



PhD in INGEGNERIA ELETTRICA / ELECTRICAL ENGINEERING - 37th cycle

**THEMATIC Research Field: OPTIMISATION OF HIGH-SPEED PERMANENT MAGNET
MOTORS INCORPORATING STRESS-RELIEF FEATURES.**

Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity

Motivation and objectives of the research in this field

Interior permanent-magnet (IPM) motors are widely adopted in the most demanding traction applications. As powertrains usually include a gearbox matching motor and final-drive speed levels, the motor rated speed is a degree of freedom which can be conveniently increased to achieve a more compact and lighter powertrain. However, increasing the maximum speed of an IPM motor is challenging due to conflicting requirements imposed by electromagnetic and mechanical constraints in the rotor design. This project will investigate new rotor design and manufacturing solutions to push the speed boundaries of IPMs by combining composite-material components and features for stress-relief in the rotor stack assemblies. These features will be brought into the overall design optimisation merging stress analysis within "core" electromagnetic and thermal modelling. Bespoke simplified computation tools will be developed for rapid design, to be validated by high-fidelity multiphysics modelling, and different IPM topologies will be considered and benchmarked. Criteria for optimal motor design will also be devised to incorporate stress-relief and achieve the highest gain in the overall motor performance.

Methods and techniques that will be developed and used to carry out the research

The research programme will start with a thorough literature review in the areas of IPM motor design, 1 / 3 materials, and stress analysis. Multiphysics modelling studies to predict electromagnetic performance, stress



	<p>distribution and safety margins will be conducted on different rotor assembly concepts incorporating features for stress relief. Various IPM topologies will be compared and a motor prototype will be designed targeting typical application requirements for high-spec sport cars. The research activity will include prototyping and experimental tests order to validate the design methodologies.</p>
Educational objectives	<p>During the project, the PhD candidate will develop sound research and technical skills in the areas of electromagnetics / electric machine design, stress analysis, and optimisation. These will include advanced multiphysics modelling techniques and use of state-of-the art simulation software and lab instrumentation. During their work on the project, the candidate will also sharpen their soft-skills in technical writing, communication, and project planning.</p>
Job opportunities	<p>The strong technical background and research skills developed by the candidate during the project will facilitate taking on highly-paid jobs in industry both in engineering and R&D divisions, particularly within the automotive sector and related OEMs, motorsport and aerospace industry, which are currently transitioning towards electrification. The acquired expertise in electric motor design is also relevant to automation and appliance industry. According to a 2019 survey on PhD graduates in engineering at Politecnico di Milano, their employment rate after one year of graduation is 98%, with an average salary more than 30% above that of MSc graduates.</p>
Composition of the research group	<p>1 Full Professors 3 Associated Professors 0 Assistant Professors 3 PhD Students</p>
Name of the research directors	Matteo Iacchetti

Contacts
matteo.iacchetti@polimi.it

Additional support - Financial aid per PhD student per year (gross amount)



Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	564.01 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
<p>Educational activities: Financial aid per PhD student is available for purchase of study books and material, funding for participation in courses, summer schools, workshops and conferences, instrumentations and computer, etc. The amount is about Euro 3.000,00.</p> <p>Teaching assistantship: Availability of funding in recognition of supporting teaching activities by the PhD student. There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.</p> <p>Awards: Awards will be recognized to the PhD candidate up to Euro 1.500,00 (gross amount, after completion of the 3rd year). More details about this program will be provided by PhD Program Steering Committee.</p> <p>Computer availability: individual use. Desk availability: individual use.</p>