC: Open-Source Control and Sensing Platform for Advanced Electric Motor Drives
Nathan Petersen, Eric Severson, *United States*

IEMDC23-000437 – Open-Source Design Procedure for Traction Interior PMSMs using the (x,b) Design Plane
Gaetano Dilevrano, Paolo Ragazzo, Simone Ferrari, Gianmario Pellegrino, *Italy*

IEMDC23-000029 – Gym-Electric-Motor (GEM) Control: An Automated Open-Source Controller Design Suite for Drives
Felix Book, Arne Traue, Maximilian Schenke, Oliver Wallscheid, Barnabas Haucke-Korber, *Germany*

IEMDC23-000088 – Parameter Identification Methods for Multi-Phase Permanent Magnet Synchronous Machines
Michael Hoerner, Valentin Hoppe, Timo Wilfling, Armin Dietz, Petros Karamanakos, Ralph Kennel, *Germany*

Thursday, May 18 | 3:20 PM – 5:20 PM

Oral Session 25: Rotating Electric Machines 8

CYRIL MAGNIN I

Session Chairs:
Ebrahim Amiri, Mehmet Kulan

IEMDC23-000428 – Overload Capability Test of a Permanent Magnet Synchronous Motor for E-bike Application
Chiara Conto, Nicola Bianchi, *Italy*

IEMDC23-000395 – Analysis of a Continuous Halbach Array Permanent Magnet Motor for Electric Vehicles
Aravindakshan Ananthanpillai, Philippe Masson, Vandana Rallabandi, Mark Senti, *United States*

IEMDC23-000242 – Design Comparison of Outer and Inner Rotor Permanent Magnet Motors for Hydrofoil Boat
Zhaokai Li, Nicholas Honeth, Luca Peretti, *Sweden*

IEMDC23-000168 – Centralized Robust Control of 2 MW Drivetrain Supported on 3 Radial Magnetic Bearings
Rafal Jastrzebski, Atte Putkonen, Leonid Chechurin, Akira Chiba, *Finland*

IEMDC23-000014 – Fast Analytical Force Estimation in Active Magnetic Bearings using a Magnetic Equivalent Circuit Model
Mehmet Kulan, Nick Baker, *United Kingdom*

IEMDC23-000433 – Optimal Design of Bearingless Multi-Three Phases Permanent Magnet Synchronous Machines
Mauro Di Nardo, Mohammad Ilkhani, Meiqi Wang, Michele Degano, Chris Gerada, Gianvito Gallicchio, Francesco Cupertino, Marcus Gaertner, Christian Brecher, Maik Hoppert, *United Kingdom*

Oral Session 26: Condition Monitoring, Fault Diagnosis and Prognosis 3

CYRIL MAGNIN III

Session Chairs:
Jose Enrique Ruiz-Sarrio, Baoyun Ge

IEMDC23-000330 – Reliable Detection of Broken Bar Fault through Negative Sequence of Stray Flux in Induction Motors
Taner Goktas, Muslum Arkan, *Turkey*

IEMDC23-000313 – Broken-bar Fault Detection by Injecting a Frequency Modulated Continuous Wave Signal
Dehong Liu, Anantaram Varatharajan, Abraham Goldsmith, Chuizheng Kong, Laxman kumar Sigatapu, Yebin Wang, *United States*

IEMDC23-000200 – Rotor Cage Assessment in Soft-Started Induction Motors Applying DWT and Hilbert Transform to Transient Stray Flux Signals
Vicente Biot-Monterde, Angela Navarro-Navarro, Jose E. Ruiz-Sarrio, Jose Antonino Daviu, *Spain*

IEMDC23-000423 – Detection of Rotor Bar Fault through Stray Flux Based Analytical Signal Angular Fluctuation Method
Taner Goktas, Muslum Arkan, *Turkey*

IEMDC23-000261 – Non-Uniform Demagnetization Considering Load Unbalance for SPMSMs Based on Motor Current Derivative Analysis
Yelong Yu, Xiaoyan Huang, Ang Liu, Zhuo Chen, Ye Ma, *China*

* Special Session 2: Novel Multi-Torque Component Machines

POWELL

Session Chairs:
Shaofeng Jia, Jagadeesh Tangudu

IEMDC23-000084 – Analtical Model and Design of Dual PM Vernier Machines Based on Differential Magnetic Circuit
Hailin Huang, Tianjie Zou, Dawei Li, Ronghai Qu, Michele Degano, Christopher Gerada, *United Kingdom*

IEMDC23-000161 – Mitigation of Cogging Torque in a Double-Stator Single-Rotor PMSG for Direct Drive Offshore Wind Turbines
Warda Gul, Gao Qiang, Adam Walker, Tianjie Zou, Hailin Huang, Chris Gerada, *United Kingdom*

IEMDC23-000184 – Analysis of Unipolar End Leakage Flux in Vernier PM Machines
Zi-Qiang Zhu, *United Kingdom*

IEMDC23-000430 – Novel Compact Three Dimensional PM Machines for Ultra High Power Density Applications
Jagadeesh Tangudu, Zhentao Stephen Du, *United States*

IEMDC23-000156 – Design Principles of Dual Winding Dual Permanent Magnet Machines with Multi-torque Components
Pengcheng Sun, Shaofeng JIA, Deliang Liang, *China*

IEMDC23-000343 – Comparison of Dual-Stator Permanent Magnet Machines with Different Rotor Topologies
Minchen Zhu, Lijian Wu, Dongliang Liu, Pingliang Zeng, *China*

* Special Session 3: NVH Mitigation Techniques for High Power Density Electric Machines

MISSION

Session Chairs:
Tianjie Zou, Maher AlBadri

IEMDC23-000411 – A Novel Controll Method to Reduce Torque Harmonics Using Harmonic Current Injection
Martin Bremer, Andreas Langheck, Martin Doppelbauer, *Germany*

IEMDC23-000038 – Electromangetic Force Estimation Using Strain Gauges in Permanent Magnet Synchronous Machines
Yifei Cai, Chiba Akira, *Japan*

IEMDC23-000082 – Study on Electric Motor Vibration Suppression by Active Dynamic Vibration Absorber
Takeshi Okada, Takashi Kosaka, Paul Steinmann, Makoto Isobe, Hiroaki Matsumori, Nobuyuki Matsui, *Japan*

IEMDC23-000359 – On-Load Electromagnetic Force Analysis of a 160kW Interior PM Traction Motor Based on Frozen Permeability Method
Hua Li, Tianjie Zou, Xiaochen Zhang, He Zhang, Hailin Huang, David Gerada, Zeyuan Xu, Christopher Gerada, *China*

IEMDC23-000228 – Stress Analysis on Rotor Lamination of Permanent Magnet Assisted Synchronous Reluctance Machine
liwen liu, Qiantao Huang, *China*

Notes

POSTER SESSION 1

Wednesday, May 17 | 4:00 PM – 5:30 PM

CYRIL MAGNIN FOYER

Session Chairs:
Taner Goktas, Wolfgang Gruber

Rotating Electrical Machines

IEMDC23-000296 – Effect of Cooling Methods on Continuous Output Capability of a Permanent Magnet Synchronous Motor
Kensuke Sasaki, Kan Akatsu, *Japan*

IEMDC23-000424 – Effects of Rotor Asymmetries on d-q Axis Parameters in Synchronous Reluctance Machines
César Gallardo, Carlos Madariaga, Juan Tapia, Michele Degano, *Chile*

IEMDC23-000173 – Performance Comparison of Synchronous Reluctance Machines with Different Rotor Designs
Junichi Asama, Mikito Kawamura, *Japan*

IEMDC23-000339 – Design and Evaluation of Novel High Saliency PM machine for electric-vehicle applications
Felipe Ortiz, César Gallardo, Carlos Madariaga, Juan Tapia, *Chile*

IEMDC23-000050 – Effect of the Damper Winding Pole-to-pole Connection on the Subtransient Reactance and Steady-state Damper Current in Hydro Generators
Andreas Ridder, Allan de Barros, Dirk Emmrich, Amir Ebrahimi, Babette Schwarz, *Germany*

IEMDC23-000012 – Analytical Radial-Force Sum Flattening of Switched Reluctance Motors Considering Current RMS for Acoustic Noise Reduction
Fares El-Faouri, Yifei Cai, chiba akira, Yusuke Fujii, *Japan*

IEMDC23-000115 – Performance Study and Cooperative Control Strategy of A Novel Partitioned Stator DC-Biased Hybrid Excited Permanent Magnet Machine
Liangliang Wei, Dongqing Liu, *China*

IEMDC23-000065 – Vibrational Analysis of an Unbalanced Brushless Doubly Fed Induction Machine
Stefan Botha, Nkosinathi Gule, *South Africa*

IEMDC23-000377 – Multi-three-phase FSCW High-speed High-power-dense Inset Bread-loaf PMSM for the Electric VTOL Application
Jitendra Kumar, B.G. Fernandes, *India*

IEMDC23-000251 – Influence of Tooth-tips on Dual 3-phase Modular Permanent Magnet Machines with Redundant Teeth
Yanxin Li, Zi-Qiang Zhu, Arwyn Thomas, Qinfen Lu, *China*

IEMDC23-000077 – Relative Performances of Pole Pair Combinations for Brushless Doubly Fed Machines
Oreoluwa Olubamiwa, Nkosinathi Gule, *South Africa*

IEMDC23-000040 – Contributions of Stator and Rotor PMs in Multi-tooth Dual-PM Machines Accounting for Stator/rotor Pole Number Combinations
Hai Xu, Zi-Qiang Zhu, Yanjian Zhou, Liang Chen, *United Kingdom*

IEMDC23-000440 – Pentagonal and Rectangular Coils for AC Loss Reduction in Electric Machines
Yuto Yamada, Hiroya Sugimoto, *Japan*

IEMDC23-000281 – Fast Evaluation of Driving Cycle Efficiency of Interior Permanent Magnet Synchronous Machines for Electric Vehicles Considering Step-Skewing
Yuhang Cheng, Yawei Wang, Ma Jimin, Liu Guanghua, Dawei Li, Ronghai Qu, *China*

IEMDC23-000101 – Design of Electric Motor for e-bike Application
Chiara Conto, *Italy*

IEMDC23-000049 – Estimation of the Damper Winding Pole-to-pole Impedance in Hydro Generators
Allan de Barros, Andreas Ridder, Amir Ebrahimi, Babette Schwarz, *Germany*

IEMDC23-000365 – Amplification of Current Unbalance Due to Induction Motors
Alexander Cogburn, Prashanna Bhattarai, *United States*

IEMDC23-000158 – Torque Improvement of a Flux-Reversal Permanent-Magnet Motor Based on Harmonic Oriented Design
Xuhui Zhu, Christopher H.T. Lee, *Singapore*

IEMDC23-000128 – Line-connected Permanent Magnet Generator with Adjustable Excitation for Variable-frequency AC Aircraft Power Systems
Haoyu Liu, Geraint Jewell, Xiao Chen, *China*

IEMDC23-000362 – Design and Development of Energy Efficient Outer Rotor Switched Reluctance Motor for Ceiling Fan
Vipin Kumar Singh, Bhim Singh, *India*

IEMDC23-000386 – Proposal of Axial-gap type Magnetic Multiple Spur Gear for In-wheel Motor System of Electric
Taiga Kamijo, Kohei Aiso, Kan Akatsu, Yasuaki Aoyama, *Japan*

Science for Advancing Research and Education of Electric Machines and Drives

IEMDC23-000239 – Deep Q Direct Torque Control with a Reduced Control Set Towards Six-Step Operation of Permanent Magnet Synchronous Motors
Barnabas Haucke-Korber, Maximilian Schenke, Oliver Wallscheid, *Germany*

Novel Multi-Torque Component Machines

IEMDC23-000180 – Studies of Mutual Inductance Suppression Between Stator and Rotor of Dual Winding Dual Magnet Machines With Multi-torque Components
Pengcheng Sun, Shaofeng JIA, Ziwei Liu, Peixiong Chen, Deliang Liang, *China*

IEMDC23-000372 – Comparative Analysis of Different Stator/Rotor Pole Combinations of a Partitioned Stator Hybrid Excitation Vernier Machine with Consequent-Pole PMs
Dongqing Liu, Liangliang Wei, *China*

IEMDC23-000282 – A Mathematical Model for Wound Field Switched Flux Machine Considering Inductance Harmonics of Field and Armature Windings
Xueyi Yan, Zhongze Wu, Wei Hua, Wentao Zhang, Ming Cheng, *China*

IEMDC23-000306 – A Novel Modular Stator Surface-mounted Permanent Magnet Machine
Xinying CHEN, Hao HUA, Dalin LI, *China*

Measurement and Self-Commissioning Techniques for AC Motor Drives

IEMDC23-000312 – On the Accuracy of Flux Linkage Identification for Synchronous Reluctance Motor Drives
Vasyl Varvolik, Giampaolo Buticchi, Dmytro Prystupa, Shuo Wang, Michael Galea, *Chile*

Transportation Applications

IEMDC23-000090 – Feasibility Study of High Torque Density YASA-Type Axial Flux Machine for High-Speed EV Drives
Yiwen Ma, Alin Stirban, Martin Doppelbauer, *Germany*

IEMDC23-000455 – Integrated Onboard Battery Charger for EVs using Six Phase IPMSM with Dual 3 Phase and Asymmetrical Winding Configurations
Zia Ullah, Ayman Abdel khalik, Shehab Ahmed, *Saudi Arabia*

IEMDC23-000223 – Design Optimization Study of Fault Tolerant and Redundant Motor Drivetrains for Urban Air Mobility Vehicles
Thomas Tallerico, Andrew Smith, Jeffryes Chapman, *United States*

IEMDC23-000035 – Design of a Synchronous Reluctance Machine for Recuperation of a Truck Trailer
Tobias Zeller, David Baumhäckel, Martin Doppelbauer, *Germany*

IEMDC23-000326 – A sustainable Booster Induction Motor for Dual Axle Automotive Applications Using Aluminum Hairpin Winding
M. Jahirul Islam, *Sweden*

Additive Manufacturing of Electric Machines

IEMDC23-000247 – Direct Conductor Cooling of Outer-Rotor Machine Enabled by Additive Manufacturing
Martin Sarap, Ants Kallaste, Payam Shams Ghahfarokhi, Toomas Vaimann, Hans Tiismus, *Estonia*

POSTER SESSION 2

Thursday, May 18 | 1:30 PM – 3:00 PM

CYRIL MAGNIN FOYER

Session Chairs:
Shaofeng Jia, Taner Goktas

Special Machines, Electromagnetic Actuators and Sensors

IEMDC23-000300 – Analyze of Dynamic Compliance of Measuring Device for High-speed Rotors
Yuchen Song, Liyi Li, Jiwei Cao, Yuqing liu, *China*

IEMDC23-000429 – Design and Analysis of Consequent Pole Asymmetric Flux Reversal Permanent Magnet Linear Machine
Yiming Shen, Zhiqiang Zeng, Christopher Lee, *China*

IEMDC23-000231 – A Novel Torque and Thrust Force Controller for an Axial Gap Type Single-Drive Bearingless Reluctance Motor Using Indirect Vector Control
Akihiro Shiratsuki, Kyohei Kiyota, *Japan*

IEMDC23-000253 – Suppression of Rotor Fluctuation and Oscillatory Motion of Bearingless Motors by Using Frequency Domain Inverse Transfer Function
Masaki Ihara, Masahide Oshima, Yoshitaka Morimoto, Akio Hayashi, Masayuki Obata, *Japan*

IEMDC23-000176 – Compact High Power Density Axial Flux PM Motor for Surgical Robotics Application
Madhavan Ramanujam, *United States*

IEMDC23-000152 – Active Control of 5-DOF Magnetically Suspended Azimuth Frame
Biao Xiang, Jianmin Xu, Zhikai Liu, *China*

IEMDC23-000199 – Construction of Radial Flux Cycloidal Magnetic Gears with Reduced Permanent Magnet Piece Count Using Consequent Poles for High Gear Ratio Applications
Shima Hasanpour, Matthew Johnson, Matthew Gardner, Bryton Praslicka, Abas Goodarzi, Hamid Toliyat, *United States*

Poster Sessions

IEMDC23-000083 – Improved Performance of Series and Parallel Hybrid Permanent Magnets Spoke-type PM Machines Using Tapered Magnets
Zi-Qiang Zhu, Seyedmilad Kazemisangdehi, Yanjian Zhou, Hailong Liu, *United Kingdom*

IEMDC23-000153 – Self-Bearing Linear Flux-Switching Permanent Magnet Motor for Linear Motion Platform Application
Sadjad Madanzadeh, Wolfgang Gruber, Rafal Jastrzebski, *Finland*

IEMDC23-000277 – Modeling and Analysis of the Giant Magneto Resistance Sensor Error in Rotor Position of PMSM
Pengwei Li, Hasnain Nisar, Ali Bazzi, Hao Lin, *United States*

IEMDC23-000447 – A Partially Superconducting Flux Reversal Machine with High Power Density
Saeid Saeidabadi, Leila Parsa, Keith Corzine, Christopher Kovacs, Timothy Haugan, *United States*

Electric Drives

IEMDC23-000452 – SynRM Sensorless MTPA Control Based on Alternate High-Frequency Square-wave Voltage Injection
Yuhao Huang, Kai Yang, Cheng Luo, Ruhan Li, Yi Wang, *China*

IEMDC23-000212 – Dynamic Regressor Extension and Mixing-Based Parameter Estimation for Permanent Magnet Linear Synchronous Machines Considering Parameter Asymmetry
Ziyu Zou, Qinfen Lu, Yanxin Li, *China*

IEMDC23-000041 – A Modified Dual-Vector Model Predictive Current Control for PMSM with Robustness Improvement
Guowang Zhang, Xuliang Yao, Jingfang Wang, Shengqi Huang, Ma He, *China*

IEMDC23-000053 – Thrust Ripple Reduction of Permanent Magnet Linear Motor for Servo System Based on Sliding Mode Iterative Learning Control With Feedforward Compensation Strategy
Dongxu Yang, Shaofeng Jia, Deliang Liang, *China*

IEMDC23-000360 – Complex Vector Modeling and Control of Interior Permanent Magnet Synchronous Machines
Samira Tungare, Shivang Agrawal, Debranjan Mukherjee, Arijit Banerjee, *United States*

IEMDC23-000201 – Extended Horizon Predictive Current Control of Switched Reluctance Machine
Mouli Thirumalasetty, Gopalaratnam Narayanan, *India*

IEMDC23-000057 – Maximum Torque Per Ampere Control Based on Model Predictive Control for Asymmetric Interior Permanent Magnet Motor
Zhaoyi Wang, Hyunwoo Kim, Jungho Ahn, Ju Lee, Inyeol Yun, *Korea, Republic of*

IEMDC23-000031 – Position Sensorless Fuzzy Active Disturbance Rejection Control of PMSM Based on Model Predictive Control
Yue Zhao, Zhiquan Deng, Suwan Ge, *China*

IEMDC23-000056 – Robust Deadbeat Predictive Current Control with Online Inductance Identification for Low-inductance SPMSM
Jialiang Dai, Hyunwoo Kim, Jungho Ahn, Ju Lee, Inyeol Yun, *Korea, Republic of*

IEMDC23-000352 – Data-Driven Denoising Technique for IFOC Induction Machine Drives to Improve Torque Response
Muhammed Ali Gultekin, Ali Bazzi, *United States*

Design Optimization, Modelling and Simulation

IEMDC23-000019 – General Modeling and Optimization Framework for Hybrid Permanent Magnet Machines
Bikrant Poudel, Ebrahim Amiri, Abdul Rahman Alsamman, *United States*

IEMDC23-000213 – Incorporating Permanent Magnet-Based Electric Machines into Kron's Tensorial Analysis Framework
Baoyun Ge, *United States*

IEMDC23-000066 – Transient Model for Synchronous Machines with Respect to Saturation of Ferromagnetic Materials
Eike Christian Krüger, Matthias Kalla, Bernd Ponick, *Germany*

IEMDC23-000310 – Analysis and Reduction of Inherent Shaft Voltage in Interior Permanent Magnet Synchronous Machines
Fangwei Zhao, Lijian Wu, Xiuhe Wang, Zhenyang Zhang, *China*

IEMDC23-000364 – Optimization Methodology for High Frequency, Slotless PM Synchronous Machines Based on Drive System Co-Design
Xiaolong Zhang, Kiruba Sivasubramaniam Haran, *United States*

IEMDC23-000279 – Analytical Modeling of 3D Airgap Slotless Halbach Permanent Magnet Synchronous Machines
Junyeong Jung, Iqbal Husain, *United States*

IEMDC23-000401 – Design Challenge of High-Speed High-Power Density Motor For Advanced Electrical Submersible Pump
Patrick Luk, *United Kingdom*

Condition Monitoring, Fault Diagnosis and Prognosis

IEMDC23-000264 – Fault Detection in Small Fan Motors Using Current Signal And Other Variables
Chen Li, Mojtaba Afshar, Bilal Akin, *United States*

IEMDC23-000182 – Stator Inter-Turn Short Circuit Fault Diagnosis using Wavelet Scattering Network Feature Extraction
Hamdihun Abdie Dawed, Khaled Aljaafari, Balanthi Beig, *United Arab Emirates*

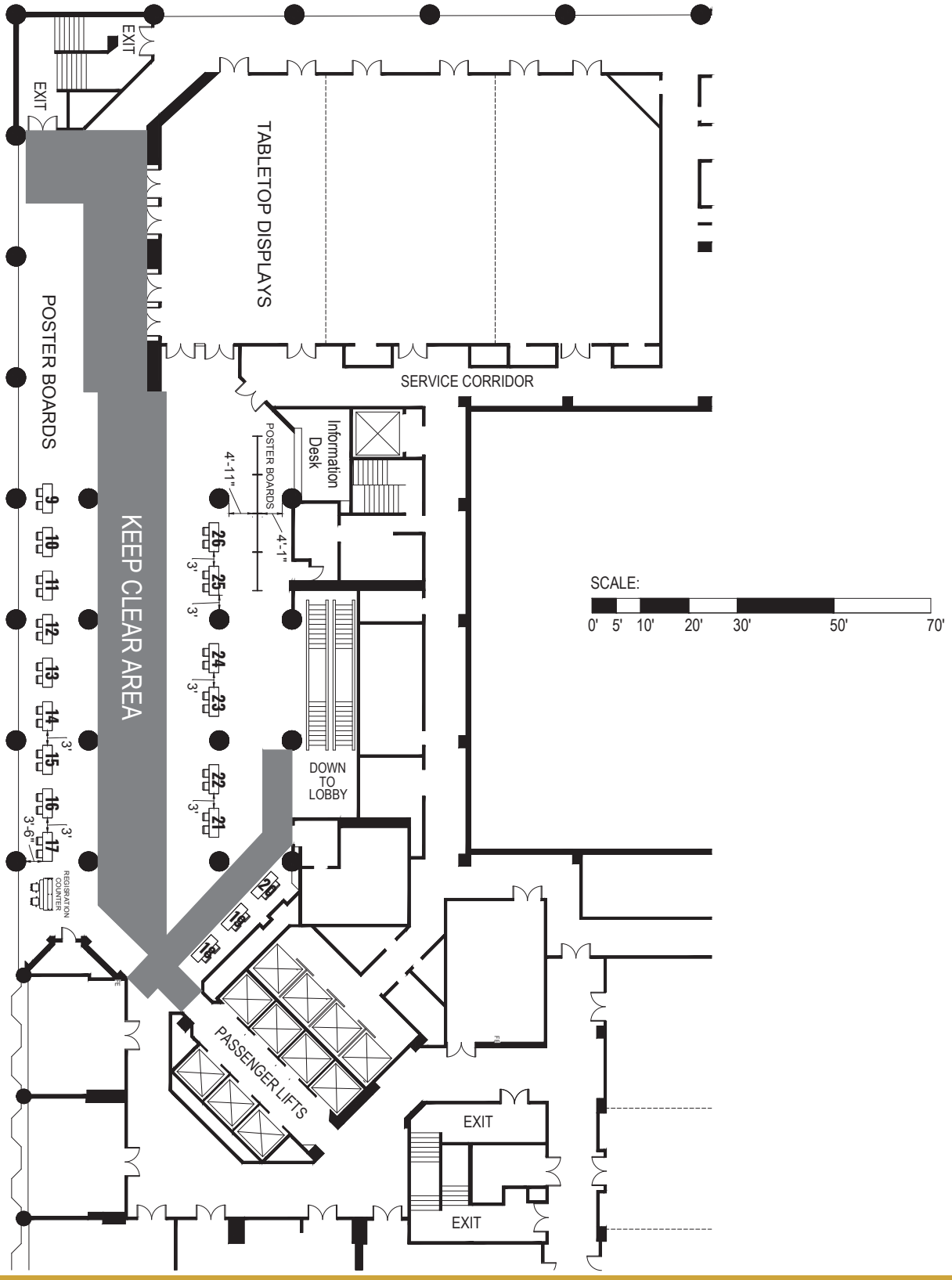
IEMDC23-000198 - Improved High-Frequency Voltage Injection-Based Magnet Temperature Estimation for PMSM
Xinyi Yu,Xinglin Li,Duc Pham,Rik W. De Doncker, *Germany*

IEMDC23-000314 - Detection of Inter-Turn Short-Circuits Fault for Dual Three-Phase PMSM Based on Vector Space Decomposition
Rupeng Duan, Lijian Wu, Zekai Lyu, Haolan Zhan, Sideng Hu, *China*

Floor Plans

EXHIBITOR

FOURTH FLOOR

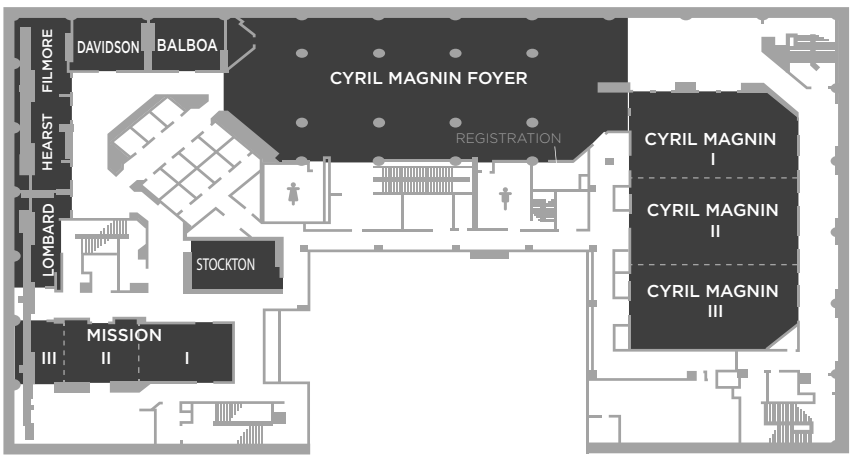


PARC 55

LEVEL TWO

LEVEL THREE

LEVEL FOUR



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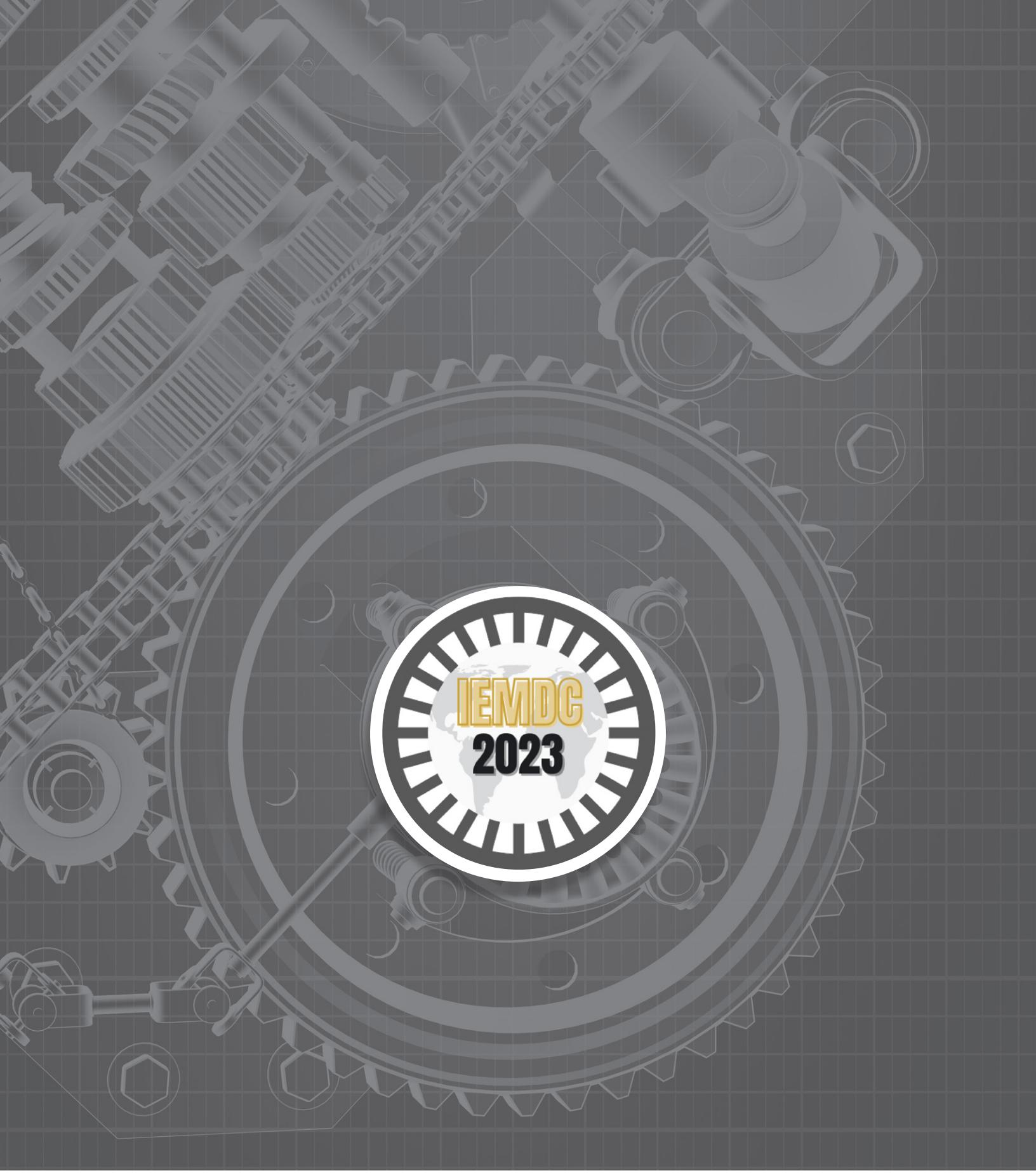

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