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¹Mitsubishi Electric Co., Ltd., Japan; ²Shibaura Institute of Technology, Japan

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Michigan State University, USA

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Huazhong University of Science and Technology, China

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¹ Newcastle University, UK; ² Rolls – Royce Plc., UK	
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¹National Taipei University of Technology, Taiwan; ²National Taiwan University, Taiwan;
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¹Johannes Kepler University Linz, Austria; ²Linz Center of Mechatronics GmbH, Austria;
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¹ University of Akron, USA; ² Bendix Commercial Vehicle Systems, USA	

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Chairs: Omer Gundogmus

Zhentao Du

1:00 pm

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Sang-Hwa Do, Kyoung-Bum Kim, Jae-Bum Park, Nyeon-Han Hong, Hee-Ra Lee
Hyundai Motor Company, Korea (South)

1:25 pm

Design and Optimization of a PMASR Motor for Low-Voltage E-Scooter Applications	1016
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Cristian Babetto¹, Nicola Bianchi¹, Giorgio Benedetti²
¹University of Padova, Italy; ²Askoll Holding s.r.l., Italy

1:50 pm

Design Analysis of a High Speed Copper Rotor Induction Motor for a Traction Application	1024
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Nicolas Riviere¹, Giuseppe Volpe¹, Marco Villani², Giuseppe Fabri², Lino Di Leonardo², Mircea Popescu¹
¹Motor Design Ltd., UK; ²University of l'Aquila, Italy

2:15 pm

Comparison between Two Conical Induction Machines Designed for an Electric Vehicle Application	1032
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Uğur Demir¹, Sara Roggia², Mustafa Caner Aküner³
¹Coşkunöz Holding A.Ş., Turkey; ²SAFRAN, France; ³Marmara University, Turkey

1:00 pm (100 minutes)

Thermal Management of Electrical Machines

Chairs: Sabrina Ayat

Guang-Jin Li

1:00 pm

Effects of Annealing on Magnetic Properties of Laminated Stator Cores and Efficiency of Induction Machines	1038
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Patrick Breining¹, Abdullah Kahveci², Martin Doppelbauer¹
¹Karlsruhe Institute of Technology, Germany; ²Thyssenkrupp Steel Europe AG, Germany

1:25 pm

- Binder Jet Printed Iron Silicon with Low Hysteresis Loss** 1045
Thang Q. Pham¹, Christiane Mellak², Hawke Suen¹, Carl J. Boehlert¹, Annette Muetze²,
Patrick Kwon¹, Shanelle N. Foster¹
¹Michigan State University, USA; ²Graz University of Technology, Austria

1:50 pm

- AC Winding Loss Reduction in High Speed Axial Flux Permanent Magnet
Machines using a Lamination Steel Sheet** 1053
N. Aliyu, N. Ahmed, N. Stannard, G.J. Atkinson
Newcastle University, UK

2:15 pm

- Magnetization Characteristics and Loss Measurements of the Axial Flux
Permanent Magnet Motor's Stator** 1061
Qurban Ali Shah Syed, Veronika Solovieva, Ingo Hahn
University of Erlangen-Nuremberg, Germany

1:00 pm (100 minutes)

Special Machines

**Chairs: Chris Gerada
Ayman El-Refaie**

1:00 pm

- Loss Breakdown of a Dual Conical Rotor Permanent Magnet Motor using
Grain Oriented Electrical Steel and Soft Magnetic Composites** 1067
Matthew C. Gardner¹, Yichi Zhang¹, Dorsa Talebi¹, Hamid A. Toliyat¹, Alan Crapo², Paul Knauer², Harold Willis²
¹Texas A&M University, USA; ²Regal Beloit Corporation, USA

1:25 pm

- Design and Analysis of Interior Permanent Magnet Two Degrees of
Freedom Motor based on Cross-Coupled Structure** 1075
Yoshiyuki Hatta, Tomoyuki Shimono, Yasutaka Fujimoto
Yokohama National University, Japan

1:50 pm

- A Novel Contactless Rotary-to-Linear Magnetic Actuator** 1081
Hussain A. Hussain
Kuwait University, Kuwait

2:15 pm

- Single-Phase Open-Circuit Fault Operation of Bearingless Multi-Sector PM Machines** 1087
Zhuang Wen, Giorgio Valente, Andrea Formentini, Luca Papini, Pericle Zanchetta, Christopher Gerada
University of Nottingham, UK

1:00 pm (100 minutes)

PM Motor Drives

**Chairs: Jiangbiao He
Maher Al-Badri**

1:00 pm

- A Novel Rotor Initial Position Detection Method Utilizing DC-Link Voltage Sensor** 1093
Ximeng Wu, Zi-Qiang Zhu
The University of Sheffield, UK

1:25 pm

**Low Inductance Effects on Electric Drives using Slotless Permanent Magnet Motors:
A Framework for Performance Analysis** 1099

Matteo Leandro¹, Nicola Bianchi¹, Marta Molinas², Ravindra Babu Ummaneni³

¹University of Padova, Italy; ²Norwegian University of Science and Technology, Norway; ³Alva Motor Solutions, Norway

1:50 pm

**Modeling, Analysis and Compensation of Resistance Imbalance in Permanent Magnet
Synchronous Motor Drives for Mass Manufacturing Applications** 1106

Prerit Pramod, Aparna Saha, Krishna Namburi, Rakesh Mitra

Nexteer Automotive Corp., USA

2:15 pm

**Comparative Performance Evaluation of Hall Effect Sensorless Control Options in
Permanent Magnet Brushless DC Motor Drives** 1110

Kevin Lee¹, Feilang Li², Wenxi Yao²

¹Eaton Corp., USA; ²Zhejiang University, China

1:00 pm (100 minutes)

Machine Vibrations

Chairs: Bilal Akin

Iqbal Husain

1:00 pm

On the Use of Vibration Synthesis to ease Electric Machine Powertrain Design 1118

F. Chauvicourt, S. Ciceo, H. Van der Auweraer

Siemens Industry Software NV, Belgium

1:25 pm

A Method of Modal Parameter Estimation based on Electromagnetic Vibration Exciter 1126

Jianfeng Hong, Shanming Wang, Yuguang Sun, Haixiang Cao

Tsinghua University, China

1:50 pm

**Acoustic Noise and Vibration in Switched Reluctance Machines:
A Comparative Study of 12/8 and 8/6 Topologies** 1130

Selin Yaman, Chenqiu Chen, Ziyang Zhang, Mahesh Krishnamurthy

Illinois Institute of Technology, USA

2:15 pm

**Experimental and Simulation based Study of Vibration Prediction in
Fractional Slot Permanent Magnet Synchronous Machines** 1138

Shuvajit Das¹, Anik Chowdhury¹, Subhra Paul², Zhao Wan², Rakib Islam³, Yilmaz Sozer¹

¹University of Akron, USA; ²Nexteer Automotive, USA; ³DURA Automotive Systems, USA

1:00 pm (100 minutes)

Machines – Numerical Modeling

Chairs: Qinfen Lu

Giuseppe Volpe

1:00 pm

Numerical Calculation of End-Coil's Leakage Inductance for Concentrated and Hairpin Windings

1144

Sebastian Moros¹, Joachim Kempkes¹, Stephan Tenner²

¹University of Applied Sciences Wuerzburg-Schweinfurt, Germany; ²ZF Friedrichshafen AG, Germany

1:25 pm

On the Numerical Transient in Time-Stepping Finite Element Analysis of Induction Motors: Fundamental Concepts

1151

Hossein Nejadi Koti, Hao Chen, Yue Sun, Nabeel A.O. Demerdash

Marquette University, USA

1:50 pm

On Shortening the Numerical Transient in Time-Stepping Finite Element Analysis of Induction Motors: Method Implementation

1157

Hossein Nejadi Koti, Hao Chen, Yue Sun, Nabeel A.O. Demerdash

Marquette University, USA

2:15 pm

Optimal Design of Cooling Fan for 200kW Class Low Voltage Motor by Numerical Analysis

1163

Chungman Jang, Jongin Lee, Minkyu Sung, Joonyeob Lee

Hyundai Electric & Energy Systems Co., Ltd., Korea (South)

3:10 pm (100 minutes)

Design of Linear Motors

Chairs: Wei Xu

Rabiul Islam

3:10 pm

Thrust Ripple Reduction of Air-Core Permanent Magnet Linear Synchronous Motor based on Arc Shaping Technique and Taguchi Method

1169

Fei Dong, Jiwen Zhao, Jing Zhao, Juncai Song

Anhui University, China

3:35 pm

Study on the Slot/Pole Combination Influences to the Thrust Performances of the Linear Permanent Magnet Vernier Machines

1175

Chaojie Shi, Ronghai Qu, Yuting Gao

Huazhong University of Science and Technology, China

4:00 pm

Computationally Fast Peak Detent Calculation for Transverse Flux PMLSM by Multi-Fidelity Surrogate

1182

Salman Ahmed¹, Kunihiko Norizuki², Yasuaki Aoyama², Takafumi Koseki¹

¹The University of Tokyo, Japan; ²Hitachi, Ltd., Japan

4:25 pm

- A Novel Flux Modulation Linear Machine with Dual-Sided Modular Primary and Multiple Pole Pitches** 1188
You Zhou, Ronghai Qu, Yuting Gao, Dawei Li, Chaojie Shi
Huazhong University of Science and Technology, China

3:10 pm (100 minutes)

Thermal Design of Electrical Machines

Chairs: Michael Galea
Shafigh Nategh

3:10 pm

- The Use of Phase Change Material for the Cooling of Electric Machine Windings formed with Hollow Conductors** 1195
Sabrina Ayat¹, Camel Serghine², Thomas Klonowski², Sébastien Yon³, Albert Mutabazi³, Steven McDaniel⁴
¹Safran Tech, France; ²Safran Helicopter Engines, France; ³Areelis Technologies, France; ⁴Safran Electrical & Power, USA

3:35 pm

- Comparative Study of Three Stator Cooling Jackets for Electric Machine of Mild Hybrid Vehicle** ... 1202
Xiaofeng Yang, Alireza Fatemi, Thomas Nehl, Lei Hao, Wei Zeng, Scott Parrish
General Motors Global R&D Center, USA

4:00 pm

- An Optimization Method for Cooling System Design of Traction Motors** 1210
Aldo Boglietti¹, Shafigh Nategh², Enrico Carpaneto¹, Luca Boscaglia¹, Claudio Scema¹
¹Politecnico di Torino, Italy; ²ABB Inc., Sweden

4:25 pm

- Air-Cooling of a Hollow High-Speed Permanent Magnet Rotor** 1216
Peter H. Connor, Antonino La Rocca, Zeyuan Xu, Michele Degano, Carol N. Eastwick, Stephen J. Pickering, Chris Gerada
University of Nottingham, UK

3:10 pm (100 minutes)

Synchronous and Reluctance Machines

Chairs: Glyn Atkinson
Thomas Lipo

3:10 pm

- Torque Performance Improvement of Doubly Salient Synchronous Reluctance Machines by Current Harmonic Injection** 1222
K. Zhang, G.J. Li, Z.Q. Zhu, G.W. Jewell
The University of Sheffield, UK

3:35 pm

- Design Aspects of a Novel Brushless Excitation System for Synchronous Machines** 1228
Jan Pötter¹, Martin Pfof¹, Gernot Schullerus²
¹TU Dortmund, Germany; ²Reutlingen University, Germany

4:00 pm

- An HTS Machine Concept with a Passive Rotor** 1234
Naireeta Deb, Thomas A. Lipo, Sastry V. Pamidi
Florida State University, USA

4:25 pm

- Design and Analysis of Mutually Coupled SRMs for Low Torque Ripple Applications using Standard Voltage Source Inverters** 1240
Siddharth Mehta¹, Md Ashfanoor Kabir², Iqbal Husain¹
¹North Carolina State University, USA; ²ABB Inc., USA

3:10 pm (100 minutes)

Induction Motor Drives
Chairs: Zhenbin Zhang
Radu Bojoi

3:10 pm

- Induction Machine with Localized Voltage Unbalance Compensation** 1248
Akihiro Imakiire¹, Thomas A. Lipo²
¹Kyushu Institute of Technology, Japan; ²University of Wisconsin, USA

3:35 pm

- Multi-Winding Transformer Fed CHB Inverter with On-Line Switching Angle Calculation based SHE Technique for VCIMD** 1256
Piyush Kant, Bhim Singh
Indian Institute of Technology Delhi, India

4:00 pm

- Saturation Interaction in a Fault-Tolerant Induction Machine Drive Due to a Zero-Sequence Stator Current** 1262
Heinrich T. Eickhoff, Roland Seebacher, Annette Muetze
Graz University of Technology, Austria

4:25 pm

- Control of a Three-Phase Wound-Rotor Induction Motor Drive for Automation Applications** 1267
Michele Mengoni, Gabriele Rizzoli, Luca Zarri, Angelo Tani, Albino Amerise, Giovanni Serra
University of Bologna, Italy

3:10 pm (100 minutes)

Permanent Magnet Machines (III)
Chairs: Edmund Marth
Gerald Jungmayr

3:10 pm

- Improved Stator/Rotor-Pole Number Combinations for Torque Ripple Reduction in Doubly Salient PM Machines** 1273
Lijian Wu, Guangqiang Ming, Liu Zhang, Youtong Fang
Zhejiang University, China

3:35 pm

- Robust Design Approach of Permanent Magnet Synchronous Motors for Torque Ripple Minimization** 1280
Subhra Paul, David Harris, Zhao Wan, Jeff Klass
Nexteer Automotive, USA

4:00 pm

- Computationally Efficient Design Procedure for Single-Layer IPM Machines** 1288
Simone Ferrari¹, Gianmario Pellegrino¹, Mohamed Zubair M. Jaffar², Iqbal Husain²
¹Politecnico di Torino, Italy; ²North Carolina State University, USA

4:25 pm

- Design and Experimental Evaluation of a High Specific Power Permanent Magnet Synchronous Machine** 1296
Longya Xu, Hongyu Wang, Han Xiong, Ziwei Ke, Julius Woo, Julia Zhang, Sheng Dong
The Ohio State University, USA

3:10 pm (100 minutes)

Permanent Magnet Machines (IV)

Chairs: Jiangbiao He
Kevin Lee

3:10 pm

- Lower-Cost Interior Permanent Magnet Machine with a Blend of Magnet Types** 1303
Qingqing Ma, Ayman EL-Refaie, Bruno Lequesne
Marquette University, USA

3:35 pm

- Comparison of Inner and Outer Rotor Configurations in Slotless PM Machines with PCB Windings** .. 1311
Nicolas Verbeek, Bruno Dehez
Université Catholique de Louvain, Belgium

4:00 pm

- Novel Rotor Design with Reduced Rare-Earth Material for PM Machines** 1318
G. Dajaku¹, H. Zhou¹, X. Dajaku¹, D. Gerling²
¹FEAM GmbH, Germany; ²Bundeswehr University Munich, Germany

4:25 pm

- Analytically Determined Graph Based Solution for Minimum Cogging in SPM Motors with Integer Slots Per Pole** 1325
Naveen Kumar Endla
Indian Institute of Technology Gandhinagar, India

Wednesday, May 15

8:40 am (75 minutes)

Control of Linear Motor Drives and Applications

Chairs: Wei Xu
Rabiul Islam

8:40 am

- Disturbance Attenuation and Response Time Improvement of Permanent Magnet Synchronous Linear Motor by using Robust Predictive Resonant Current Control** 1330
Jiwen Zhao, Lijun Wang, Zhongyan He, Juncai Song
Anhui University, China

9:05 am

- A Sensorless Finite-Set Model Predictive Direct Thrust Control of a Linear Induction Motor based on MRAS for Linear Metro** 1336
Mahmoud F. Elmorshedy¹, Wei Xu¹, Yi Liu¹, Minghai Dong²
¹Huazhong University of Science and Technology, China; ²Foshan Golden Age Motor Technology Co., Ltd., China

9:30 am

A Sliding Mode Observer for Position Estimation of the Planar Switched Reluctance Motor 1342

Jun-Di Sun^{1,2}, Guang-Zhong Cao¹, Su-Dan Huang¹, Qing-Quan Qian²

¹Shenzhen University, China; ²Southwest Jiaotong University, China

8:40 am (75 minutes)

Multiphase Machines Analysis and Design

Chairs: Franck Scuiller

Jorge Rodas

8:40 am

Predicting the Space Harmonics Generated by Symmetrical Multi-Phase Windings 1348

Franck Scuiller

École Navale, France

9:05 am

Fault Analysis for Dual Three-Phase Synchronous Reluctance Motor 1356

Jun-Kyu Park, Cristian Babetto, Nicola Bianchi

University of Padova, Italy

9:30 am

Optimal Carrier Phase-Shift Angle on Dual Three-Phase Windings Permanent Magnet Synchronous Motor 1362

Yoshihiro Miyama¹, Kan Akatsu²

¹Mitsubishi Electric Corp., Japan; ²Shibaura Institute of Technology, Japan

8:40 am (75 minutes)

System Modeling and Characterization

Chairs: Guillaume Parent

Maximilian Schneider

8:40 am

Real-Time Hardware Emulation of a Power Take-Off Model for Grid-Connected Tidal Energy Systems 1368

Nuh Erdogan¹, Donal B. Murray¹, Jochen Giebhardt², Matthias Wecker², James Donegan³

¹University College Cork, Ireland; ²Fraunhofer Institute for Energy Economics and Energy System Technology, Germany;

³Ocean Renewable Power Company, Ireland

9:05 am

Aggregate Model of Single Phase Induction Motors 1373

Bikrant Poudel¹, Rochak Shiwakoti¹, Ebrahim Amir¹, Parviz Rastgoufard¹, Thomas E. Field², Jayanth Ramamurthy²

¹University of New Orleans, USA; ²Entergy Corp., USA

9:30 am

System Loss Measurement of a Novel Outer Rotor Flywheel Energy Storage System 1379

Maximilian Schneider, Stephan Rinderknecht

Technische Universität Darmstadt, Germany

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Electric Machines Drives for Transportations Applications

Chairs: Shanelle Foster
Herbert Hess

8:40 am

Evaluation of Efficiency-Shifting Permanent Magnet Motor in Electric Vehicle 1386

Hoyun Won, Yang-Ki Hong, Minyeong Choi, Woncheol Lee, Shuhui Li, Hwan-Sik Yoon
The University of Alabama, USA

9:05 am

A Dual-Channel Enhanced Power Generation Architecture with Back-to-Back Converter for MEA Application 1392

Xiaoyu Lang, Tao Yang, Hossein Balaghi Enalou, Chen Li, Serhiy Bozhko, Patrick Wheeler
University of Nottingham, UK

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A New Three-Phase Hybride Excitation Flux-Switching Motor for EV/HEV Applications 1398

Ruiwu Cao, Xue Zhang, Xinyi Yuan
Nanjing University of Aeronautics and Astronautics, China

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Machine Manufacturing

Chairs: Ronghai Qu
Alireza Fatemi

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Hot Crimping through Innovative Inductive Heating in the Production of Electric Motors 1404

Alexander Kuehl, Maximilian Zitzelsberger, Johannes Seefried, Michael Masuch, Tim Miller, Joerg Franke
Friedrich-Alexander-University Erlangen-Nuremberg, Germany

9:05 am

Design and Construction of an IPM Motor for Automatic Tapping Machine Tool Applications 1410

Cheng-Tsung Liu¹, Chang-Chou Hwang²
¹National Sun Yat-Sen University, Taiwan; ²Feng Chia University, Taiwan

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Influence of Magnet Imperfection on Torque Ripple in SPM Machine having Double and Single Layer Windings 1415

H.Y. Sun, K. Wang, L.F. Zhang, F. Li, R.W. Cao
Nanjing University of Aeronautics and Astronautics, China

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Machine Modeling and Manufacturing

Chairs: Chushan Li
Pinjia Zhang

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Semi-Analytical Calculation of Field Distribution in Yoke/Tooth Transition in Electrical Machines 1422

Alexander Rehfeldt¹, Torben Fricke¹, Dirk Emmrich², Bernd Ponick¹
¹Leibniz University Hannover, Germany; ²Voith Hydro Holding GmbH & Co. KG, Germany

9:05 am

- Magnetic Field Prediction in Surface-Mounted PM Machines with Parallel Slot based on a Nonlinear Subdomain and Magnetic Circuit Hybrid Model** 1427
Hao Yin, Lijian Wu, Yuting Zheng, Youtong Fang
Zhejiang University, China

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- Analytically-Based Optimization of SMPM Machines for Sizing Validation Purposes** 1433
Silvio Vaschetto¹, Gerd Bramerdorfer², Andrea Cavagnino¹, Alberto Tenconi¹
¹*Politecnico di Torino, Italy*; ²*Johannes Kepler University Linz, Austria*

10:30 am (90 minutes)

Poster Session: Rotating Electric Machines

**Chairs: Seshadri S Kumar
Chushan Li**

- Deep Residual Convolutional and Recurrent Neural Networks for Temperature Estimation in Permanent Magnet Synchronous Motors** 1439
Wilhelm Kirchgässner, Oliver Wallscheid, Joachim Böcker
Paderborn University, Germany

- The Development of a New Type of Repulsion-Induction Motor** 1447
Aurelian Crăciunescu
University Politehnica of Bucharest, Romania

- An Approach to Design of Energy Efficient Single Phase Induction Motor for Ceiling Fans** 1452
Utkarsh Sharma, Bhim Singh
Indian Institute of Technology Delhi, India

- Hybrid Magnet – Field Winding Solutions for Exciters of Synchronous Generators** 1458
Giovanni Decuzzi¹, Stefano Nuzzo⁰, Paolo Bolognesi³, Paolo Giangrande¹, Michael Galea⁰
¹*University of Nottingham, UK*; ²*University of Modena and Reggio Emilia, Italy*; ³*University of Pisa, Italy*;
⁴*University of Nottingham Ningbo, China*

- Experimental Comparison of Synchronous Reluctance Motors with and without Ferrite Magnet Assistance** 1464
Sascha Neusüs, Andreas Binder
Technische Universität Darmstadt, Germany

- Experimental Verification of a Motor with Two Axially-Arranged Rotors** 1472
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Osaka University, Japan

- Experimental Study of Torque-Ripple and its Effect on the Flux Weakening Range of Synchronous Reluctance Machines** 1479
Rajendra Thike, Pragasen Pillay
Concordia University, Canada

- Online Characterization of a Synchronous Generator using an Unscented Kalman Filter** 1485
Andrew G. Miles¹, Brian K. Johnson¹, Normann Fischer²
¹*University of Idaho, USA*; ²*Schweitzer Engineering Laboratories, USA*

- Stator/Rotor Pole Combinations of Variable Flux Reluctance Machines with 2nd Harmonic Current Injection Method** 1493
L.R. Huang¹, Z.Q. Zhu¹, J.H. Feng², S.Y. Guo², J.X. Shi²
¹*The University of Sheffield, UK*; ²*CRRC Zhuzhou Institute Co. Ltd., China*

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¹ Aston University, UK; ² Lappeenranta-Lahti University of Technology, Finland	
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Newcastle University, UK	
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Huazhong University of Science and Technology, China	
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¹ University of New Orleans, USA; ² Azad University, Iran; ³ Yazd University, Iran	
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¹ Lodz University of Technology, Poland; ² Politecnico di Torino, Italy	
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Christiane Mellak ¹ , Hannes Gruebler ¹ , Heinrich T. Eickhoff ¹ , Josef Deuringer ² , Klaus Krischan ¹ , Annette Muetze ¹	
¹ Graz University of Technology, Austria; ² Siemens Healthcare GmbH, Germany	
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Ryotaro Ikeda ¹ , Sadali Yusya ² , Keiichiro Kondo ²	
¹ Chiba University, Japan; ² Waseda University, Japan	
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¹ Lappeenranta-Lahti University of Technology, Finland; ² Aston University, UK	
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ABB Inc., USA	
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¹ Air Force Research Laboratory, USA; ² PC Krause & Associates, USA; ³ UES, Inc., USA; ⁴ The Perduco Group, USA; ⁵ Air Force Institute of Technology, USA	
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¹ Southeast University, China; ² The University of Sheffield, UK; ³ The Hong Kong Polytechnic University, China	
Comparing Calculation Methods for Damper Bars in Synchronous Electric Machines	1581
William Perdikakis, Hongyu Wang, Bailey Hall, Longya Xu	
The Ohio State University, USA	

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Poster Session: Control of Electrical Drives

Chairs: Fan Wu

Keiichiro Kondo

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A Holistic DC Link Architecture Design Method for Multiphase Integrated Modular Motor Drives	1593
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Analysis of External Rotor Electric Drives for an All-Automatic Airborne Wind Energy System	1599
Stefan Urbanek ¹ , Daniel Heide ¹ , Bakr Bagaber ¹ , Martin Lohss ² , Bernd Specht ² , Xaver Paulig ² , Axel Mertens ¹ , Bernd Ponick ¹ ¹ Leibniz University Hannover, Germany; ² SkySails Power GmbH, Germany	
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Hao Wu, Jin Huang <i>Zhejiang University, China</i>	
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Josiah Haruna ¹ , Tsarafidy Raminosa ² , Olorunfemi Ojo ¹ ¹ Tennessee Tech University, USA; ² Oak Ridge National Laboratory, USA	

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Suman Kumar Neogi, Kishore Chatterjee <i>Indian Institute of Technology, Bombay, India</i>	
Current Source Inverter Drive System for Switched Reluctance Motors	1670
Mohammadreza Dibaji ¹ , Aliakbar Damaki Aliabad ¹ , Ebrahim Amiri ² , Mohammad Divandari ³ ¹ Yazd University, Iran; ² University of New Orleans, USA; ³ Azad University, Iran	
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Chenwei Ma ^{1,2} , Xuliang Yao ² , Huayu Li ¹ , Frederik De Belie ¹ ¹ Ghent University, Belgium; ² Harbin Engineering University, China	
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Fayez F.M. El-Sousy ¹ , Mahmoud Amin ² , Osama A. Mohammed ³ ¹ Prince Sattam bin Abdulaziz University, Saudi Arabia; ² Manhattan College, USA; ³ Florida International University, USA	
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Anant Kumar Singh, Ramakrishnan Raja, Tomy Sebastian, Awab Ali <i>Halla Mechatronics, USA</i>	
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Sridhar Seshagiri ¹ , Nitya Krishnan ¹ , Jordana Bratt ² ¹ San Diego State University, USA; ² Viasat, Inc., USA	
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Zhe Zhang ¹ , Ali Bazzi ⁰ ¹ University of Connecticut, USA; ² American University of Beirut, Lebanon	
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Poster Session: High Performance Linear Machines and Drives

Chair: Renato Galluzzi

- Mover Position Detection for PMSLM based on Sinusoidal Fringe Pattern and Fourier Phase Analysis** 1742
Jing Zhao, Jiwen Zhao, Fei Dong, Juncai Song, Fang Xie
Anhui University, China
- New Double-Sided Wound Field Flux-Switching Linear Motor with Non-Overlapping Winding** 1746
Ruiwu Cao, Enchao Su
Nanjing University of Aeronautics and Astronautics, China
- Investigation of Prediction Models for Forces Calculation in Linear Induction Motor with Data-Based System Identification Algorithms** 1752
Gang Lv¹, Dihui Zeng¹, Tong Zhou¹, Michele Degano²
¹Beijing Jiaotong University, China; ²University of Nottingham, UK
- Demagnetization Modeling Research for Permanent Magnet in PMSLM using Extreme Learning Machine** 1757
Juncai Song, Jiwen Zhao, Fei Dong, Jing Zhao, Liang Xu, Lijun Wang, Fang Xie
Anhui University, China
- Core Loss Minimization of the Linear Generator by using High Graded Magnetic Materials for Harvesting Oceanic Wave Energy** 1762
Omar Farrok¹, Mahbubur Rahman Kiran¹, Md Rabiul Islam², Wei Xu³, Jianguo Zhu⁴
¹Ahsanullah University of Science and Technology, Bangladesh; ²University of Wollongong, Australia;
³Huazhong University of Science and Technology, China; ⁴The University of Sydney, Australia
- A Complete Equivalent Circuit Model for Linear Induction Motor Considering Thrust, Vertical and Transversal Forces** 1766
Dihui Zeng¹, Gang Lv¹, Tong Zhou¹, Michele Degano²
¹Beijing Jiaotong University, China; ²University of Nottingham, UK
- Linear Oscillatory PMSM Drives: A Revisit in 2019** 1772
I. Boldea¹, L.N. Tutelea¹, A.A. Popa¹, Wei Xu²
¹Politehnica University Timisoara, Romania; ²Huazhong University of Science and Technology, China

10:30 am (90 minutes)

Poster Session: Multiphase Machines and Drives

Chairs: Yoshihiro Miyama

- Circulating Harmonic Currents Prediction for VSI Fed Dual Three-Phase IPMSM** 1778
Donglin Ye, Jian Li, Ronghai Qu
Huazhong University of Science and Technology, China
- Design Optimization and Analysis of a Synchronous Reluctance Machine for Fault-Tolerant Applications** 1784
Cristian Babetto¹, Nicola Bianchi¹, Ambra Torreggiani², Claudio Bianchini², Matteo Davoli³, Alberto Bellini⁴
¹University of Padova, Italy; ²University of Modena and Reggio Emilia, Italy; ³Raw Power S.r.l, Italy;
⁴University of Bologna, Italy
- New Direct Torque and Flux Control with Improved Torque per Ampere for Switched Reluctance Motor** 1792
Krishna Reddy Pittam¹, Deepak Ronanki², Parthiban Perumal¹, Sheldon S. Williamson²
¹National Institute of Technology Karnataka, India; ²University of Ontario Institute of Technology, Canada

Nonlinear Backstepping with Time Delay Estimation for Six-Phase Induction Machine 1798
Yassine Kali¹, Jorge Rodas², Maarouf Saad¹, Jesus Doval-Gandoy³, Raul Gregor²
¹École de Technologie Supérieure, Canada; ²Universidad Nacional de Asunción, Paraguay;
³Universidad de Vigo, Spain

Information Technologies for Distributed Machine Drives: An Overview 1805
Filippo Savi¹, Giampaolo Buticchi¹, Chris Gerada¹, Pat Wheeler¹, Davide Barater²
¹University of Nottingham Ningbo, China; ²University of Modena and Reggio Emilia, Italy

1:00 pm (90 minutes)

Poster Session: Rotating Electric Machines

Chairs: Pinjia Zhang

Alireza Fatemi

Comparison of AC Motors to an Ideal Machine Part II – Non-Sinusoidal AC Machines 1810
Thomas A. Lipo, Wenbo Liu, Zhentao Du
University of Wisconsin, USA

Efficiency Improvement of In-Wheel Magnetic Geared Motor and Feasibility Study for Walking Support Machines 1818
Koki Ito, Takahisa Kadomatsu, Kenji Nakamura
Tohoku University, Japan

Schwarz-Christoffel-Based Open-Circuit Clamping Plate Field Calculation in Hydro Generators 1824
Torben Fricke¹, Babette Schwarz², Bernd Ponick¹
¹Leibniz University Hannover, Germany; ²Voith Hydro Holding GmbH & Co. KG, Germany

3D-Printed Rapid Prototype Rigs for Surface Mounted PM Rotor Controlled Segment Magnetisation and Assembly N/A
Juan I. Melecio¹, A. Mohammed¹, Nigel Schofield², S. Djurović¹
¹The University of Manchester, UK; ²University of Huddersfield, UK

On the Design of Partial Discharge-Free Low Voltage Electrical Machines 1837
Vincenzo Madonna¹, Paolo Giangrande¹, Weiduo Zhao², He Zhang², Chris Gerada⁰, Michael Galea⁰
¹University of Nottingham, UK; ²University of Nottingham Ningbo, China

A Magnetic Equivalent Circuit for Synchronous Alternator Excitation System Design 1843
Adam Larson¹, Steven D. Pekarek²
¹Kohler Power, USA; ²Purdue University, USA

Fast Evaluation of High Frequency Electromagnetic Force and Vibration for Electrical Machines based on Field Reconstruction Technique 1849
Yunsong Xu, Haiyang Fang, Dawei Li, Ronghai Qu, JiaXiong Guo
Huazhong University of Science and Technology, China

An Equivalent Winding Factor Larger than 1 by using Flux Barriers in the Stator 1855
Johannes Walter Gerold¹, Dieter Gerling²
¹FEAAM GmbH, Germany; ²Bundeswehr University Munich, Germany

A Method to Suppress Vibration Due to Fabrication Tolerance by using Triple Three-Phase Winding Motor 1863
Kan Yang¹, Kan Akatsu¹, Yoshihiro Miyama², Kodai Okazaki²
¹Shibaura Institute of Technology, Japan; ²Mitsubishi Electric Corp., Japan

A Trade Study on Motor Types for Large HVAC Systems with Integrated Motor-Compressors	1869
Samith Sirimanna ¹ , Byung Hoon Min ¹ , Xiaolong Zhang ¹ , Yangxue Yu ¹ , Xuan Yi ¹ , Kiruba Haran ¹ , Ivan Jadric ² , Matt Heisey ² , Ajit Kane ² , Jeb Schreiber ²	
¹ University of Illinois Urbana-Champaign, USA; ² Johnson Controls International PLC, USA	
Analysis of Inherent Unbalanced Currents in Three-Phase Multi-Branch Brushless Exciter	1875
Wei Du, Yuguang Sun, Lin Gui Tsinghua University, China	
A Comparative Study between System-Level PMSM Models with either Current or Flux-Linkage State Variables used for Vibro-Acoustic Computation	1881
Sebastian Ciceo ^{1,2,3} , Fabien Chauvicourt ¹ , Johan Gyselinck ² , Claudia Martis ³	
¹ Siemens Industry Software, Belgium; ² Université Libre de Bruxelles, Belgium; ³ Technical University of Cluj-Napoca, Romania	
Design of a Hybrid Magnets Variable Flux Memory Machine based on Hysteresis Model	1889
Hai Xu, Jian Li, Junhua Chen, Meng Ge Huazhong University of Science and Technology, China	
A Review of Electrical Machine Optimization Methods with Emphasis on Computational Time	1895
Qingqing Ma ¹ , Hao Chen ² , Ayman EL-Refaie ¹ , Yue Sun ¹	
¹ Marquette University, USA; ² Beijing Institute of Technology, China	
Optimal Design of a Fully Superconducting Machine for 10-MW Offshore Wind Turbines	1903
Thanatheepan Balachandran, Dongsu Lee, Kiruba S. Haran University of Illinois Urbana-Champaign, USA	
Modeling and Analysis of Novel Star-Delta Winding Configuration with Odd Slot Numbers for Reduced Space Harmonics using Winding Function	1910
Shruthi Mukundan, Himavarsha Dhulipati, Guodong Feng, Jimi Tjong, Narayan C. Kar University of Windsor, Canada	
Voltage Stress Modeling and Measurement for Random-wound Windings Driven by Inverters	1917
Yanyan Xie ¹ , Julia Zhang ¹ , Franco Leonardi ² , Alfredo R. Munoz ² , Micheal W. Degner ² , Feng Liang ²	
¹ The Ohio State University, USA; ² Ford Motor Company, USA	

1:00 pm (90 minutes)

Poster Session: Special Machines

Chairs: Dean Patterson

Nick Baker

Optimization of Transverse Flux Permanent Magnet Machine with Double Omega-Hoop Stator	1925
Zhou Jia, Lin Wu, Weifeng Chen, Li Yu, Yongjuan Cao, Hongyun Jia Nanjing University of Information Science and Technology, China	
Mathematical Model for a Novel Electromechanical Actuator based on Lagrange-Maxwell Equation	1929
Jinhua Du ¹ , Yun Long ¹ , Shangbin Yuan ¹ , Jiangbiao He ² , Kun Yang ¹ , Shixiao Li ¹	
¹ Xi'an Jiaotong University, China; ² University of Kentucky, USA	
Unbalance Vibration Compensation of Magnetic Bearing Systems based on Beetle Antennae Search Algorithm	1937
Hongbo Sun, Dong Jiang, Zaidong Hu, Tian Li, Junquan Lai Huazhong University of Science and Technology, China	

Accelerating Virtual Hotspots Analysis in Static Electromagnetic Devices	1944
John Wanjiku <i>Mentor Graphics, A Siemens Business, Canada</i>	
Assessing the Effect of Geometric Error on the Performance of Magnetic Gears	1951
Alexandros Leontaritis, Aydin Nassehi, Jason Yon <i>University of Bristol, UK</i>	
Magnetic Equivalent Circuit Modeling of Partitioned Stator Doubly Salient Permanent Magnet Machines	1959
Warat Sriwannarat ¹ , Nuwantha Fernando ² , Apirat Siritaratiwat ¹ , Pirat Khunkitti ¹ <i>¹Khon Kaen University, Thailand; ²RMIT University, Australia</i>	
A General Framework for the Analysis and Design of a Wireless Resonant Motor	1966
Besong John Ebot, Yasutaka Fujimoto <i>Yokohama National University, Japan</i>	
Decoupled Model for Asymmetrical Dual Three Phase Permanent Magnet Synchronous Machine ...	1971
Yuzheng Chen, Linhui Fan, M. Raza Khowja, Serhiy Bozhko, Tao Yang <i>University of Nottingham, UK</i>	
Performance of a Halbach Cycloidal Magnetic Gear with Respect to Torque Density and Gear Ratio	1977
Hailin Huang ¹ , Jonathan Bird ² , Ronghai Qu ¹ <i>¹Huazhong University of Science and Technology, China; ²Portland State University, USA</i>	
Nonlinear Modeling of a Magnetic Levitation System	1985
Xing-Dong Fu, Su-Dan Huang, Guang-Zhong Cao, Chao Wu, Wen-Bo Li, Xiao-Sheng Yang <i>Shenzhen University, China</i>	
Parametric Analysis and Design of Magnetic Lead Screw	1990
Xiao Liu, Yuxing Liu, Xionsong Li <i>Hunan University, China</i>	
An Improved Radial Force Model of Sharing Suspension Windings Bearingless Switched Reluctance Motor	1996
Yi Hao, Xilian Wang, Di Cheng <i>Beijing Jiaotong University, China</i>	
High-Frequency Analysis and Measurement Techniques with Mixed-Mode Conversion of Induction Motors for Shaft-Voltage Prediction	2002
Manje Yea ¹ , Younggon Ryu ² , Jinguok Kim ¹ , Ki Jin Han ³ <i>¹Ulsan National Institute of Science and Technology, Korea (South); ²LG Electronics, Korea (South); ³Dongguk University, Korea (South)</i>	
A Study on Electromagnetic-Spring Actuator for Low Cost Miniature Actuator Systems	2008
Sewoong Kim, Changseop Lee, Hyunyoung Choi <i>Agency for Defense Development, Korea (South)</i>	
A Novel DC-Biased Current Dual PM Vernier Machine	2014
Shaofeng Jia ¹ , Kuankuan Yan ¹ , Deliang Liang ¹ , Ronghai Qu ² , Jinjun Liu ¹ , Jiangbiao He ³ <i>¹Xi'an Jiaotong University, China; ²Huazhong University of Science and Technology, China; ³University of Kentucky, USA</i>	

1:00 pm (90 minutes)

Poster Session: Thermal, Material and Efficiency Issues in Electrical Machines

Chairs: Guang-Jin Li
Michael Galea

- Thermal Network Calibration using Short-Transient and Steady-State Thermal Tests** 2021
Eric Armando¹, Aldo Boglietti¹, Enrico Carpaneto¹, Devi Geetha Nair²
¹Politecnico di Torino, Italy; ²Aalto University, Finland
- Electromagnetic Properties of Soft Magnetic Composites and Electrical Steels at High Frequencies Considering Material Manufacturing Techniques** 2027
Daniel Gumbleton-Wood¹, Glynn J. Atkinson¹, Lars Sjöberg²
¹Newcastle University, UK; ²Höganäs AB, Sweden
- Scaling of Permanent Magnet Machines with Thermal Effects** 2035
Nicklas Makowski, Brian Helenbrook
Clarkson University, USA
- SMC Materials in Electrical Machine Prototypes** 2042
Emir Pošković, Luca Ferraris, Fausto Franchini, Andrea Cavagnino, Marco Actis Grande
Politecnico di Torino, Italy
- Equivalent Thermal Conductivity Prediction of Form-Wound Windings with Litz Wire Considering Transposition Effect** 2048
Xuan Yi, Xiaoqian Qiao, Tianyu Yang, Kiruba S. Haran, Nenad Nmiljkov
University of Illinois Urbana-Champaign, USA
- Temperature-Dependent Demagnetization of Nd-Fe-B Magnets for Electrified Vehicles** 2056
Peng Peng¹, Julia Zhang¹, Wanfeng Li², Franco Leonardi², Chuanbing Rong²,
Michael W. Degner², Feng Liang², Leyi Zhu²
¹The Ohio State University, USA; ²Ford Motor Company, USA
- Design of the High Efficiency IPMSM Considering the Operating Point with Different Characteristic ...** 2063
Soo-Gyung Lee, Min-Ro Park, Kyong-Soo Cha, Jae-Hyun Kim, Jung-Pyo Hong
Hanyang University, Korea (South)
- Survey of Insulation Systems in Electrical Machines** 2069
Rasul Hemmati, Fan Wu, Ayman EL-Refai
Marquette University, USA

1:00 pm (90 minutes)

Poster Session: Energy and Grid Connected

Chair: Gianmario Pellegrino

- ANFIS based Neuro-Fuzzy Control of DFIG for Wind Power Generation in Standalone Mode** 2077
Iffe K. Amin¹, M. Nasir Uddin⁰, M. Marsadek²
¹Lakehead University, Canada; ²Universiti Tenaga Nasional, Malaysia
- LVRT Capabilities of Solar Energy Conversion System Enabling Power Quality Improvement** 2083
Priyank Shah, Bhim Singh
Indian Institute of Technology Delhi, India
- Particle Swarm Optimization based Adaptive Neuro-Fuzzy Inference System for MPPT Control of a Three-Phase Grid-Connected Photovoltaic System** 2089
Jeffrey Andrew-Cotter, M. Nasir Uddin, Iffe Khairul Amin
Lakehead University, Canada

Effective Wind Energy Extraction using a Modified Robust Predictive Control in Grid Tied WECS 2095
Subarni Pradhan, Shadab Murshid, Bhim Singh, Bijaya Ketan Panigrahi
Indian Institute of Technology, India

Adaptive Neuro-Fuzzy Controller for Grid Voltage Dip Compensations of Grid Connected DFIG-WECS 2101
Iffe K. Amin¹, M. Nasir Uddin⁰, M.A. Hannan², AHM. Z. Alam³
¹Lakehead University, Canada; ²Universiti Tenaga Nasional, Malaysia; ³International Islamic University, Malaysia

3:00 pm (100 minutes)

Analysis of Electric Machines for Transportation Applications

Chairs: Nuh Erdogan
Ashfanoor Kabir

3:00 pm

Impact of Ultra-Conducting Winding on the Power Density and Performance of Non-Heavy Rare Earth Traction Motors 2107
Tsarafidy Raminosa, Tolga Aytug
Oak Ridge National Laboratory, USA

3:25 pm

AC Winding Losses in Automotive Traction E-Machines: A New Hybrid Calculation Method 2115
Giuseppe Volpe^{1,2}, Mircea Popescu¹, Fabrizio Marignetti⁰, James Goss¹
¹Motor Design Ltd., UK; ²University of Cassino, UK; ³Southern Lazio, Italy

3:50 pm

Principle of a Novel Dual-Mode Reluctance Motor for Electric Vehicle Applications 2120
Kyohei Kiyota, Kosuke Ichyanagi, Kenji Amei, Takahisa Ohji
University of Toyama, Japan

4:15 pm

Comparison of Parallel Slots against Parallel Teeth in an In-Wheel Halbach Array Motor 2126
Iago Martinez Ocaña¹, Barrie Mecrow¹, Nick J. Baker¹, Chengwei Gan², Simon Brockway², Chris Hilton²
¹Newcastle University, UK; ²Protean Electric Ltd., UK

3:00 pm (100 minutes)

Thermal, Material and Efficiency Issues in Electrical Machines

Chairs: Sabrina Ayat
Shafigh Nategh

3:00 pm

A Hybrid Thermal Modeling Method for Traction Motors used in Duty-Cycles 2132
Claudio Scema¹, Shafigh Nategh², Aldo Boglietti¹, Luca Boscaglia¹, Daniel Ericsson³
¹Politecnico di Torino, Italy; ²ABB AB, Sweden; ³COMSOL AB, Sweden

3:25 pm

Numerical Study on the Impact of End Windings Porosity on the Fluid Flow and Heat Transfer in a Totally Enclosed Fan-Cooled Electrical Machine 2138
Salvatore La Rocca¹, Stephen J. Pickering¹, Carol N. Eastwick¹, Chris Gerada¹, Kristian Rönnerberg²
¹University of Nottingham, UK; ²ABB AB Corporate Research, Sweden

3:50 pm

Design and Thermal Analysis of a Rotating Transformer 2144

Jonathan Godbehere¹, Andrew Hopkins², Xibo Yuan², Andrew Bloor², Phil Mellor²

¹Motor Design Limited, UK; ²University of Bristol, UK

4:15 pm

Design of Liquid Cooled IPM Motor for High Torque Density Applications 2152

Dylan Broomfield, Russ Marvin

LC Drives, USA

3:00 pm (100 minutes)

PM Machines

Chairs: Mark Thiele

Glynn Atkinson

3:00 pm

A Novel Drive Train Concept for Personalized Upper Body Exoskeletons with a Multiphase Axial Flux Machine 2160

Marcel Waldhof, Andreas Echle, Nejila Parspour

University of Stuttgart, Germany

3:25 pm

Effects of Manufacturing Imperfections and Design Parameters on Radial Magnetic Forces in the BLDC Claw-Pole Motor 2167

Stefan Leitner, Hannes Gruebler, Annette Muetze

Graz University of Technology, Austria

3:50 pm

Comparative Study between Doubly Salient PM Machine with New Stator/Rotor-Pole Number Combination and Biased Flux PM Machine 2174

Lijian Wu, Guangqiang Ming, Liu Zhang, Youtong Fang

Zhejiang University, China

4:15 pm

A Distributed and Scalable Electromechanical Actuator for Bio-Inspired Robots 2180

Bonhyun Ku, Yanpei Tian, Sunyu Wang, Elie Libbos, Shivang Agrawal, Arijit Banerjee

University of Illinois Urbana-Champaign, USA

3:00 pm (100 minutes)

Predictive Control of Electrical Drives

Chairs: Nasir Mohammad Uddin

Radu Bojoi

3:00 pm

Hierarchical Model Predictive Speed and Current Control of an Induction Machine Drive with Moving-Horizon Load Torque Estimator 2188

Oliver Wallscheid, Etienne Florian Bouna Ngoumtsa, Joachim Böcker

Paderborn University, Germany

3:25 pm

A Novel Formulation of Continuous Control Set MPC for Induction Motor Drives 2196

Andrea Favato, Paolo Gherardo Carlet, Francesco Toso, Silverio Bolognani

University of Padova, Italy

3:50 pm

**Finite Control Set-Model Predictive Control for the Dual Fed Common
dc-link Open-End Winding PMSM Drive** 2203
Luca Rovere, Andrea Formentini, Pericle Zanchetta
University of Nottingham, UK

4:15 pm

**Continuous-Control-Set Model Predictive Control with Integrated Modulator in
Permanent Magnet Synchronous Motor Applications** 2210
Sören Hanke, Oliver Wallscheid, Joachim Böcker
Paderborn University, Germany

3:00 pm (100 minutes)

Machine Review Papers

**Chairs: Ronghai Qu
Pinjia Zhang**

3:00 pm

**Design Guidelines for Synchronous Machine Topologies with High Torque and
Wide Field Weakening Demands** 2217
Sridhar Balasubramanian, Christian Heister, Markus Henke
Technische Universität Braunschweig, Germany

3:25 pm

**Towards Fully Additively-Manufactured Permanent Magnet Synchronous Machines:
Opportunities and Challenges** 2225
Fan Wu, Ayman M. EL-Refaie
Marquette University, USA

3:50 pm

Introducing Physics of Failure Considerations in the Electrical Machines Design 2233
Vincenzo Madonna¹, Paolo Giangrande¹, Michael Galea⁰
¹*University of Nottingham, UK;* ²*University of Nottingham Ningbo, China*

4:15 pm

Dual-Stator Line-Start Vernier Permanent Magnet Synchronous Machine 2239
Mengxuan Lin, Dawei Li, Xiang Ren, Kangfu Xie, Ronghai Qu
Huazhong University of Science and Technology, China

3:00 pm (100 minutes)

Machine Modeling

**Chairs: Alireza Fatemi
Hiu Yang**

3:00 pm

**Braking Torque Compensation Strategy and Thermal Behavior of a Dual
Three-Phase Winding PMSM during Short-Circuit Fault** 2245
P. Giangrande¹, V. Madonna¹, S. Nuzzo⁰, C. Gerada¹, M. Galea⁰
¹*University of Nottingham, UK;* ²*University of Modena and Reggio Emilia, Italy;*
³*University of Nottingham Ningbo, China*

3:25 pm

Application of a Hybrid Modeling Approach for Eddy Current Estimation in Hairpin Windings 2251

David Philipp Morisco^{1,2}, Ioan Liviu Iepure¹, Andreas Moeckel²

¹Robert Bosch GmbH, Germany; ²Technical University of Ilmenau, Germany

3:50 pm

A Novel Variable Flux Dual-Layer Hybrid Magnet Memory Machine with Bypass Airspace Barriers 2259

Hui Yang¹, Hao Zheng¹, Heyun Lin¹, Z.Q. Zhu², Shukang Lyu¹

¹Southeast University, China; ²The University of Sheffield, UK

4:15 pm

A Comparative Study of Methods for Calculating AC Winding Losses in Permanent Magnet Machines 2265

Narges Taran¹, Vandana Rallabandi¹, Dan M. Ionel¹, Greg Heins², Dean Patterson²

¹University of Kentucky, USA; ²Regal Beloit Corp., Australia