



PhD in INGEGNERIA ELETTRICA / ELECTRICAL ENGINEERING - 38th cycle

**INTERDISCIPLINARY Research Field: MULTIPHYSICS APPROACH TO THE EVALUATION
OF ELECTROMAGNETIC COMPATIBILITY OF ELECTRIC VEHICLES**

Monthly net income of PhDscholarship (max 36 months)

€ 1195.0

In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Research, during the three-year period, the amount could be modified.

Context of the research activity

Motivation and objectives of the research in this field

Interdisciplinary PhD Grant

The PhD research will be carried out in collaboration with research groups of the PhD programme in "**MECHANICAL ENGINEERING**".

See <https://www.dottorato.polimi.it/?id=422&L=1> for further information.

Integrated evaluation of the electromagnetic compatibility (EMC) of all electronic components and electromechanical devices installed on board the latest generation of electric vehicles represents one of the greatest challenges in view of the ubiquitous installation of V2X and C-ITS systems. In fact, if assessment of EMC of the individual components was enough in past years, installation of an increasing number of electrical and electronic devices in a volume of limited size, such as an electric vehicle, no longer allows carrying out element-by-element analyses. Nowadays, integrated analysis of the overall electromagnetic (EM) environment is of paramount importance in order to understand the dominant coupling phenomena, mitigate their effects, and develop guidelines for EMC-oriented design. Moreover, to improve performance, electric vehicles with motors (and parts involving power electronics) directly installed in the rims are currently under investigation, the so-called in-wheel motors (IWM). This solution, optimal from the point of view of mechanical performance and cooling, represents a challenge from an EMC point of view as it does not allow,



	<p>or only allows in part, installation of all those shields that are usually used. Aim of this research is therefore to develop an integrated mechanical-electrical-EMC multi-physics approach for the design of electromechanical components of the latest generation electric vehicles, with particular attention to solutions with IWM. This research activity will address both design and experimental verification, with the aim of providing OEMs with practical indications on how to optimize their solutions.</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>As mentioned in the research objectives, both theoretical and experimental techniques to be implemented in this project are highly interdisciplinary. The aim is to move from a step-by-step design approach (mechanical, electrical, electromagnetic compatibility) to an integrated multi-physics design strategy, which therefore should allow reduction of both development time and optimization of the final product (the electric vehicle). An ex-post verification of the performance of the individual parts (with the problem of not knowing how to remedy any interference) is replaced by prediction and integrated verification of the entire vehicle system, having control of all components. The project therefore aims at developing new integrated simulation methodologies as well as new experimental techniques capable of evaluating the EM interaction between the different subsystems included in the electric vehicle.</p>
<p>Educational objectives</p>	<p>The aim is to form highly qualified PhD candidates in: a) Electromagnetic Compatibility, with the ability to face complex EMC/EM problems in electric vehicles, b) multi-physics simulation and analysis of electromechanical components.</p>
<p>Job opportunities</p>	<p>Successful fulfilment of the research programs associated with these Scholarships will provide PhD candidates with the qualifications required to seek employment in diversified industry and university sectors in the EE field, such Transportation and Automotive</p>
<p>Composition of the research group</p>	<p>3 Full Professors 1 Associated Professors 3 Assistant Professors</p>



	5 PhD Students
Name of the research directors	Sergio Pignari, Francesco Castelli Dezza

Contacts
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Additional support - Financial aid per PhD student per year (gross amount)			
Housing - Foreign Students	1st year	2nd year	3rd year
	1500.0 € per student	1500.0 € per student	1500.0 € per student
	max number of financial aid available: 1, given in order of merit ..		
Housing - Out-of-town residents (more than 80Km out of Milano)	1st year	2nd year	3rd year
	1000.0 € per student	1000.0 € per student	1000.0 € per student
	max number of financial aid available: 1, given in order of merit ..		

Scholarship Increase for a period abroad	
Amount monthly	597.50 €
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. This amount is equal to 10% of the annual gross amount, for 3 years.</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>



Computer availability: individual use.

Desk availability: individual use.