POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 38th cycle

Research Area n. 2 - Sustainable Mobility

Number of scholarship offered	4
Department	DIPARTIMENTO DI MECCANICA

Description of the Research Area

In order to address the societal challenges defined by EU and referring to CO2 emission, energy efficiency, noise pollution, zero accidents and renewable energy, a wide range of solutions need being studied and developed, which are applicable to the **design, integration of design and manufacturing, testing and monitoring of transport systems, vehicles and infrastructures.**

This research area encompasses a wide range of applications related to road, rail, air and waterborne transport modes. The main topics related to this area are systems and components design, vehicle dynamics and control, vehicle-infrastructure dynamic interaction, vehicle aerodynamics and vibroacoustics, active, passive and preventive safety, intelligent transport systems, diagnostics and prognostics, new and advanced propulsion systems, energy harvesting solutions and innovative charging methods for ground and maritime applications.
There are 4 available scholarships in this area:
- 1 generic
- 3 thematic (to be specifically selected during application procedure)

The generic scholarship available refers to the following theme:
- Railways and automotive

3 thematic scholarships, on the following topics:
- Experimental data, driving simulator, digital twins for automotive product design
- Reduction of vibration and noise emissions of an electric axle for a high-performance vehicle
- Optimal Routing and Rebalancing of Mobility-on-Demand Systems in Mixed Traffic

Applicants should select thematic scholarships following the instructions provided in the call for application/application procedure.
The PhD scholarships available in this area are partially funded with the support of the Italian Ministry of Education, University and Research, through the project Department of Excellence LIS4.0 (Integrated Laboratory for Lightweight e Smart Structures).

Further information on the thesis topics available in this can be found at the following link: https://www.mecc.polimi.it/us/phd/admission/

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Research Area n. 2 - Sustainable Mobility

THEMATIC Research Field: EXPERIMENTAL DATA, DRIVING SIMULATOR, DIGITAL TWINS FOR AUTOMOTIVE PRODUCT DESIGN

Monthly net income of PhDscholarship (max 36 months)
€ 1325.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch,during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	New automated or electric vehicles need proper design paradigms. Safety, comfort performance and efficiency (particularly lightweight construction) are to be reached. The PhD researcher will further improve advanced design tools for developing innovative automotive components.
Methods and techniques that will be developed and used to carry out the research	Methods and Techniques depend on the automotive component under study. The following activities are undertaken. Collecting proper experimental data by means of innovative outdoor tests (brakes, tires, suspension systems, etc). Collecting perceived performance of virtual automotive components by the Driving Simulator of the Politecnico di Milano. Developing advanced computational techniques to make virtual testing of automotive components.
Educational objectives	The PhD will be in contact with a number of automotive companies, either carmakers or suppliers. He/she will understand how develop automotive products without forgetting the manufacturing process.
Job opportunities	Our last survey on MeccPhD Doctorates highlighted a 100% employment rate within the first year and a 35% higher salary, compared Master of Science holders in the same field.

Composition of the research group	2 Full Professors 2 Associated Professors 1 Assistant Professors 0 PhD Students
Name of the research directors	Proff. Gianpiero Mastinu, Massimiliano Gobbi

Contacts
Phone 02 2399 8289 / 8214 Email: gianpiero.mastinu@polimi.it, massimiliano.gobbi@polimi.it; phd-dmec@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	662.5 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

Financial aid is available for all PhD candidates (purchase of study books and materials, funding for participation in courses, summer schools, workshops and conferences) for a total amount of euro 5401, 42.

Accommodation in Politecnico's Residences (http://www.residenze.polimi.it) is available for PhD candidates; special rates will be applied to selected out-of-town candidates (detailed info in the call for application). Our candidates are strongly encouraged to spend a research period abroad, joining high-level research groups in the specific PhD research topic, selected in agreement with the Supervisor.

An increase in the scholarship will be applied for periods up to 6 months (approx. 660 euro/month - net amount).

Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. 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.

POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 38th cycle

Research Area n. 2 - Sustainable Mobility

THEMATIC Research Field: OPTIMAL ROUTING AND REBALANCING OF MOBILITY-ON-DEMAND SYSTEMS IN MIXED TRAFFIC

Monthly net income of PhDscholarship (max 36 months)
€ 1325.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch,during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	In the past decades, the adoption of communication technologies coupled with the emergence of mobility sharing systems has resulted in a widespread use of Mobility-on-Demand (MoD) services. One of the main operational challenges that these services face is deciding the routing and rebalancing policies. Currently, MoD systems use user-centric routing services to route their vehicles and dynamic pricing combined with a real-time heat-map of the users' demand to rebalance their fleets. This user-centric approach, in which every driver acts selfishly to minimize their own travel time, end up in a network that reaches an equilibrium known as the Wardrop equilibrium. Unfortunately, this equilibrium is in general suboptimal compared to the one achievable when vehicles are coordinated by a central controller in a system-centric approach. An almost centralized control approach can be achieved by re-routing vehicles through routing services (e.g., Waze and Google Maps) that account for all the different requests at the same time.The problem becomes even more challenging if we consider the combination of MoD services with Connected and Automated Vehicles (CAVs) since these fleets of CAVs can be centrally controlled.
Methods and techniques that will be developed and used to carry out the	There is not much literature on the joint solution of

research	congestion-aware routing and rebalancing problems. Most approaches approximate the travel time function relating traffic density to travel times to address the non-convex nature of the problem. Other approaches have been investigated that use thresholds or piecewise-affine approximations of the travel time to relax the problem to a quadratic program. Yet, depending on the congestion levels, these approaches may lack in accuracy. Moreover, reactive private traffic introduces additional complexity but it has been shown that, under a system-centric optimal-routing strategy and a reasonable degree of penetration of CAVs, both CAVs and non-CAVs can achieve better performance in terms of travel time and energy savings. The research will further expand these analyses to account for intermodal routing possibilities.
Educational objectives	The research aims at developing mathematical methods for the optimal control of traffic in real scenarios in presence of CAVs and, eventually, intermodal routing. The optimal solution is searched considering different penetration degrees of CAVs as well as different communication approaches (only CAVs and CAVs plus some of the non-CAVs through commercially available routing services).
Job opportunities	The primary job opportunity will be in the traffic management and shared mobility companies as well in the public authorities in charge of urban mobility systems. Our last survey on MeccPhD Doctorates highlighted a 100% employment rate within the first year and a 35% higher salary, compared to Master of Science holders in the same field.
Composition of the research group	1 Full Professors 3 Associated Professors 3 Assistant Professors 0 PhD Students
Name of the research directors	Prof. Francesco Braghin

Contacts
francesco.braghin@polimi.it phd-dmec@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)	--

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Research Area n. 2 - Sustainable Mobility

THEMATIC Research Field: REDUCTION OF VIBRATION AND NOISE EMISSIONS OF AN ELECTRIC AXLE FOR A HIGH-PERFORMANCE VEHICLE

Monthly net income of PhDscholarship (max 36 months)
€ 1325.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch, during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	Due to increasing environmental concerns, hybrid and electric vehicles are getting more and more widespread. Electric motors allow the redesign of the vehicle driveline. An interesting opportunity for car-manufacturers is represented by electric axles. Electric axles in fact allow to make electric drivetrains more compact, integrating all the components like electronics and reduction gearing in one single unit. Besides opportunities offered by electric/hybrid drivelines, even new challenges are introduced. An aspect of particular interest is the evaluation of NVH (noise vibration harshness) and acoustic performance of a vehicle. Being electric motors less noisy than internal combustion engine (ICE), transmission noise is more obvious and therefore it becomes more and more important for the purposes of driving comfort. The target of the research is the study of innovative solutions for reducing vibrations and noise of an electric axle of a high-performance vehicle. Specifically, the candidate will have to model the electric axle including its deformability so to valuate the dynamic response to known imposed forces, such as gear meshing forces, electromagnetic forces, misalignments, etc. The model of the electric axle will be used to study and develop solutions for reducing vibrations and noise transferred to the driver. In particular, the effect of composite materials, bushings, damping

	patches/pads, internal acoustic shields will be investigated. Moreover, the possibility of using systems for active noise cancellation to reduce gear meshing and electromagnetic noise will be explored.
Methods and techniques that will be developed and used to carry out the research	The research will be carried out mainly from a numerical point of view. A 3D flexible multibody model of the electric axle will be developed and characterized using experimental data.The multibody model of the electric axle will be used to identify the most promising solutions for reducing vibrations and noise transmitted to the driver. The vibrations transmitted to the driver will be evaluated by means of inertance and noise transfer functions. A feasibility analysis on the applicability of active noise cancelation systems will also be performed. The research will be carried out in cooperation with an industrial partner that will provide adequate support for the development of the models. Experimental data will be used for model validation and for identifying the model parameters. Moreover, the most promising identified solutions could be experimentally tested.
Educational objectives	Combine and master different modelling techniques; Develop competences on innovative components; Develop team-working attitude
Job opportunities	Car manufacturers; Electric driveline designers and manufactures; NVH testing and evaluation
Composition of the research group	1 Full Professors 1 Associated Professors 0 Assistant Professors 0 PhD Students
Name of the research directors	Proff. Edoardo Sabbioni, Roberto Corradi

Contacts
Phone +39.02.2399.8417 (Prof. Edoardo Sabbioni) Email: roberto.corradi@polimi.it; edoardo.sabbioni@polimi.it; phd-dmec@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)	--

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