Bio

Ayman M. El-Refaie (ayman.el-refaie@marquette.edu) received the M.S. and Ph.D. degrees in electrical engineering from the University of Wisconsin Madison on 2002, and 2005 respectively. Between 2005 and 2016 he has been a principal engineer and a project leader at the Electrical Machines and Drives Lab at General Electric Global Research Center. His interests include electrical machines and drives. Since January 2017 he joined Marquette University as the Werner Endowed Chair for Energy Sustainability. He has over 120 journal and conference publications. He has 46 issued US patents. At GE, he worked on several projects that involve the development of advanced electrical machines for various applications including, aerospace, traction, wind, and water desalination. He was the chair for the IEEE IAS Transportation Systems committee and an associate editor for the Electric Machines committee. He was a technical program chair for the IEEE 2011 Energy Conversion Conference and Exposition (ECCE). He was the general chair for ECCE 2014 and 2015 ECCE steering committee chair. He was the general chair of IEMDC 2019. He was the IEEE IAS Industrial Power Conversion Systems Department Chair (2018-2019) and member of the IEEE Industry Applications Society executive board (2016-2019). He is an IEEE Fellow and a member of Sigma Xi He is the recipient of two paper awards. He receeived several awards including the IAS Andrew W. Smith Outstanding Young Member Award 2009, University of Wisconsin Alumni Association" 2009 Frward Under 40" award for outstanding alumni, GE Global Research Center"2011 Hull Award" for early career researchers and 2019 Nagamoori Award.

List of Topics

(1) Role of electrical machiens and drives in electrification

Over the last few decades, there has been serious effort to replace mechanical and hydraulic systems with electrical systems. This effort also includes replacing fixed-speed and old electrical drives with higher performance variable-speed drives. This is mainly due to the higher reliability, efficiency and robustness of electrical systems. This trend of "more electric" systems could be seen across a wide range of applications. These include traction, aerospace, actuation, mining, oil & gas, and industrial applications as examples. This push for electrification posed a lot of challenges to develop electrical systems that meet the demanding requirements of the various applications including harsh environments, high power density, high efficiency and fault tolerance in safety-critical applications. At the heart of the electrification effort is the development of advanced electrical machines and drives. This presentation will provide an overview of the various applications where electrification is taking place. The presentation will focus on electrical machines and drives that have been developed or are currently under development

(2) Faul-tolerant Permanent Magnet machines

Synchronous permanent magnet (PM) machines have been gaining a lot of interest over the years. This is due to their several advantages including high power density, high efficiency and high reliability. One of the key concerns about PM machines especially in safety-critical applications (such as the more-electric aircraft) has been the issue of fault-tolerance since the machine cannot be de-excited. A lot of work has been done both on the machine side as well as the power converter side (including power converter configuration and remedial control strategies). This presentation will provide a thorough review and summary of what has been covered in literature up-to-date. The presentation will highlight the tradeoffs (including weight, cost and reliability) involved in the various proposed methods and strategies with more emphasis on the machine side. The methods discussed in this study include active control methods form converter side, memory motors, doubly-salient and flux-switching machines, use of auxiliary windings, mechanical flux-weakening methods, use of shunts and shields, thermal protection and transverse flux machines. The study will also include some comments about where the research in this area is heading in the future.

(3) Electrical machiens that redcue rare-earth materials

Important global efforts are underway toward lowering the cost of electric machines especially for electric and hybrid vehicles by reducing or eliminating the use of rare earth materials which have been experiencing significant price increases and volatility. This presentation will present several designs that reduce or eliminate rare-earth materials. The presentation will provide a quantitative comparison of the performance of various machine topologies as well as highlight the key tradeoffs.

(4) Electrical machines for transporatation electriciation

The growing interest in electrification has led to a growing interest in hybrid/electrical traction applications. Many hybrid/electrical vehicles have been commercially introduced. Various technologies for the traction motors/generators have been developed. The requirements for motors/generators for hybrid/electrical traction applications are very

demanding in terms of power density, efficiency, and cost. In addiiton hybrid/electric propulsion applicatins fr aerospace has been a fast growing area over the past few years. This presentationwill provide a comprehensive review of the state of the art highlighting the key global trends and tradeoff of various technologies. The presenattion will cover arsopace application, light-duty vehicles , medium- and heavy-duty vehicles, off-highway vehicles (OHVs), locomotives, and ship propulsion.

(5) Role of advanced materials in electrical machines

There has been a revived and growing role for electrical machines and drives across a wide range of applications. Such applications include, hybrid/electrical traction applications, aerospace applications, and renewable energy. All these applications present different set of requirements and challenges. The common trend is that there is a need for higher-performance electrical machines in terms of higher power/torque density, and higher efficiency while keeping cost under control. There has been a lot of work done around coming up with novel machine topologies, optimizing more conventional topologies as well as improved thermal management schemes. Like many other areas of engineering/research, advanced materials can play a key role in opening up the design space for electrical machines leading to a step improvement in their performance. This presentation will present an overview of some of the key advanced materials that are either recently developed or are currently under development and their potential impact on electrical machines.