ROMA TRE UNIVERSITY
Department of Civil, Computer Science and Aeronautical Technologies Engineering

PhD PROGRAMME IN

MODELS AND METHODS FOR SUSTAINABLE ENGINEERING

Programme Prospectus (Manifesto degli Studi)

41st Cycle — Academic Year 2025/2026

Coordinator: Prof. Marco Sebastiani
Deputy Coordinator: Prof. Alessandro Lidozzi

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Project description

The doctoral programme aims to train future research doctors in the competences relating to modelling and the development of experimental methodologies for engineering oriented toward the characteristic themes of the energy transition and sustainability. The latter is understood here not only in the sense of fair and efficient management of resources, but in its broadest meaning, which includes the protection of the quality of life and the health of citizens among the primary objectives of a sustainable future.

Achieving climate neutrality by 2050, within a resilient production system, currently represents one of the main objectives of the European Commission under the Horizon Europe programme, and the present doctoral programme is deeply and actively embedded within this vision. The broad spectrum of competences that characterise the faculty members of the Board, together with their consolidated experience in national and international projects on the themes of environmental sustainability, will make it possible to promote a strongly multidisciplinary education and research environment, characterised by continuous and deep interaction among the different fields. Students of the programme will be able to develop research projects on the themes proper to the disciplinary areas of materials science and technology, condensed matter physics, flight mechanics, photonics, acoustics, the science of complex systems, electrical engineering, fluid dynamics, static conversion of electrical energy and electric drives, automatic controls, bioengineering, telecommunications, aerospace constructions and structures, enriching and deepening their knowledge also on topics functional to enhancing their methodological development capabilities, such as robust multidisciplinary optimisation under uncertainty, mathematical physics, the theory of networks and complex systems, and computational intelligence applied to optimisation and to the identification of non-linear physical models. Within the scope of sustainability, the theme of integrated mobility and the disciplines connected to it — such as, for example, transport and infrastructure — will also be of interest to the programme.

It is worth emphasising that the project envisages the conduct of research and training activities within the areas of the distributed laboratories, recently established, and participating in the initiatives for socialisation and sharing of results organised periodically at the departmental level. Worth mentioning are the Doctorate Day, or the PhDLife initiative, recently launched, which envisages periodic seminar-style meetings in which a scholar of consolidated experience offers an educational seminar and attends the students' presentations, followed by an open debate.

The doctoral programme also draws on the assessment of the educational project by representatives of the industrial world, among whom the heads of the companies co-financing doctoral scholarships and the members of the Department's permanent steering committee.

For the 41st doctoral training cycle, the Board of faculty members, while confirming the eligibility of any project falling within the general themes described above, has identified some key themes of particular interest within the framework of the many ongoing research projects. In addition to the specific themes linked to the scholarships co-financed by companies and/or on projects (described in detail in the dedicated section of the call), the following themes have been identified:

1. Quantum algorithms for computational fluid dynamics;
2. Thermoacoustic instabilities in modern combustors;
3. Performance prediction of drones in urban environments;
4. Simulation of drone flight;
5. Assessment and prediction of the performance of drones flying in urban environments;
6. Reconstruction of the state and loads of helicopter blades through virtual sensing for condition monitoring and performance improvement;
7. Multiscale study of diffusion and synchronisation models on ordinary complex networks (same-sign interactions) and signed networks (interactions of both signs);
8. Smart materials for advanced applications;
9. Analysis of nozzles as a passive noise-reduction device for jet noise;
10. Advanced mechanical characterisation at the nanometric scale of microcapsules;
11. Advanced Cooling Architectures for Static Power Converters and Electric Drives;
12. Next-Generation Power Converters and Advanced Control Structures.

Programme objectives

The present doctoral training project intends to provide advanced competences and technical skills in modelling and methodological development aimed at the analysis and design of complex technological systems that ensure the full satisfaction of the needs emerging from civil society while guaranteeing, at the same time, full environmental sustainability and the acceptance of technological innovations by citizens. This ambitious project requires an intrinsically multidisciplinary approach that enables the future research doctor to carry out innovation activities in the fields proper to industrial engineering, information engineering and civil engineering, also benefiting from the knowledge proper to the basic sciences. From this perspective, the ability to formulate and solve multidisciplinary problems of extremely high complexity — which can be tackled only by those possessing a very broad-spectrum preparation aligned with the most advanced frontiers of research — becomes of vital importance.

The strongly multidisciplinary nature of the Board members, evidenced not only by their scientific fields of affiliation but also by the variety of the research themes documented in a substantial scientific output, guarantees the cultural framework on which to build the educational programme aimed at the ambitious objectives described. Highly qualified courses taught by the faculty of the Board will be an integral part of the students' educational activity, and will be complemented by an intense seminar activity delivered by leading international experts in the respective fields. At the beginning of their doctoral path, students will be able to define, with the help of their supervisors, the educational path most suited to their project,

choosing among the courses offered by the faculty of the Board. Courses and seminars will not have the sole objective of providing the necessary theoretical competences with a rigorous approach aligned with the state of the art in the respective fields, but also of preparing students to operate with the most advanced tools for experimental analysis, digitally assisted additive manufacturing, materials characterisation, and the simulation of complex systems. The recent creation of five Distributed Laboratories within the Department of Civil, Computer Science and Aeronautical Technologies Engineering (DICITA) will allow students to operate under the best conditions to put these objectives into practice. Through laboratory activity, students will be able to acquire the multidisciplinary and transversal operational competences and techniques currently much in demand in the labour market. The distributed laboratories recently established at DICITA are:

1. Distributed Laboratory of Computational Models for Complex Systems (MCSisCom)
2. Distributed Laboratory for the Safety of Natural Systems and Infrastructures (DISSEMINATE)
3. Distributed Laboratory of Optical and Magneto-Electro-Acoustic Characterisations (COMETA)
4. Distributed Laboratory of Real-Time Digital Twin for advanced design and diagnostics (RTD-Twin)
5. Distributed Laboratory of Additive Manufacturing (3DINGLab — already recently upgraded).

The infrastructural investment linked to the creation and future development of the distributed laboratories will allow doctoral students to plan their activities relying on an operating context of extremely high technological value, in constant evolution and aligned with the most advanced laboratories at the international level, both within and outside Europe. The technological equipment of the distributed laboratories will facilitate direct interaction with researchers and doctoral students operating in similar facilities abroad, allowing the exchange of data, the cross-verification of methodologies and models and, of course, the inbound and outbound mobility of students.

In this regard, it is worth specifying that the practice for doctoral students of benefiting, during the doctorate, from a significant period of stay abroad — indicatively from 3 months to one year — will be consolidated. Doctoral students will be hosted by universities, research centres, and companies engaged in applied research, with offices in European and non-European countries, taking advantage of the very broad network of contacts of the faculty and researchers affiliated with the Board of this doctoral proposal.

Expected Employment and Professional Outcomes

The professional figure trained in accordance with the educational principles described will be characterised by highly specialised competences, framed however within an intrinsically and deeply multidisciplinary vision. The combination of competences and infrastructures, also based on an interconnected network of international collaborations, will enable students to acquire those transversal competences which, combined with the specific vertical specialisations of each project, will provide the flexibility and adaptability that are increasingly required today of researchers and engineers engaged in the development and consolidation of new methods and models for sustainable engineering. This will allow the future research doctor to make available their distinctive preparation, pertinent to their

disciplinary field, in the most diverse contexts, interfacing effectively with colleagues from different backgrounds. The research doctor will be able to integrate without difficulty into pre-existing work groups and to contribute effectively to forming new ones. The development of so-called soft skills will be an aspect that will not be neglected in the educational process. The ability to communicate, to address and solve problems, to adapt to rapidly evolving operating conditions and to always maintain a high level of creativity will be characteristics that will help make the professional figure of the future research doctor of certain interest for any working context.

It must also be emphasised how the themes addressed, the competences acquired and the theoretical-experimental approach of the three-year path will make the profile of the graduating research doctor strongly attractive to the industrial world. The technological challenges expected in the near future — such as, for example, the energy transition and renewable energies, or the new paradigms of air, naval and land transport — will require the new generations of engineers engaged in the production sector to have modelling and analysis capabilities in line with the most advanced knowledge. The identification and modelling of non-linear systems, the characterisation of innovative materials, the most advanced techniques of optimisation under uncertainty, and the use of computational intelligence for data analysis and projections are competences in which industries are increasingly investing. The profiles trained by this doctoral project will be aligned with these needs. Of course, the professional profile graduating from the PhD in Models and Methods for Sustainable Engineering will be of certain interest to public or private research centres and bodies and to academic institutions. The emphasis that will be placed on internationalisation aspects will guarantee the marketability of the professional skills developed on the international labour market, providing future research doctors with the broadest and freest possibility of planning their career and, ultimately, their professional life.

2. Board of PhD council Members

Coordinator

Surname and Name	University/Institution	Department/Structure	Position	Competition Sector / CUN Area	Scopus Author ID / ORCID
SEBASTIANI Marco	Roma Tre University	Civil, Computer Science and Aeronautical Technologies Engineering	Associate Professor (L. 240/10)	09/D1 — Area 09	Scopus: 7005846216

Coordinator's Profile

Marco Sebastiani is a researcher in the fields of materials science, surface engineering, thin-film synthesis, and advanced mechanical characterisation and microscopy at the nanometric scale. His experience has earned him worldwide recognition, contributing significantly to both academic research and industrial applications. Over the last decade, Sebastiani has demonstrated leadership capabilities in coordinating and participating in large-scale international research projects, obtaining prestigious recognitions.

In terms of teaching activities, since 2011 he has been lecturer of various courses (both fundamental and advanced) in Materials Science and Technology, in the bachelor's and master's degrees in aeronautical, mechanical and biomedical engineering at Roma Tre University.

Sebastiani's career is characterised by his role as a leader and key contributor to a variety of European and national research initiatives. He was awarded a Fulbright scholarship, which underlines his international standing and his ability to foster international collaborations. His leadership is particularly evident in his involvement in European and national projects. Over the last ten years, Sebastiani has been coordinator of two major European projects and two large national projects, one of which is the PRIN2020 CONCERTO project, in which he took on the key role of project coordinator. In the broader context of research infrastructure development, Sebastiani has also led the Roma Tre University unit within the PNRR iENTRANCE@ENL project, an initiative aimed at supporting the energy transition and circular economy efforts. His experience in project coordination extends to complex multidisciplinary collaborations. In particular, Sebastiani has successfully led work packages in six large European projects, including DigiCell, MIRIA, COBRAIN, NANOMECOMMONS, OYSTER and ISTRESS. In these roles, he has demonstrated organisational and managerial skills, combined with the ability to navigate the complex dynamics of international research consortia. His research work has essentially focused on the nanometric-scale characterisation of cutting-edge materials and on the development of innovative design and synthesis pathways for nanomaterials, contributing significantly to advances in the field.

In addition to coordinating research projects, Sebastiani is deeply involved in the academic and editorial community. He is an editor of the prominent journal "Materials and Design" (IF 7.6). He is regularly a Guest Editor for several high-impact international journals, including "Current Opinion in Solid State & Materials Science" (IF 12.2), "Materials Science and Engineering A" (IF 6.1) and "Nanomaterials" (IF 4.4).

Furthermore, he is a co-founder and active member of the European Materials Characterisation Council (EMCC), further demonstrating his commitment to the advancement of the field on a continental scale. He is also an active member of the ongoing European AMI2030 action, which is leading to the creation of a new European Partnership on Advanced Materials (IM4EU). As further evidence of his leadership and research management capabilities, since 2021 he has held the position of Deputy Director for research activities at the Department of Civil, Computer Science and Aeronautical Engineering of Roma Tre University.

The impact of Sebastiani's research is reflected in his exceptional publication record. According to Scopus, he is co-author of 118 peer-reviewed articles, obtaining over 5,000 citations and an h-index of 35 (May 2025). These metrics highlight his influential contribution to scientific knowledge and his broad engagement with the scientific community. Sebastiani's work has not only been influential at the academic level but has also been widely recognised in the public sphere. His research has been featured by major Italian news outlets, including IL SOLE 24 ORE, TG1/RAI and the innovation magazine PLATINUM, highlighting the social relevance and practical applications of his work. Further results and details are reported in the CV attached to this proposal. In 2023, his achievements earned him a place among the top 2% of the most influential scientists worldwide, according to Stanford University.

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7. https://cordis.europa.eu/project/id/760827/
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9. https://www.sciencedirect.com/journal/materials-and-design/about/editorial-board
10. http://characterisation.eu/council-structure/
11. https://www.ami2030.eu

Members of the Board (Faculty and Researchers of Italian Universities)

No.	Surname and Name	Role	Position	Comp. Sector	CUN Area	SSD	Scopus ID
1	BEMPORAD Edoardo	Member	Full Professor	09/D1	09	ING-IND/22	6603406713
2	BERNARDINI Giovanni	Member	Associate Professor (L. 240/10)	09/A1	09	ING-IND/04	35232425700
3	CALIANO Giosue'	Member	Associate Professor (L. 240/10)	09/E1	09	ING-IND/31	6603730794

No.	Surname and Name	Role	Position	Comp. Sector	CUN Area	SSD	Scopus ID
4	CAMUSSI Roberto	Member	Full Professor	09/A1	09	ING-IND/06	7004133150
5	CARRESE Stefano	Member	Full Professor (L. 240/10)	08/A3	08	ICAR/05	6507418153
6	CINCOTTI Gabriella	Member	Full Professor	09/G2	09	ING-INF/06	7006105313
7	DI MARCO Alessandro	Member	Associate Professor (L. 240/10)	09/A1	09	ING-IND/06	24503030900
8	GABRIELLI Andrea	Member	Associate Professor (L. 240/10)	02/B2	02	FIS/03	57208761172
9	GENNARETTI Massimo	Member	Full Professor	09/A1	09	ING-IND/04	6701446768
10	IEMMA Umberto	Member	Full Professor (L. 240/10)	09/A1	09	ING-IND/04	55843896300
11	LANZARA Giulia	Member	Associate Professor (L. 240/10)	09/D1	09	ING-IND/22	24436633700
12	LIDOZZI Alessandro	Member	Associate Professor (L. 240/10)	09/E2	09	ING-IND/32	24766926100
13	MANCINELLI Matteo	Member	Fixed-term Researcher - full time (Art. 24 c.3-b L. 240/10)	09/A1	09	ING-IND/06	57190523173
14	SALVINI Alessandro	Member	Full Professor	09/E1	09	ING-IND/31	7004998609
15	**SEBASTIANI Marco**	**Coordinator**	Associate Professor (L. 240/10)	09/D1	09	ING-IND/22	7005846216
16	SERAFINI Jacopo	Member	Associate Professor (L. 240/10)	09/A1	09	ING-IND/03	18134636300
17	SOLERO Luca	Member	Full Professor (L. 240/10)	09/E2	09	ING-IND/32	35513447200

All members are affiliated with the Department of Civil, Computer Science and Aeronautical Technologies Engineering of Roma Tre University and have confirmed their membership of the programme.

3. Educational Project

Planned Teaching Activity — Courses Offered

No.	Course title	Total hours	Distribution in the cycle	Course description	Final assessment
1	**Presentation and critical analysis of the state of the art on smart and functional materials**	18	first year	Presentation and critical analysis of the state of the art on smart and functional materials, with particular attention to nanostructured materials, composite materials, and applications in aeronautics and aerospace.	**NO**
2	**Computational Intelligence**	12	second year	Heuristics. Evolutionary Computation. Genetic Computation. Neural Computation. Applied Machine Learning. Soft Computing. The course aims to provide competences relating to the development and use of methodologies for solving high-complexity problems through the most advanced heuristic and artificial-intelligence-based techniques.	**NO**
3	**From Cyber-Physical System to Real-Time Digital Twin (for Electric Power Applications)**	16	second year	The course provides an overview of the tools for modelling physical systems on computing platforms for real-time digital twins. The 'hands-on' use of Hardware-In-the-Loop (HIL) and Power Hardware-In-the-Loop (PHIL) simulators will be an integral part of the course.	**NO**
4	**Theory of Complex Networks**	12	first year	Introduction to and in-depth study of the theory of complex networks, and their relevance in various fields of engineering, with particular attention to the potential impact on the green transition and the digital transition.	**NO**
5	**Topics in Dynamics of the Deformable Continuum**	12	first year	Topics in the Dynamics of the Deformable Continuum, and a description of the potential applications to the various fields of engineering of interest for this doctoral programme, and in greater detail for the aeronautical and aerospace sectors.	**NO**
6	**Advanced multiscale methodologies for materials characterisation**	12	first year	Advanced multiscale methodologies for the morphological, microstructural and microanalytical characterisation of materials in bulk or as films/coatings using optical, ionic, electronic, X-ray and contact probes. Advanced and complementary methods, models and techniques for characterisation: fundamentals, operating	**YES**

No.	Course title	Total hours	Distribution in the cycle	Course description	Final assessment
				principles of the techniques, and applications.	
7	**Correlative multi-technique mechanical characterisation at the micro and nano scale**	16	second year	Methods, models and techniques for the study of complex mechanical properties at the micro and nano scale of systems with extensive interfaces: fundamentals, operating principles of the techniques, and applications.	**YES**
8	**Surface engineering for the enhancement of performance and durability**	16	second year	Methods, models and techniques for the production of films, coatings and overlays used to study the surface properties of systems for advanced mechanical engineering and micro-device applications: fundamentals, numerical and analytical modelling, characterisation methods through technological, mechanical, tribological and chemical testing.	**YES**
9	**3D printing at the nano-micro-meso scale for the study of nanostructured materials and nanoarchitectures**	16	second year	Principles and methods for high-resolution rapid prototyping for the study of the multiscale properties of materials. The course aims to provide the doctoral student with the competences to produce very high-resolution prototypes that can be used to study mechanical properties down to nanometric scales for applications in micro-devices and nanomaterials.	**YES**
10	**Short Course in Aeroacoustics**	12	first year / second year	The course provides an introduction to the main concepts of computational fluid dynamics and aeroacoustics, with particular reference to the implementation of high-fidelity methodologies exploiting parallel computing platforms.	**NO**
11	**Short Course on CFD and CAA**	16	first year / second year	Introduction to, topics in, and in-depth study of CFD (Computational Fluid Dynamics) and CAA (Computational Aeroacoustics) methods, and how they can be applied to the key sectors of aeronautical and aerospace engineering.	**NO**

4. Operational and Scientific Facilities

Type	Brief description
Equipment and/or Laboratories	The laboratories in which doctoral students can carry out their research activities are those available at DICITA, where all the appropriate instrumental and computing resources are available. The recent establishment of the distributed laboratories (see the description and objectives section) makes the department's entire instrumental apparatus available to each doctoral student, allowing the planning of cross-cutting activities in a simple and effective manner.
Library holdings	Doctoral students can make use of the section's documentation centre and of the Scientific-Technological Area Library, located at the same premises as the department and its main laboratories. The documentary holdings of the BaST cover all the themes proper to the programme and allow easy consultation of digital material from any internal and external workstation (via VPN).
Library holdings	Subscriptions to print journals have been cancelled in order to increase the economic commitment toward online databases, which allow a faster updating of the state of the art on all the themes proper to the doctoral programme.
E-resources	There are numerous university agreements with the largest global providers (Elsevier, Thomson), which doctoral students can access once they have acquired their personal credentials from the research office. The Scopus- and WoS-based search and consultation system is also active and available. Doctoral students will be encouraged to use open-access data- and document-sharing platforms.
E-resources	The department offers shared computing laboratories alongside the autonomous ones of the individual groups. License agreements are available for the software Mathematica, Matlab, the entire AutoDesk catalogue, COMSOL, Labview, and Ansys-Fluent. Particular attention is paid to advanced open-source tools, both as users (OpenFOAM, SU2, FreeCAD...) and as developers (AcouSTO, FrIDA...).
E-resources	Each work group hosts doctoral students in the spaces dedicated to the laboratory activities relating to the research in which the student is involved. At the section and department level there are various reception facilities offering spaces for study, writing activities and network access. Hardware tools for intensive computing based on the latest-generation scalar and distributed technologies are available.
Other	Great importance is given to the concept of "open science", encouraging doctoral students to use open-access sharing tools. Upon activation, a community will be established on the Zenodo platform, connected to the OpenAIRE infrastructure (Open Access Infrastructure for Research in Europe). Doctoral students will be required to publish the results of their research according to the criteria of green/gold open access (Berlin Declaration on Open Access to Knowledge in the Sciences, 2003).