Diagnostic algorithms for fault detection in multiphase electrical machines

Scope of the research:
Multiphase permanent magnet machines are becoming attractive alternative for a variety of industry applications. In this context, diagnosing the status of the rotor magnets and of the stator winding integrity are necessary to guaranty the continuity of operation with a minimum level of performance even in case of faults. The research deals with the development of techniques suitable for quantifying the level of rotor demagnetization and high winding resistance in closed-loop controlled multi-phase AC permanent magnet machines m-PSM.

Research activity
Rotor Magnet Demagnetization (RMD) is well known as one of the major root cause of problems in PMSM, which commonly leads to air-gap flux disturbance and degraded operating performance.

For the detection of RMD in three-phase PMSM, a large variety of approaches have been proposed including, differential inductance calculation, temperature estimation based on dynamic model, vibration analysis, acoustic behavior monitoring, or torque spectral analysis. Another category of fault-detection techniques for RMD is electrical signal-based approaches, mainly using stator currents, voltages and magnetic-flux analysis. The research will be focused on the development of algorithms for the detection of RMD in m-PMSMs which have not received enough attention, and a relatively small number of papers have been published on this issue.

The starting point of the research will be the signal-based approach, Current Signature Analysis (CSA) and Voltage Signature Analysis (VSA) sensitivities for detecting RMD for five-phase AC PMSM.

The research activity will include modelling of the machine, development the detection strategy, development of signal analysis.

The research will be carried out by using numerical models of machines and FOC control systems. Once the technique will be properly set up, it will be tested and verified on the m-PMSM prototypes available in the LEMAD laboratory. Testing will be performed on machines either in healthy or fault condition using the same FOC control algorithm and inverter. The results of the experimental test will be used for tuning the diagnostic indexes calculation procedure and for validating the diagnostic method.