Distinguished Lectures: Abstracts and Author's Bio

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Gianmario Pellegrino (F' 22, SM '13, M'06) is Professor of Power Converters, Electrical Machines and Drives at Politecnico di Torino, Turin, Italy.

He was a visiting fellow at Aalborg University, the University of Nottingham, and the University of Wisconsin-Madison.

Dr. Pellegrino is co-founder of the open-source platform SyR-e for the design and simulation of electrical motors and drives, constantly developed and validated in the context of collaborations with the industry and widely adopted world-wide.

Dr. Pellegrino is an IEEE Fellow, an Associate Editor for the IEEE Transactions on Industry Applications and the recipient of the 8th Grand Nagamori Award.

He co-authored 65 IEEE journal papers and ten patents and received nine Best Paper Awards.

He is a founding member of the Power Electronics Interdepartmental Center (PEIC) of Politecnico di Torino, and a member of the Advisory Board of PCIM Europe.

He is currently serving as Adjunct Vice Rector for Technology Transfer at Politecnico di Torino.

1. Sustainable Electrical Motors for Traction

This lecture addresses rare-earth element (REE) dependency in traction motors and alternative designs focusing on alternative Permanent Magnet (PM) materials, Electrically Excited Synchronous- and Induction-Motors. Current trends in eMotors for traction such as high-speed designs (30+ krpm) and direct oil cooling are also covered. Case studies include oil-cooled prototypes with 95% peak efficiency and hybrid FeN/NdFeB structures reducing REE use by 73%. To a wider extent, Environmental Priority Strategy analysis is applied to selected case studies showing the critical environmental role of copper along the one of REE-based PM materials.

2. Efficient design and characterization workflow for AC machines

This lecture introduces the SyR-e open-source toolchain for rapid magnetic-thermal-mechanical co-design of AC machines via parametric FEA, signature design space exploration, and multi-objective optimization. Key innovations include FEAfix-corrected equations for torque/power factor design planes, balancing rotor-stator geometry, electric loading, PM and copper mass as well as multi-domain scaling for axial length and PM minimization while maintaining efficiency and thermal loading targets. The reference case study is Tesla Model 3 rear axle traction motor.

3. Comprehensive design workflow for PMSM drives: machine design and calibrated control

This lecture introduces a Permanent Magnet Synchronous Motor (PMSM) design methodology integrating electromagnetic design, thermal analysis, and control calibration into a unified workflow running within the SyR-e toolchain. The signature FEAfix preliminary design method is used for rapid design space exploration, followed by FEA-based design fine tuning and multi-domain validation and characterization of the selected design. The reference case study is the Tesla Model 3 rear axle traction motor drive, showing that the workflow requires less than 24 hours of computation for a vector-controlled e-drive designed from scratch, and drastic time reduction for an optimized design.

4. Comprehensive design workflow for EESM drives: machine design and calibrated control

This lecture introduces an Electrically Excited Synchronous Motor (EESM) design methodology integrating electromagnetic design, thermal analysis, and control calibration into a unified workflow running within the SyR-e toolchain. The signature FEAfix preliminary design is used for rapid design space exploration, followed by FEA-based design fine tuning and multi-domain validation and characterization of the selected design. The reference case study is a 150kW pk, 17000rpm max traction motor drive, showing that the workflow requires less than 48 hours of computation for a vector-controlled e-drive designed from scratch, and drastic time reduction for an optimized design.

5. Parameters Identification and Commissioning of AC Motor Drives

This lecture presents advanced commissioning techniques for AC drives, focusing on the identification of flux maps of PM and Reluctance Synchronous motor drives for traction applications. An overview of state-of-art techniques is provided, focusing on implementation of reference ones such as constant speed test bed identification and standstill self-commissioning using square-wave high voltage pulses. Harmonic effects can be included in the measurement campaign, using the dq-theta approach, alternative to the dq fundamental flux map model. Case studies include real-scale traction motors.

6. Reduced-order thermal models and hotspot observers for traction e-Motors

This lecture focuses on 1st and 2nd order lumped-parameter thermal models for real-time hotspot prediction in high-density traction motors. The framework employs short-time thermal transients (STTT) and DC steady-state tests to calibrate thermal resistances/capacitances without mechanical locking. The models integrate ambient/coolant temperatures and per-unit loading factors, enabling transient analysis with ±3°C accuracy. Experimental validation on oil-cooled prototypes demonstrates 15% peak temperature reduction via adaptive cooling control. The multi-three phase motor case is also addressed.