



**POLITECNICO**  
MILANO 1863

**PhD School - Politecnico di Milano**

**Regulations of the PhD Programme in**  
*Mechanical Engineering*  
**Cycle XXXVII**

**Location: Milano Bovisa**

## **1. General Information**

PhD School - Politecnico di Milano

PhD Programme: **Mechanical Engineering**

Course start: **November 2021**

Location of the PhD Programme: **Milano Bovisa**

Promoter Department: **Department of Mechanical Engineering**

Scientific Disciplinary Sectors: **ING-IND/12 (Mechanical and Thermal Measurements), ING-IND/13 (Applied Mechanics), ING-IND/14 (Mechanical Design and Machine Construction), ING-IND/15 (Design Methods for Industrial Engineering), ING-IND/16 (Manufacturing Technology and Systems), ING-IND/21 (Metallurgy).**

PhD School Website: <http://www.polimi.it/phd>

PhD Programme Website: <http://www.mecc.polimi.it/dottorato/>

Areas:

**Area 1 - Advanced Materials and Smart Structures**

**Area 2- Sustainable Mobility**

**Area 3 - Engineering Design and Manufacturing for the Industry of the Future**

**Area 4 – MeccPhD International Track**

## 2. General presentation

The PhD Programme in Mechanical Engineering of Politecnico di Milano offers top-level knowledge in one of the most profitable sectors in Italy and Worldwide; it is a key instrument to access Academia at national and international level and to achieve prominent positions in large international companies devoted to research and development, innovation and design. The primary employment market is composed of leading companies and organizations dedicated to innovation, research and technical development, high-tech SMEs and governmental departments. Our Programme currently ranks 15<sup>h</sup> in the world according to *QS World University Rankings* (Mechanical, Aeronautical & Manufacturing Engineering 2021), and masters more than 140 PhD Candidates, 26% of them international. Female presence accounts for 14%. The Programme undergoes annually to institutional evaluation at national level (Accreditamento ANVUR); in 2019 we have received full recognition by the Agency, and have also being appointed the seal of “innovative” doctorate, having fulfilled the criteria in terms of Interdisciplinarity, Internationalization, Intersectoriality. The same recognition was granted in 2020.

Our PhD programme is also involved within the 5-year project “**Departments of Excellence**”, started in 2018. MeccPolimi, infact, has been selected among over 750 Italian Universities and was appointed an additional funding of 9ml €. The project presented is now being developed in the field of Sustainable Mobility, with specific focus on LIghtweight and Smart Structures (LIS4.0). As for doctoral activities, the project will consist in funding 2 PhD scholarships/year for 3 years, and in two additional grants funded by the Department during year 4 and 5. The first 6 scholarships have already been assigned.

The PhD Programme is run by a Coordinator and a Faculty Board. The Coordinator chairs the Faculty Board, oversees the preparation of the annual educational programme and organises the general educational activities of the PhD course (see Attachment A1). The Faculty Board is responsible for the educational programme and for teaching and administrative activities related to the PhD course (see Attachment A2).

The Programme covers a number of different disciplines, being devoted, in particular, to innovation and experimental activities. It relies on the development of an interdisciplinary and integrated high-level educational offer, by focusing on a comprehensive scientific proposal, from conception to realization; the core of our research lines falls within the societal trends identified at international and national levels: sustainable transport, health and wellbeing, clean energy, innovation and job creation. We also have ongoing collaborations with national and international most renowned research groups and laboratories.

Within this scenario, our purpose is to train highly skilled profiles, qualified to meet academic and industrial most challenging demands: our graduates are prepared to embrace careers and industrial paths at the forefront of technology, responding efficiently to a call for innovation and top-level research. We aim at preparing scientists who intend to be mainly involved in the field of Industrial Engineering, addressing theoretical and experimental activities in four major research areas:

## ***Area 1 - Advanced Materials and Smart Structures***

Research on **advanced materials and smart structures** is playing a crucial role in all the branches of mechanical and production engineering. The design and development of innovative **materials** (e.g. nano- and micro-structured materials, foamed alloys, metamaterials, bioinspired ones) is relevant to enhance specific functional properties customized on engineering applications. Both the innovative and existing materials require **new processes** to enhance material performance, to integrate new features and/or reduce the effect on the environment (i.e., eco-friendly production). New (numerical and experimental) multiscale models have to be investigated in order to characterize the mechanical behavior of materials under different service conditions and degradation patterns.

Moving from the material to the component and then to the mechanical systems, **smartness** and **metamaterials** can further help reaching customized functional performance. Development of smart materials, smart components and integrated measurement and control systems can lead to significant benefits (e.g. structural health monitoring, vibration attenuation, energy harvesting, quality control). Eventually, advanced modelling and experimental investigation of the **interaction between the structure and the environment** (e.g., wind engineering, bridge aeroelasticity, tall buildings and roof aerodynamics, cable dynamics, wind turbines) can aid designing a **new generation of large structures** where dynamic control is included at the design level.

## ***Area 2 - Sustainable Mobility***

In order to address the societal challenges defined by EU and referring to CO<sub>2</sub> emission, energy efficiency, autonomous systems, 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.

## ***Area 3 - Engineering Design and Manufacturing for the Industry of the Future***

Industrial production in Europe accounts for the 16% of the European GDP and remains a key driver for innovation, productivity and job creation. As stated in the 2014-15 road map of the PPP Factory of the Future “future factory will be clean, highly performing, environmentally friendly and socially sustainable”.

This research area focuses on improving the performance of the industry of the future through the innovative application of technologies, processes and methods to the design and manufacturing of industrial products. The entire life cycle of the product is considered and in particular:

- i) R&D&I activities for product and process innovation;
- ii) product ideation and development;
- iii) manufacturing process investigation, optimisation, planning and control;
- iv) manufacturing system design and planning;
- v) product service and disposal.

Hence, all the activities required to transform ideas into final products making use of zero defect, affordable, personalized, and eco-efficient manufacturing processes are integrated and investigated within the context of a highly competitive and globalized world from prototyping to mass production. PhD candidates working in this area will be involved in research activities that address the above targets through projects possibly involving other universities and research institutes, as well as Italian and international companies interested in the same topics.

#### ***Area 4 – MeccPhD International Track***

In addition to areas 1, 2 and 3, the PhD Programme in Mechanical Engineering comprises a research area devoted to an **International Track**, designed to foster the development of scientific research topics in collaboration with top-level European Technical Universities. We aim to provide doctoral candidates with highest-level international scientific training in the field of Mechanical Engineering by means of transnational research collaborations and mobility between strategic academic partners.

In fact, **the PhD thesis carried on by candidates enrolled within this area** foresee the supervision of two Faculty members, the first one belonging to PoliMi and the second one to one of the Idea League partner universities: **Chalmers University of Technology, Delft University of Technology, ETH Zurich, RWTH Aachen University**. Candidates selected in this area will develop their doctoral thesis by spending alternative research period/s in the Home/Host University. At the end of the Programme the candidate will receive the title of PhD in Mechanical Engineering from PoliMi (within a cotutelle agreement) or from both universities (if enrolled in the framework of a Double PhD). Within this area three Double PhD Agreements (two with TU Delft and one with RWTH Aachen as well as a four co-supervised thesis with ETH (1) and TU Delft (3).

### **3. Objectives**

The main target of our Doctoral Programme is to provide PhD candidates with specific training in Mechanical and Industrial Engineering and to strengthen their research skills in industrial and academic contexts. At the end of the PhD Programme our students will be able to carry out innovative projects on product, process and manufacturing systems, by properly considering functionality, constructive and energetic issues, while selecting materials, manufacturing processes, configuration and management strategies for manufacturing systems and measurement control services and devices. In addition to field-related competences, we foster the development of soft/transferable skills by integrating in the doctoral path specifically designed courses and activities delivered by our Doctoral School. The aim is to provide our PhDs with a complete set of transversal competences for their future career.

## 4. Professional opportunities and job market

The PhD Programme in Mechanical Engineering offers top-level knowledge in one of the most profitable sectors in Italy and worldwide; it is a key instrument to access leading enterprises and to achieve prominent positions in large international companies devoted to research and development, innovation and design. The primary employment market is composed of leading companies and organizations dedicated to innovation, research and technical development, high-tech SMEs and governmental departments.

The latest survey run by PoliMi Career Service showed that our PhD holders are 97% employed after one year, in national and international companies (50%) and academic and non-academic research institutions (50%) engaged in innovation, research and technical development. On average, the survey showed that people earning our PhD title are paid 35% more than the corresponding employees with a master title.

## 5. Enrolment

### 5.1 Admission requirements

Admission to PhD courses takes place on the basis of public selections; furthermore, Politecnico di Milano, by resolution of the Academic Senate, may stipulate **agreements** with foreign Universities and/or Institutions with the aim of setting up PhD courses that may also involve issue of joint, double or multiple qualifications.

Italian and International citizens can apply. They are requested to have graduated in accordance with the pre-existing laws D.M. 3.11.1999 n. 509, or to hold a Master of Science degree in accordance with D.M. 3.11.1999 n. 509, or a Master of Science in accordance with D.M. 22.10.2004 n. 270, or similar academic title obtained abroad, equivalent for duration and contents to the Italian title, with an overall duration of university studies of at least five years. The certified knowledge of the English language is a requirement for admission. The admission to the Programme is established according to the evaluation of the candidates' curricula, motivation letters, and an illustrative report about the development of a possible PhD research, which candidates will send contextually with their application to the admission announcement.

### 5.2 Admission deadlines and number of vacancies

The number of vacancies is indicated in the Call for admission to the 37<sup>th</sup> PhD cycle Programmes, available at <http://www.polimi.it/phd>. Scholarships both on general and on specific themes are available, in accordance with what is specified in the call for admission.

Each year, within our Programme, we award approximately 30 scholarships, funded by the Ministry of Education (MIUR), EU and other Governmental projects, and the Department itself. Industrial/external scholarships and Executive PhD paths (candidates employed by industries) are also available; our main scholarship sponsors are: Pirelli, BLM Group, ESA European Space Agency, Rold Elettronica, Saes Getters, ST Microelectronics, Inaf - Osservatorio Astronomico di Brera, Fondazione Politecnico,

Fondazione Cariplo, Comau, MUSP, ITIA-CNR, Clamp, Faro, IIT, , Impact Innovations, Celada, Pama, Tenova, Monzese, Lamborghini, Iseo Serrature, Eureinox, Baker Hughes, Enel Foundation, GE Power, ENI, Boldrocchi, MCM, Salvi, Pennservice, Thyssenkrupp Steering AG, Rete Ferroviaria Italiana

Our scholarships holders receive 1.325 euro/month (net amount), extra-funding (550 euro/month) for research periods abroad, and benefit from financial aid for research materials and conferences. All positions are free of tuition fees.

## 6. Contents

### 6.1 Research development

The aim of the Doctoral Programmes of Politecnico di Milano is the development of a research-oriented mind-set, together with specific expertise and skills related to the selected research topic. During their doctoral career, candidates must acquire problem-solving capabilities in a complex context, including in-depth analysis of the problem, identification of an original solution and capability of evaluating its applicability in a given context. These skills provide PhD candidates with a solid background, suitable both for the academic field and the private or public sector.

The main objective is the development of an original research contribution: candidates are asked to acknowledge and complete the state of the art in the selected field, thus being able to produce, with the PhD thesis, innovative knowledge in the specific research topic. In addition, the contents should be coherent with the research topics developed within the department in which the PhD Programme is carried out, achieving a grade of complexity to be dealt with team working, within the Department research lines/groups, and in collaboration with international teams.

The research activity is normally carried out in the first 2.5 years and is then followed by the submission of a Doctoral Dissertation. The document shall provide scientific original contribution and state of the art in the field, methodology, final outcomes and possible further developments. In particular, within the PhD Programme in Mechanical Engineering the Doctoral Dissertation can be presented both in the form of a “*monograph*” or as “*article-based*”. The *article-based* thesis should be a coherent piece of writing consisting in the presentation of at least 3 published original papers written by the PhD candidate as principal author, addressing a single main overarching goal. Specific regulations are available at Department level.

The doctoral activity is carried out under the guidance of a Supervisor, responsible for candidate’s research activity, study plan and thesis development. The Supervisor can belong to an institution other than Politecnico di Milano; s/he can be supported by one or more co-supervisors. Also, within the first six months, a member of the PhD Faculty is chosen as Tutor, who will monitor the overall achievements of the student and oversee quality and coherence of study plan and research activity. The Faculty Board may assign extra course credits to one or more candidates, in case they need to complete their preparation in specific topics, relevant for their research projects.

### 6.2 Requirements for the PhD Title achievement

The achievement of the PhD title in Mechanical Engineering requires at least three years of full-time study and research, and the development of a PhD thesis. Also, a minimum of 20 credits from PhD-level courses must be achieved as follows (*see also paragraph 6.3*):

- at least 10 credits should be selected on topics connected with the research subject, from PhD courses offered by the PhD Programme in Mechanical Engineering (or other Departments) and/or other Universities (subject to the approval of Supervisor);
- at least 10 credits should be selected from PhD courses offered by the PhD School of Politecnico di Milano, aimed at training the PhD candidates in soft and transferable skills. The skills and abilities provided by these courses are expected to help candidates across different areas of their careers in order to respond to the rapidly evolving needs of the global economy and society at large. The courses are held by internal Faculty or external professors/experts in the specific topic. The following **table** shows the list of the course offered by the PhD School for the Academic year 2021-2022:

<b>Lecturer</b>	<b>Course</b>
<b>Aliverti Andrea</b>	Ethics in Research
<b>Armondi Simonetta</b>	Strengthening Critical Spatial Thinking
<b>Arnaboldi Michela</b>	Advanced Interaction Skills for Academic Professionals
<b>Balducci Alessandro</b>	Approaches to Resilience: Social, Economic, Environmental and Technological Challenges of Contemporary Human Settlements
<b>Biscari Paolo</b>	English for Academic Communication
<b>Cardilli Lorenzo</b>	European Culture
<b>Chiodo Simona</b>	Epistemology of Scientific and Technological Research (Technologies Reshaping Humans)
<b>Di Blas Nicoletta</b>	Professional Communication
<b>Gianinetto Marco</b>	The Copernicus Green Revolution for Sustainable Development
<b>Iarossi Maria Pompeiana</b>	Power of Images and Visual Communication for Research Dissemination
<b>Jacchetti Emanuela</b>	Communication Strategies that Score in Worldwide Academia
<b>Lavagna Monica</b>	Sustainability Metrics, Life Cycle Assessment and Environmental Footprint
<b>Mancini Mauro</b>	Project Management (in Action)
<b>Masarati Pierangelo</b>	Ethical Aspects of Research on Dual-Use Technologies
<b>Ossi Paolo Maria</b>	Sulla responsabilità della Tecnica
<b>Paganoni Anna Maria</b>	La comunicazione nella Scienza
<b>Pizzocaro Silvia Luisa</b>	Practicing Research Collaboration / La pratica della collaborazione nella ricerca
<b>Raos Guido</b>	Science, Technology, Society and Wikipedia
<b>Sancassani Susanna</b>	Teaching Methodologies, Strategies and Styles
<b>Valente Giovanni</b>	Scientific Reasoning: Philosophy, Logic and



	Applications
<b>Volonte' Paolo Gaetano</b>	Introduction to Academic Research
<b>Zani Maurizio</b>	Laboratorio di insegnamento a classi numerose

- during the first year, mandatory attendance of at least 75% of our MeccPhD Lectures, monthly seminars delivered by international visiting faculty and researchers on relevant topics in the field of Mechanical Engineering.

Further activities intended to develop the candidate's personal skills and research expertise are encouraged during the PhD path, including stages, external courses (held by companies or other institutions), national and international seminars, conferences and workshops, participation in national and international research projects, support to teaching activities.

Candidates are also strongly encouraged to spend a period of at least 3/6 months doing research activity outside Italy in a research institution (academic or non-academic) and to present their research results in national and international conferences and journals: in order to assess the scientific dissemination skills and to be admitted to the final exam, candidates are required to publish at least one research paper on an international journal and to attend an international conference, presenting the results of their research.

### **6.3 Objectives and general framework of the teaching activities**

The PhD Programmes and the PhD School activate teaching forms of different kind and credit value, including courses, seminars, project workshops, laboratories. These activities aim at:

1. developing basic knowledge, common to the PhD Programme;
2. examining the basic research issues (problems, theories, research methods) which represent the founding element of the PhD Programme and which identify clearly its cultural position;
3. deepening in a specialist way some research issues connected with the problems developed in the thesis.

All PhD-level courses are held in English.

#### **Courses and activities are developed as follows:**

##### **PREPARATORY COURSES**

If the Supervisor and Tutor find it useful or necessary for the candidate to attend preparatory courses (within Politecnico di Milano) the Faculty Board of the PhD Programme can assign a number of extra-credits to be achieved, in order to complete the training path. Credits acquired in this manner will be considered additional, with reference to compulsory credit requirements.

##### **MAIN COURSES**

Designed to develop PhD candidates' expertise in the area of their thesis, they should be attended in the first two years (mainly in the first year) in order to refine tools and methods to fully develop high-level research in the last part of the PhD path.

### **SPECIALISTIC COURSES, LONG-TRAINING SEMINARS**

The attendance of specialist courses, workshops, schools, seminars is strongly encouraged and (if these seminars, workshops are certified and foresee a final exam) may permit to acquire credits according to the modalities established by the PhD Faculty Board and upon approval of the study plan submitted by the candidate (*point 6.4*). These courses and workshops can also be inserted in the study plan even if they do not foresee a final exam (and therefore not qualified as credits), as optional "additional teaching".

In the following **table** the list of courses offered by the PhD Programme in Mechanical Engineering for the academic year 2021-22 is shown. Additional courses at Programme and School level can be activated afterwards.

### **COURSES OFFERED WITHIN THE PHD PROGRAMME IN MECHANICAL ENGINEERING**

<b>Course</b>	<b>Lecturers</b>	<b>Credits</b>
<b>Bio-Inspired Systems</b>	Simone Cinquemani Barbara Mazzolai (IIT)	5
<b>Data and Knowledge in Product Development</b>	Giorgio Colombo Stefano Borgo (CNR)	5
<b>Human Response to Vibration</b>	Marco Tarabini Pierre Lemerle (Institut National de Recherche et de Sécurité) Neil Mansfield (Nottingham Trent University)	5
<b>Integrated Experimental and Computational Approaches to the Diagnostics of the Structure and Components</b>	Emanuele Zappa Gabriella Bolzon Maria Pia Lamongelli	5

<b>Mechanical Measurements with Micro Sensors and Embedded Systems for the Industrial Engineer</b>	Paolo Chiariotti Alberto Corigliano Diego Melpignano (ST Microelectronics)	5
<b>Methods for Health Monitoring and prognosis of Engineering Systems Subject to Degradation</b>	Claudio Sbarufatti Francesco Cadini Keith Worden(University of Sheffield)	5
		5
<b>Multibody System Dynamics</b>	Federico Cheli Pierangelo Masarati	5
<b>Smart Materials based on Metallic and Ceramic Systems</b>	Riccardo Casati, Francesco Braghin, Elisabetta Gariboldi, Nora Lecis, Carlo Mapelli, Maurizio Vedani	
<b>Statistics in the Big Data Era</b>	Panagiotis Tsiamyrtzis	5
<b>Wind Farm Control and Resource Assessment through Lidar Remote Sensing Technology</b>	Alberto Zasso Giacomo Iungo (UT Dallas)	5

#### **6.4 Presentation of the study plan**

PhD candidates must submit a study plan in agreement with the Supervisor; the study plan may be revised periodically (approximately every three months), in order to adequate it to possible changes in the course list, or to needs motivated by the development of their PhD career. The study plan must be approved by the PhD Programme Coordinator, according to the modalities established by the PhD Faculty Board.

#### **6.5 Annual evaluations**

At the end of each academic year all candidates present their research work to the Faculty Board and receive a formal evaluation (A/B/C/D) in order to be admitted to the following year. Candidates who do not pass the exam are qualified either as “Repeating candidate” (Er) or “not able to carry on with the PhD (Ei)”. In the former case (Er), the candidates are allowed to repeat the PhD year at most once. The PhD scholarships – if any – are suspended during the repetition year. In the latter case (Ei) the

candidates are excluded from the PhD programme and lose their scholarships – if any.  
In case the Faculty Board holds appropriate to assign directly an exclusion evaluation (Ei) without a previous repetition year, the request must be properly motivated, and validated by the PhD School.

→ ***Within the Doctoral Programme in Mechanical Engineering candidates' progression is evaluated as follows:***

- April: semi-annual evaluation (half-year milestone with candidate's Supervisor and Tutor);
- October: admission to the following year (A-B-C-D-E – annual milestone with evaluation of candidates by commissions composed by the Faculty Board).

## **6.6 Final Exam**

Candidates' admission to the Final Exam is determined before the end of the PhD path (during the second half of the 3<sup>rd</sup> year - 4<sup>th</sup> year in case of international agreements or executive PhDs) by an internal commission composed by Faculty members. If the candidate is admitted to the Final Exam, the thesis<sup>1</sup> is sent to two external reviewers for evaluation. The reviewers provide two possible outcomes:

- **Admitted to Final Defence (Oral Exam)**  
(The external reviewers can also recommend minor changes).
- **Postponed (up to 6-months delay)**  
(The external reviewers recommend major revisions, and the revised thesis is re-submitted within 6 months: it undergoes a new review and is then admitted to the Oral Exam).

Following the external review, Candidates must make any corrections and/or revisions in consultation with the Supervisor before undergoing the Final Defence, which will be held in front of an examination board (with internal and external members).

The Final Defence consists of a comprehensive presentation of the PhD thesis to the examination board (approx. 50-60 minutes) plus discussion/questioning. The board is asked to discuss the work disclosed in the thesis, its significance, and candidate's overall presentation and Defence. During this phase, the reviewers' written evaluation as well as the candidate's third year assessment are taken into consideration in order to deliberate the final grade, which can be chosen as follows:

- Achievement of the PhD title;
- Achievement of the PhD title With Honors (Cum Laude); Honors requirements are based on the overall activity of the Candidate and are in any case linked to admission grade **A** to the final exam (see point 1). The PhD cum laude is given to the top 5 percent of the graduating class.

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<sup>1</sup> Starting with the 32nd cycle of the PhD Programme in Mechanical Engineering, the PhD Faculty Board has approved the introduction of a **second track** for the submission of the final PhD Thesis. In addition to a standard "monograph", the PhD Thesis can also be presented as *article-based*.

## 7. Laboratories

One of the key elements of our Doctoral Programme is represented by our laboratories: we feature some of the most unique, active and innovative set-ups in Europe. Learn more on our labs at <http://www.mecc.polimi.it/us/research/departmental-laboratories/> and <http://www.mecc.polimi.it/us/research/interdepartmental-laboratories/>.

## 8. Internationalization

We foster internationalization by strongly recommending and supporting candidates' mobility abroad, for short-term study and research periods up to 18 months. Our Institution is member of Idea League ([www.idealeague.org](http://www.idealeague.org)), Alliance4Tech ([www.alliance4tech.eu](http://www.alliance4tech.eu)) and ENHANCE (<https://enhanceuniversity.eu/>), a group of strategic partnerships with leading European Technical Universities. We also promote, draft and activate European and extra-European Joint Degrees, Double PhDs and Joint Doctoral Thesis (Cotutelle); our Department is actively involved in EU-based and governmental third-level education agreements such as H2020, Erasmus Mundus, China Scholarship Council and Brazilian Confap.

We have ongoing agreements with MIT (Progetto Rocca), Technion – Israel Institute of Technology (Double PhD), Shanghai Jiao Tong University (Double PhD), École Centrale Paris (Cotutelle), Delft University of Technology (Double PhD and Cotutelle), RWTH Aachen (Double PhD), X'ian Jiao Tong University (Double PhD), University of Antwerp (Double PhD), Northwestern Polytechnical University (Double PhD), TUM (Cotutelle), ETH Zurich (Cotutelle), University of Illinois at Urbana Champaign (Cotutelle), Laval University (Double PhD), EAFIT (Cotutelle), Qatar University (Double PhD), AGH - Akademia Górniczo-Hutnicza (Cotutelle), NTNU (Cotutelle), Peter the Great St. Petersburg Polytechnic University

We also have ongoing collaborations within a wider international network, that includes some of the highest-level and best-known universities all over the world, such as the University of California at Berkeley (US), Imperial College London (UK), Tsinghua University (CN), University of Michigan (US), École Polytechnique Fédérale de Lausanne (CH), Norwegian University of Science and Technology (NTNU), University of Southampton (UK), Technical University of Denmark (DK), Pennsylvania State University (US), Chalmers University of Technology (SE), Virginia Tech (US), Technische Universität Berlin (DE), University of Bristol (UK), Warsaw University of Technology (PL), The University of Sheffield (UK), Politècnica de València (ES)

## 9. Intersectoriality

Interaction with, and exposure to non-academic sectors, provides significant benefits to both doctoral candidates and research and innovation employment sectors. Direct exposure to the challenges and

opportunities in non-academic sectors of the economy and of society at large, is fostered within our PhD Programme by networking, inter-sectoral mobility and wide access to knowledge.

In particular, we have ongoing collaborations with a number of SMEs, international companies and research agencies, such as Pirelli, BLM Group, ESA European Space Agency, Rold Elettrotecnica, Saes Getters, ST Microelectronics, Tesmec, Inaf - Osservatorio Astronomico di Brera, Fondazione Politecnico, Fondazione Cariplo, Comau, MUSP, ITIA-CNR, Clamp, IIT, Impact Innovations, Celada, Pama, Tenova, Monzese, Lamborghini, Iseo Serrature, Eureinox, Baker Hughes, Enel Foundation, GE Power, ENI, Boldrocchi, MCM, Salvi, Pennservice, Univerlecco, Thyssenkrupp Steering AG, Rete Ferroviaria Italiana

## 10. Interdisciplinarity

Starting with the 33<sup>rd</sup> cycle (2017) a multidisciplinary doctoral path was introduced within Politecnico, and 20 additional grants were funded with the aim of developing a research activity co-supervised by Faculty members belonging to two different doctoral programmes, on strategic research themes (Industry 4.0, Health, Smart Cities, High Risks, Cultural Heritage).

Our Doctoral Programme is currently mastering 15 PhD interdoctoral PhD Thesis (3 appointed in 2018, 8 in 2019 and 4 in 2020); 7 are managed directly by our Department, and 8 are run by other Doctoral Programmes. . 5 more interdoctoral scholarships managed by our PhD programme will be included in the 37<sup>th</sup> Cycle PhD call, together with 2 more interdisciplinary scholarships handled by other doctoral programmes.

## 11. Contacts

### **PhD Programme Coordinator:**

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## **Attachment A1 – PhD Programme Coordinator**

### **Prof. Daniele Rocchi - Short CV**

Professor at the Department of Mechanical Engineering, Politecnico di Milano

#### **PROFESSIONAL PROFILE**

Mechanical Engineer

Since 2002: Researcher in Applied Mechanics at the Department of Mechanical Engineering of Politecnico di Milano;

Since 2014: Associate Professor at the Department of Mechanical Engineering of Politecnico di Milano.

Since 2019: Professor at the Department of Mechanical Engineering of Politecnico di Milano

#### **SCIENTIFIC ACTIVITY**

The research activity is mainly focused on the dynamics of mechanical systems and in particular on their interaction with the wind (wind engineering) through a continuous synergic use of experimental and numerical approaches (both by developing specific numerical models and by using CFD simulations).

The scientific activity is completed with 32 papers on international journals, more than 100 contributions on International Conferences, almost 30 contributions on national journals and congresses, the supervision of 6 PhD students and the scientific and technical responsibility of several projects in these fields

A brief list of the competences is hereinafter reported:

**Bridge Aeroelasticity:** study of the aeroelastic behavior of long span bridges (stability and buffeting response) through wind tunnel tests on sectional models and full aeroelastic models, CFD simulations and numerical models. Development of numerical models to simulate the non linearities of the aeroelastic response of bridges. Study of VIVs (Vortex Induced Vibrations). Design of wind barriers through wind tunnel tests.

**Cable Dynamics:** study of the wind energy input through wind tunnel tests on single and bundle cables. Experimental analysis in water tunnel and CFD analysis of devices to reduce vortex induced vibrations of cables. Wind tunnel study of a cable interaction with a wind turbine wake.

**Vehicle Aerodynamics:**

**RAILWAY VEHICLES:** study of the cross wind effects on railway vehicles through wind tunnel tests, CFD simulations and multi-body simulations. Development of a stochastic method to compute the CWCs (Characteristic Wind Curves). Wind tunnel tests, full scale tests and CFD simulations for the analysis of ballast projection, slip-stream and overpressures on noise barrier induced by high speed trains passing. Full scale tests, CFD and numerical simulations to compute the overpressure during tunnel crossing of high-speed trains. Study of the pantograph aerodynamics through wind tunnel tests and numerical simulations of its response to wind loads. Full scale tests and numerical simulations of the pressure comfort for sealed and not sealed trains. HS Train running resistance estimation through full scale tests.

**ROAD VEHICLES:** Investigation of the dynamic response of a high-sided vehicle passing through the wake of a bridge pylon through wind tunnel tests and numerical simulations.

**Wind-building interaction:** Wind tunnel tests and CFD studies are used to analyze the genesis of the large pressures peak on suction zones of buildings and roofs through their correlation with the turbulence characteristics (turbulence structures) of the incoming wind.

Noise and vibrations: Transmission of the vibrations induced by pass-by trains to the surrounding structures in railway field for different infrastructure typologies through full scale experiments. Full scale measurements of the pass-by noise emission from trains through a beam-forming microphone array technique.

## QUALIFICATIONS

- Member of the Board of the Italian Association for Wind Engineering (ANIV, Italian section of the IAWQ, International Association for Wind Engineering) for the period 2011-2015 and 2015-2019
- Member of the organizing committee of the Sixth International Colloquium on: Bluff Body (BBAA VI) held in Milan on July 20-24, 2008 under the IAWQ (International Association for Wind Engineering) framework
- Member of the scientific committee of the XIII Conference of the Italian Association for Wind Engineering IN-VENTO 2014 that will be held in Genova on June 22-25, 2014
- Peer reviewer for the following international journals: Journal of Wind Engineering and Industrial Aerodynamics (Elsevier); Journal of Bridge Engineering (ASCE), Vehicle System Dynamics (Taylor&Francis)
- Member of the Faculty of the PhD Programme in Mechanical Engineering of Politecnico di Milano since October 2014
- Deputy Head of the PhD Programme in Mechanical Engineering of Politecnico di Milano since October 2014
- Head of the PhD Programme in Mechanical Engineering of Politecnico di Milano since October 2017
- Member of the Board of directors of the PhD School of Politecnico di Milano since February 2019
- Member of the Scientific board of the GVPM (Wind tunnel of Politecnico di Milano) since April 2017
- Member of the Working group CEN/TC 256 "Railway applications" WG6 "Aerodynamics" since 2006



## Attachment 2 – MeccPhD Faculty Board

<b>Last Name</b>	<b>First Name</b>	<b>Affiliation</b>	<b>SSD</b>
1. Rocchi	Daniele	Programme Coordinator- Dept. of Mechanical Engineering	ING-IND/13
2. Belloli	Marco	Dept. of Mechanical Engineering	ING-IND/13
3. Beretta	Stefano	Dept. of Mechanical Engineering	ING-IND/14
4. Bernasconi	Andrea	Dept. of Mechanical Engineering	ING-IND/14
5. Braghin	Francesco	Dept. of Mechanical Engineering	ING-IND/13
6. Bruni	Stefano	Dept. of Mechanical Engineering	ING-IND/13
7. Cascini	Gaetano	Dept. of Mechanical Engineering	ING-IND/15
8. Cheli	Federico	Dept. of Mechanical Engineering	ING-IND/13
9. Cigada	Alfredo	Dept. of Mechanical Engineering	ING-IND/12
10. Colombo	Giorgio	Dept. of Mechanical Engineering	ING-IND/15
11. Colosimo	Bianca Maria	Dept. of Mechanical Engineering	ING-IND/16
12. Corradi	Roberto	Dept. of Mechanical Engineering	ING-IND/13
13. Giglio	Marco	Dept. of Mechanical Engineering	ING-IND/14
14. Gobbi	Massimiliano	Dept. of Mechanical Engineering	ING-IND/14
15. Guagliano	Mario	Dept. of Mechanical Engineering	ING-IND/14
16. Lecis	Nora	Dept. of Mechanical Engineering	ING-IND/21
17. Manzoni	Stefano	Dept. of Mechanical Engineering	ING-IND/12
18. Mapelli	Carlo	Dept. of Mechanical Engineering	ING-IND/21
19. Mastinu	Gianpiero	Dept. of Mechanical Engineering	ING-IND/14
20. Matta	Andrea	Dept. of Mechanical Engineering	ING-IND/16
21. Monno	Michele	Dept. of Mechanical Engineering	ING-IND/16
22. Pennacchi	Paolo	Dept. of Mechanical Engineering	ING-IND/13
23. Previtali	Barbara	Dept. of Mechanical Engineering	ING-IND/16
24. Resta	Ferruccio	Dept. of Mechanical Engineering	ING-IND/13
25. Sabbioni	Edoardo	Dept. of Mechanical Engineering	ING-IND/13
26. Saggin	Bortolino	Dept. of Mechanical Engineering	ING-IND/12
27. Tolio	Tullio	Dept. of Mechanical Engineering	ING-IND/16
28. Vedani	Maurizio	Dept. of Mechanical Engineering	ING-IND/21

### Attachment 3 – MeccPhD Advisory Board

<b>Last Name</b>	<b>First Name</b>	<b>Company-Organization</b>	<b>Position</b>
BELTRAME	Roberto	Microelettrica Scientifica SpA and KBRSI (Knorr-Bremse Rail Systems Italia)	CEO and President
BRAGHIERI	Paolo	Natuzzi SpA, S3K SpA, Power Venture SpA	Real estate entrepreneur and member of the advisory board
CAPOCCIA	Lorena	Sicme Motori	CEO
CEDERLE	Paolo	Unicredit Business Integrated Solutions	Former CEO
CHIERCHIA	Lucia	Gellify	Managing Partner
FACONDO	Alessio	RMS Srl, Top Management Consulting	Founder and CEO
FAINELLO	Marco	Add-For SpA	Managing Director
MANZONI	Paolo	NEGOCO Sr	Co-founder
MOSA	Paolo	Snam Rete Gas	CEO
PESCIO	Bartolomeo	Yara International	President-European Division
ZANELLA	Andrea	Dianax Srl	CEO