High Power Density Electric Machine Design for Aerospace Propulsion

SPEAKERS

Sara Roggia
Head of Protection and Control
MagniX

Bulent Sarlioglu
Professor
University of Wisconsin-Madison

ABSTRACT

The electrification of aircraft is rapidly advancing, driven by significant efforts to develop electric propulsion systems. This burgeoning field is underpinned by innovations and technological advancements aimed at achieving fully electric architectures utilizing energy sources like batteries and fuel cells for aircraft propulsion. Electric machines and power electronics play a pivotal role in delivering the high performance and fault-tolerant capabilities essential for aviation applications. Achieving high power density and fault redundancy is critical in aerospace systems, necessitating advancements in materials such as high-density permanent magnets, improved steel alloys for electric machines, and wide-bandgap devices for power electronics. Additive manufacturing further supports these goals by enabling designs with greater specific power and higher efficiency, which are crucial for aerospace electrification and the potential realization of net-zero carbon emissions in air transportation.

This tutorial will begin with an overview of the current state-of-the-art in commercial and electric aircraft, followed by a discussion of future trends in electric propulsion, including All-Electric Propulsion (AEP), Hybrid Electric Propulsion (HEP), and Turboelectric Propulsion (TEP). Prof. Sarlioglu will highlight the latest advancements in electrical systems for flying vehicles and airplanes, exploring various propulsion architectures such as series and hybrid systems while addressing the challenges and opportunities in the application of electric machines and power electronics. The tutorial will delve into enabling technologies and key machine design considerations specific to aerospace applications. Different electric machine topologies will be examined, including Permanent Magnet Synchronous Machines (PMSM), Induction Machines (IndM), Switched Reluctance Machines (SRM), Synchronous Reluctance Machines (SynRM), and Axial Flux Machines (AFM). Their respective advantages and disadvantages will be analyzed in terms of efficiency, speed range, reliability, compactness, cost, and manufacturability. Additionally, topics on integrated motor drives and fault-tolerant drive systems will be explored in depth.

About The Speakers:

Bulent Sarlioglu:
Bulent Sarlioglu is a Professor at the University of Wisconsin-Madison and Director of Technology at the Wisconsin Electric Machines and Power Electronics Consortium. Previously with Honeywell Aerospace, he contributed to electric motor drives for aircraft like the Airbus A380 and A350. An expert in electrical machines, drives, and power electronics, he holds 24 U.S. patents and has published over 280 technical papers. Dr. Sarlioglu is a recipient of the IEEE PES Cyril Veniott Award, NSF CAREER Award, and Grand Nagamori Award. He is a Fellow of the National Academy of Inventors (2021) and IEEE (2022).

Sara Roggia:
Sara Roggia (IEEE SM'20, M'16) earned her B.Sc. and M.Sc. in Electrical Engineering from Politecnico di Bari, Italy, and a Ph.D. in electrical machine design from the University of Nottingham, UK, as a Marie Curie Fellow in 2017. She has contributed to novel electrical machine technologies for more electric aircraft and has held roles at Motor Design Limited, SAFRAN, and magniX. Currently Head of Protection and Controls at magniX, her work focuses on protection and control algorithms for inverters. Sara holds five patents and has authored over 18 scientific publications.