



**POLITECNICO**  
MILANO 1863

**PhD School - Politecnico di Milano**

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

**Location: Milano Bovisa**

## **1. General Information**

PhD School - Politecnico di Milano

PhD Programme: **Mechanical Engineering**

Course start: **November 2022**

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 13<sup>h</sup> in the world according to QS World University Rankings (Mechanical, Aeronautical & Manufacturing Engineering 2022)**, 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 2020 we have received full recognition by the Agency, and have also been appointed the seal of “innovative” doctorate, having fulfilled the criteria in terms of Interdisciplinarity, Internationalization, Intersectoriality. The same recognition was granted in 2021.

Our PhD programme is also involved in the 5-year project “Departments of Excellence”, started in 2018. MeccPolimi, in fact, 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 a 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 7 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 to be 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, optimization, 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 foresees the supervision of two Faculty members, the first one belonging to PoliMi and the second one to one of the partner universities.** 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 four co-supervised theses (one with ETH and three with TU Delft) have been activated so far.

### **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 38<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, Peenservice, Thyssenkrupp Steering AG, Rete Ferroviaria Italiana

Our scholarships holders receive 1.325 euro/month (net amount), extra- funding (660 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 mindset, 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. 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,**

**either from PhD courses (preferably) offered by the PhD Programme in Mechanical Engineering or by other PhD Programmes (either of Politecnico di Milano or of other Universities), or from Master level courses;**

- 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 2022-2023:

<b>Professor</b>	<b>Course name</b>
Armondi Simonetta	Strengthening Critical Spatial Thinking
Biscari Paolo	English for Academic Communication
Biscari Paolo	Industrial Skills
Biscari Paolo	Scientific Communication in English
Brunetto Domenico	Innovative Teaching Skills
Canina Maria Rita	Creative Design Thinking
Cardilli Lorenzo	European Culture
Di Blas Nicoletta	Professional Communication
Fuggetta Alfonso	Project Management Basics
Oxoli Daniele	The Copernicus Green Revolution for Sustainable Development
Iarossi Maria Pompeiana	Power of Images and Visual Communication for Research Dissemination
Masarati Pierangelo	Ethical Aspects of Research on Dual-Use Technologies
Mauri Michele	Research Communication. Issue mapping: exploring public debates surrounding academic topics
Ossi Paolo Maria	Sulla responsabilità tecnica
Oppio Alessandra	How to support Complex decisions: Approaches and Tools
Paganoni Anna Maria	La comunicazione nella Scienza
Pizzocaro Silvia Luisa	Practicing Research Collaboration
Raos Guido	Science, Technology, Society and Wikipedia

Sancassani Susanna	Teaching Methodologies, Strategies and Styles
Sciuto Donatella	Research Skills
Volonte' Paolo Gaetano	Introduction to Academic Research
Mancini Mauro	Project Management (In Action)
Tanelli Mara	Cognitive biases and discriminations: implications, risks and opportunities
Balducci Alessandro	Approaches to Resilience: Social, Economic, Environmental and Technological Challenges of Contemporary Human Settlements Modeling and Automated Verification of Real-Time Systems

**During the first year, it is mandatory to attend at least 6 of the MeccPhD Lectures (or 50% of them, if less than 12 are scheduled), the series of seminars delivered by international visiting faculty and researchers on relevant topics in the field of Mechanical Engineering.**

**The choice of the courses must be made in agreement with the Supervisor.**

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 to 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 the 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**

**Main courses (PhD or Master level) are intended** to develop PhD candidates' expertise in the area of their thesis and 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.

**OTHER COURSES**

**The attendance of other courses, workshops and schools is strongly encouraged and, if a certificate reporting the number of credits assigned (minimum 3) and the results of a final evaluation is issued, it may permit to acquire credits which can be considered equivalent to those acquired by attending the main courses. For these credits to be acquired, preliminary approval and evaluation by the PhD Faculty Board is required. Courses and workshops of less than 3 credits or without final evaluation (and therefore not qualified as credits) can be inserted in the study plan as optional “additional teaching”.**

In the following **table** the list of courses offered by the PhD Programme in Mechanical Engineering for the academic year 2022-23 is shown. Additional courses at Programme and School level can be activated afterwards.

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

<b>Lecturers</b>	<b>Course</b>	<b>Credits</b>
Panagiotis Tsiamyrtzis	<i>Statistics in the Big Data Era</i>	5
Hamid Reza Karimi Ahmet Enis Cetin (University of Illinois – Chicago)	<i>Introduction to Computer Vision and Sensor Data Processing Using Deep Learning</i>	5

Emanuele Zappa Gabriella Bolzon (DICA) Maria Pia Limongelli (DASTU)	<i>Integrated experimental and computational approaches to the diagnostics of structures and components</i>	5
Tullio Tolio Bariş Tan (Koç University)	<i>Stochastic modelling and analysis of production systems</i>	5
Riccardo Casati Francesco Braghin, Elisabetta Gariboldi, Nora Lecis, Carlo Mapelli, Maurizio Vedani	<i>Smart materials based on metallic and ceramic systems</i>	5
Marco Tarabini Pierre Lemerle (INRS – Institut National de Recherche et de Sécurité) Neil Mansfield (Nottingham Trent University)	<i>Human Response to Vibration</i>	5
Federico Cheli Pierangelo Masarati	<i>Multibody System Dynamics</i>	5
Simone Cinquemani Barbara Mazzolai (Istituto Italiano di Tecnologia)	<i>Bio-Inspired Systems</i>	5
Paolo Chiariotti Alberto Corigliano (DICA) Diego Melpignano (ST Microelectronics)	<i>Mechanical measurements with Micro-Sensors and Embedded Systems for the Industrial Engineer</i>	5
Giorgio Colombo Stefano Borgo (CNR)	<i>Data and knowledge in product development</i>	5
Bianca Maria Colosimo Tommaso Ghidini (ESA)	<i>Additive manufacturing for space and aerospace applications</i>	5
Francesco Braghin Loris Roveda (SUPSI – Scuola Universitaria della Svizzera Italiana)	<i>AI applications to industrial robotics</i>	5

Andrea Matta Mohsen Jafari (Rutgers University)	<i>Artificial Intelligence</i>	5
Laura Maria Vergani David Taylor (Trinity College Dublin)	<i>Fracture mechanics and its application to biologic materials</i>	5

#### **6.4 PhD Agreement**

**During the first year of the doctoral program, the PhD candidates must sign a PhD Agreement with their own Supervisor and tutor (co-supervisor), according to the "Doctoral Agreement Manual" attached to the University PhD Regulations.**

#### **6.5 Presentation of the study plan**

PhD candidates must submit a study plan drawn 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 courses' list, or to needs motivated by the development of their PhD career. The study plan is approved by the PhD Programme Coordinator, according to the modalities established by the PhD Faculty Board.

#### **6.6 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:***

- **during the 6<sup>th</sup>, 18<sup>th</sup> and 30<sup>th</sup> month from the intake, semi-annual evaluation (half-year milestone with candidate's Supervisor and Tutor);**
- **during the 12<sup>th</sup> and 24<sup>th</sup> month from the intake, admission to the following year (with evaluation according to the A-B-C-D-E grading system – annual milestone with evaluation of candidates by commissions composed by members of the Faculty Board).**

#### **6.7 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, executive PhDs or one year extension of the Phd path) 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 the 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 examiners).

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.

**Candidates can also be awarded a European Doctoral Degree if conditions reported in article 10.9 of the University PhD Regulations are met.**

## 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

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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*.

([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)

The PhD Programme supports a minimum of one scholarship per year in the framework of these internationalization activities.

## **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, Peenservice, 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 each year 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 19 PhD interdoctoral Phd Thesis (8 appointed in 2019, 4 in 2020 and 7 in 2021); 11 are managed directly by our Department, and 8 are run by other Doctoral Programmes. 3 more interdoctoral scholarships managed by our PhD programme will be included in the 38<sup>th</sup> Cycle PhD call, together with 1 more interdisciplinary scholarship handled by another doctoral programme.

## **11. Contacts**

### **PhD Programme Coordinator:**

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

### **Prof. Andrea Bernasconi - Short CV**

Associate Professor at the Department of Mechanical Engineering, Politecnico di Milano

#### **PROFESSIONAL PROFILE**

2011 - today Associate professor of Machine and Vehicle Design, at the Department of Mechanical Engineering of Politecnico di Milano

2002 – 2011 Assistant professor of Machine and Vehicle Design, at the Department of Mechanical Engineering of Politecnico di Milano

2000 – 2002 Research assistant, at the Department of Mechanical Engineering of Politecnico di Milano

1997 – 2000 PhD in Mechanics of Materials, University of Pisa, Pisa, Italy

1995 – Master's Degree in Mechanical Engineering, Politecnico di Milano

#### **SCIENTIFIC ACTIVITY**

His research activity is mainly focused on Lightweight Design and Composite Materials, Hybrid metal-composite structures, joining techniques, particularly adhesive joints and their structural health monitoring.

He is author of 46 papers published in international archive journals (1900 citations, h-index 22). He teaches Lightweight design of mechanical structures and Finite element Simulation for Mechanical Design at the Master's course in Mechanical Engineering of Politecnico di Milano. He has supervised 3 and co-supervised 1 PhD Students and he is currently supervising 5 PhD students.

During several years of research and activities and collaborations with industries, he gained a deep knowledge and expertise in the following fields:

##### **Lightweight Design and Composite Materials**

The activity research focuses on the mechanical behavior of composite materials and polymers reinforced with short fibers, and on the design of mechanical components optimized with respect to mass (lightweight design), in particular through the adoption of hybrid solutions based on the use of reinforced polymers and metals (multi-material hybrid structures, like car suspension arms and railway axles). More recently, attention has shifted to polymeric materials reinforced with short fibers to be used for the production of components using additive technologies

##### **Adhesive joints and their structural health monitoring**

The research activity focuses on the fatigue behavior of adhesive joints: experimentation, modeling and monitoring techniques. Experimental techniques for monitoring the structural integrity of structures in composite materials and adhesive joints are developed using optical fiber, Bragg grating (FBG) and fiber optics, non-grating sensors, using Optical Backscatter Reflectometry (OBR), and acoustic emission.

## Multiaxial fatigue of metals

The research activity focused on multiaxial fatigue testing of steels under not-proportional multiaxial loads, and on the development of numerical methods useful for the implementation of the most common multiaxial fatigue criteria, with particular attention to their computational efficiency, aimed at reducing the calculation times required by the fatigue assessment of components based on structural analyses with finite element models. Results were applied to the analysis of the rolling contact fatigue of railway wheels.

## Fatigue of welded joints

The expertise acquired on the fatigue assessment methods for welded joints during his entire career is continuously applied in the context of industrial applications, particularly in the railway sector.

## QUALIFICATIONS

- Member of the Faculty of the PhD Programme in Mechanical Engineering of Politecnico di Milano since October 2011
- Deputy Coordinator of the PhD Programme in Mechanical Engineering of Politecnico di Milano since October 2017
- Coordinator of the PhD Programme in Mechanical Engineering of Politecnico di Milano since January 2022
- Member of the scientific committee of: AB2015 – 3rd International Conference on Structural Adhesive Bonding, ECCM 17 17th European Conference on Composite Materials, AB2017 – 4th International Conference on Structural Adhesive Bonding, Fatigue 2018, ECCM 18 – 18th European Conference on Composite Materials, AB2019 – 5th International Conference on Structural Adhesive Bonding, AB2021– 6th International Conference on Structural Adhesive Bonding, ICFC8 - the Eighth International Conference on Fatigue of Composites
- Member of the Editorial Board of the following international journals: Journal of Adhesion, Materials MDPI
- Peer reviewer for the following international journals: International Journal of Fatigue, Composites Science and Technology, International Journal of Adhesion and Adhesives, Journal of Adhesion, Composites Part A, Composites Part B, Composite Structures

## Attachment 2 – MeccPhD Faculty Board

<b>Last Name</b>	<b>First Name</b>	<b>Affiliation</b>	<b>SSD</b>
1. Barella	Silvia	Dept. of Mechanical Engineering	ING-IND/21
2. Belloli	Marco	Dept. of Mechanical Engineering	ING-IND/13
3. Beretta	Stefano	Dept. of Mechanical Engineering	ING-IND/14
4. Bernasconi	Andrea	Programme Coordinator- 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. Cheli	Federico	Dept. of Mechanical Engineering	ING-IND/13
8. Cigada	Alfredo	Dept. of Mechanical Engineering	ING-IND/12
9. Colombo	Giorgio	Dept. of Mechanical Engineering	ING-IND/15
10. Colosimo	Bianca Maria	Dept. of Mechanical Engineering	ING-IND/16
11. Corradi	Roberto	Dept. of Mechanical Engineering	ING-IND/13
12. Gariboldi	Elisabetta	Dept. of Mechanical Engineering	ING-IND/21
13. Giglio	Marco	Dept. of Mechanical Engineering	ING-IND/14
14. Gobbi	Massimiliano	Dept. of Mechanical Engineering	ING-IND/14
15. Graziosi	Serena	Dept. of Mechanical Engineering	ING-IND/15
16. Guagliano	Mario	Dept. of Mechanical Engineering	ING-IND/14
17. Lecis	Nora	Dept. of Mechanical Engineering	ING-IND/21
18. Manzoni	Stefano	Dept. of Mechanical Engineering	ING-IND/12
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. Rocchi	Daniele	Dept. of Mechanical Engineering	ING-IND/13
26. Sabbioni	Edoardo	Dept. of Mechanical Engineering	ING-IND/13
27. Saggin	Bortolino	Dept. of Mechanical Engineering	ING-IND/12
28. Tolio	Tullio	Dept. of Mechanical Engineering	ING-IND/16

### 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)	Managing Director and CEO, respectively
BRAGHIERI	Paolo	GBC s.a.	Business owner
CAPOCCIA	Lorena	Sicme Motori	CEO and Board Member
CEDERLE	Paolo	Everis SpA	Italian Executive Chairman and Country Manager
CHIERCHIA	Lucia	Gellify	Managing Partner
FACONDO	Alessio	Fimer SpA	CEO
FAINELLO	Marco	Addfor S.p.A and Danisi Engineering	Executive Director and CTO, respectively
GHIDINI	Tommaso	ESA – European Space Agency	Head of Structures, Mechanisms and Materials Division at TEC-MS Mechanical Department
MANZONI	Paolo	NEGOCO Sr	Co-founder
PESCIO	Bartolomeo	Yara International	SVP and Head BU Nordics
ZANELLA	Andrea	Kedrion Biopharma Dianax S.r.l	Global Marketing Director and Vice Chairman, respectively