

**PhD Programme Table - 39th cycle**  
**Call for Applications for the admission to the PhD programmes (39<sup>th</sup> cycle) A.Y. 2023/2024**  
**for scholarships funded by Next Generation EU – NRRP ex M.D. 117/2023 and M.D.**  
**118/2023 and from other sources**



Errata Corrige 23/05/2022 – section “Research Fields” added

PROGRAMME’S NAME	<b>MATHEMATICS</b>
DURATION	3 years
PROGRAMME START DATE	01/11/2023 (DD/MM/YYYY)
LANGUAGES	Italian, English
COORDINATOR	Prof.ssa Valeria Simoncini ( <a href="mailto:valeria.simoncini@unibo.it">valeria.simoncini@unibo.it</a> )
PHD POSITIONS	12
ADMISSION PROCEDURE	Qualifications evaluation Oral examination

**Available Positions and Scholarships**

Pos. n.	Financial Support	Description	Positions linked to a specific research topic
1	<b>PhD Scholarship</b>	Totally funded by the University of Bologna general budget	
2	<b>PhD Scholarship</b>	Totally funded by the University of Bologna general budget	
3	<b>PhD Scholarship</b>	Totally funded by the University of Bologna general budget	
4	<b>PhD Scholarship</b>	Totally funded by the University of Bologna general budget	
5	<b>PhD Scholarship</b>	Totally funded by the University of Bologna general budget	
6	<b>PhD Scholarship</b>	Totally funded by the University of Bologna general budget under the Progetti di Sviluppo Strategico dei Dipartimenti (PSSD) initiative	Mathematical models for life sciences, cognitive neuroscience, data analysis, social sciences, finance
7	<b>PhD Scholarship</b>	Totally funded by the University of Bologna general budget under the Progetti di Sviluppo Strategico dei Dipartimenti (PSSD) initiative	Mathematical models for life sciences, cognitive neuroscience, data analysis, social sciences, finance
8	<b>PhD Scholarship</b>	Funded by the Department of Mathematics with funds made available by the project ERC - CUP J33C22004270006 - GRANT Agreement n. 101077154	Applications of logic to topology, mathematical analysis or algebra
9	<b>PhD Scholarship PNRR ex M.D. 118/2023 - Public Administration</b>	Funded by the EU - NextGenerationEU with funds made available by the National Recovery and Resilience Plan (NRRP) Mission 4, Component 1, Investment 4.1 (M.D. 118/2023) - Public Administration	Mathematical models and methods for human resource planning, environmental protection and safety measures, in the public sector
10	<b>PhD Scholarship</b>	Funded by the EU - NextGenerationEU with funds made available by the National Recovery and	Mathematical models and methods for human resource

	<b>PNRR ex M.D. 118/2023 - Public Administration</b>	Resilience Plan (NRRP) Mission 4, Component 1, Investment 4.1 (M.D. 118/2023) - Public Administration	planning, environmental protection and safety measures, in the public sector
<b>11</b>	<b>PhD Scholarship PNRR ex M.D. 118/2023 - Public Administration</b>	Funded by the EU - NextGenerationEU with funds made available by the National Recovery and Resilience Plan (NRRP) Mission 4, Component 1, Investment 4.1 (M.D. 118/2023) - Public Administration	Mathematical models and methods for human resource planning, environmental protection and safety measures, in the public sector
<b>12</b>	<b>PhD Scholarship PNRR Campioni Nazionali</b>	Funded by the EU - NextGenerationEU with funds made available by the National Recovery and Resilience Plan (NRRP) - Campioni Nazionali (CN HPC) - CUP J33C22001170001	Energy-aware matrix computations for scientific computing in HPC environments

All PhD positions winners shall fulfill the learning and research obligations decided by the Academic Board and the obligations foreseen in the relevant regulations, funding schemes and eventual agreements, and in the Call for Applications. Moreover, applicants awarded with PhD scholarships funded by Next Generation EU shall fulfill specific obligations foreseen in the relevant funding scheme, in the relevant regulations and in the Call for Applications.

## Admission Exams

	DATE AND TIME	RESULTS
<b>Qualifications evaluation</b>	Applicants' participation is not required	Available from <b>26/06/2023**</b>
<b>Oral examination</b>	<b>Date:</b> starting from <b>04/07/2023 – 8.30 a.m. CEST*</b> <b>Place:</b> In presence, Aula Seminario I, Department of Mathematics, Piazza di Porta San Donato 5, Bologna. Remotely, using Microsoft Teams	Available from <b>17/07/2023**</b>

\* In case that the oral examination cannot be completed in one day due to the large number of applicants, the oral examination detailed schedule shall be made available on the webpage [Studenti Online](#) together with the results of the qualifications evaluation. **During the oral examination, applicants may express their interest in one or more positions linked to specific research topics. Furthermore, applicants interested in the research topic “Mathematical models and methods for human resource planning, environmental protection and safety measures, in the public sector” may express to the Admission Board their interest in one of the specific areas of application described in the “Research Field” section of the present PhD programme table. Such a further indication will be registered by the Admission Board for information only.**

\*\* The **results of the admission exams** will be available on the webpage [Studenti Online](#) (select “summary of the requests in progress” > “see detail” and open the .pdf file at the bottom of the page). **No personal written communication will be sent to applicants concerning the examinations results.**

## Required and Supporting Documents to be attached to the application

All the documents listed below **shall be drawn up in English or in Italian**. In case of documents originally issued in any other language (e.g. identity document, qualifications), an official translation is required.

Only qualifications obtained **during the last 5 calendar years** shall be taken into consideration, except for the University Degree. The Admission Board will assess the relevance of the supporting documents to the PhD Programme.

REQUIRED DOCUMENTS	
<b>Identity document</b>	Valid identity document with photo (i.e. identity card, passport)
<b>Curriculum Vitae</b>	No specific CV format is required
<b>Degrees</b>	Documents attesting the awarding of the first and second cycle degrees, the exams taken and the marks obtained (see Art. 3 of the Call for Applications)
SUPPORTING DOCUMENTS	
<b>Thesis abstract</b>	Abstract of the <b>second cycle degree thesis</b> . Graduated applicants may submit the draft of the thesis. Abstracts cannot exceed 5,000 characters (min 4,000 characters), including spaces and

	formula possibly used. The above figure does not include: the title of the thesis, the outline, references, and images such as graphs, diagrams, tables etc.
<b>Reference letter/s</b>	<b>No more than 3 reference letters</b> signed by Italian and international academics and professionals in the research field, which do not form part of the Admission Board, attesting the suitability of the applicant and his/her interest in the scientific research. Letters shall be uploaded following the procedure on <a href="#">Studenti Online</a> , detailed in the Call for Applications (Art. 3.2).
<b>Personal Statement</b>	The statement shall include the reasons prompting the applicant to attend the PhD Programme and <b>those relevant experiences and research interests</b> , that make the applicant suitable for the specific PhD Programme (3000 characters maximum, including spaces).
<b>Other documents</b>	<ul style="list-style-type: none"> <li>- Postgraduate vocational programmes and/or specialisation programmes relevant to the PhD Programme</li> <li>- Research activity of any kind - whether basic, applied, translational, etc. - carried out in any capacity, including when covered by research grants, and as a staff member of research projects</li> <li>- Periods of study abroad, completed by applicants outside their countries of origin (e.g. Erasmus programme or other similar mobility programmes)</li> <li>- Other qualifications attesting the suitability of the applicants (scholarships, prizes, etc.)</li> </ul>

## Evaluation criteria\*

Scores will be expressed in points out of 100, as follows.

### 1. Qualifications evaluation

Minimum score for admission to the oral examination: 30 points, Maximum score: 50 points

Passed exams, final mark and Weighted Average Mark (WAM) for the First (Bachelor's) and Second cycle degrees (Master's), in order to evaluate the applicants' whole study, general knowledge and their consistency with the PhD programme's main research topics	13 points max
Thesis abstract	5 points max
Reference letter/s	12 points max
Curriculum Vitae, personal statement and other evaluable documents	20 points max

### 2. Oral examination

Minimum score for eligibility: 30 points, Maximum score 50 points

English language proficiency	2 points max
General knowledge of the PhD programme's main research topics and of the research topics linked to the available PhD positions	48 points max

Oral examination aims to assess the suitability of the applicant for scientific research as well as the general knowledge of the PhD programme's main research topics and of the research topics linked to the available PhD positions. **During the oral examination, the applicant's English proficiency shall be assessed.**

The oral examination is carried out in Italian or English.

\* Possible further evaluation criteria will be available on the [University website](#), selecting the relevant PhD Programme > "More information".

## Research Fields

Applicants interested in the research topic "Mathematical models and methods for human resource planning, environmental protection and safety measures, in the public sector" (PhD scholarships NRRP ex M.D. 118/2023) may express to the Admission Board their interest in one of the specific areas of application listed below:

### 1. Space and timetable planning problems for universities (ref. Prof. Marco Antonio Boschetti)

The planning of the university class timetable is a problem that requires a huge amount of work every year for teachers and technical-administrative staff. The problem not only requires the definition of a timetable compatible with the needs of teachers and students, but also the selection of the most suitable spaces (e.g., rooms, labs, etc.) with respect to some specific parameters (e.g., capacity, available equipment, etc.). Today, only solutions with limited capacity are available on the market; therefore, the project aims to study the problem from a strategic, tactical, and operational point of view to provide effective support for solving real-world problems. The mathematical models and solution methods will be based on mathematical programming

and combinatorial optimization approaches. Moreover, they could also have other interesting applications in the Public Administration, such as for example in the healthcare management, where with appropriate adaptations they could be used to plan the assignment of spaces and personnel to departments and services, also defining their timetables. Partner: the partner in the Public Administration will be the University of Modena and Reggio Emilia, which already collaborates with the University of Bologna on the proposed topic.

2. **Classical and quantum algorithms for optimal staff allocation (ref. Prof. Giacomo De Palma)**  
The project has the goal to develop classical and quantum algorithms for the optimal allocation of the staff within an organization by phrasing the problem as a combinatorial optimization problem. Combinatorial optimization problems consist in finding the optimal element within a finite set of possible choices and have an extremely wide application spectrum. The project will tackle the problem to optimize the staff allocation with algorithms based on Hopfield networks and on the Quantum Approximate Optimization Algorithm and will include an exchange in a public research body among CNR, INFN and CINECA.
3. **Technological ecosystems for visually impaired students and teachers' inclusion (ref. Prof. Andrea Maffia)**  
ICTs allow schooling for visually impaired people. However, mathematical texts pose accessibility challenges because of diverse contents (e.g. formulae, graphs, etc.). Through available ICTs, the reading of math is possible, but only a combined ecosystem of technologies may provide the opportunity of doing mathematics. An actual inclusion requires interaction between visually impaired students/teachers and their classmates. A combined approach drawing on high mathematical, technological, and pedagogical competences is needed to analyze the international state of the art and to develop experimental practices for our national context.
4. **HPC Implementation of Data Science Techniques for Environmental Monitoring in the Reno, Lavino, and Samoggia Valleys (ref. Prof. Davide Palitta)**  
Nowadays, the increasing amount of data available thanks to continuous measurements and estimations asks for cutting-edge, highly-specialized techniques to represent big and heterogeneous data, along with sophisticated computational methods able to process it in real time. A clever blend of HPC resources and algorithmic advances is key to respond to these urgent challenges. This PhD project aims at achieving remarkable progress in data science techniques with a particular focus on their HPC implementation. One of the main goals will be to apply such schemes to environmental monitoring applications, like, e.g., hydrogeological instability, in order to improve the diagnostic and predictive capabilities of local public administrations. To this end, some of the benchmark data that will be employed throughout the PhD project will be provided by the Union of the municipalities of the Reno, Lavino and Samoggia valleys. The selected PhD candidate will spend a research period of at least 6 months at CINECA.
5. **Ecological transition of public administrations: stochastic optimization for the management of renewable sources (ref. Prof. Andrea Pascucci)**  
The proposed project aims to support the digital and ecological transition of public administrations through the management and optimization of renewable energy plants, focusing on the production of photovoltaic systems and the trend of energy prices. In particular, the project intends to address multi-objective optimization problems with stochastic inputs using machine learning techniques to improve the utility and reliability of forecasts. The goal is to ensure greater efficiency and costeffectiveness of public action, promoting the transition to sustainable energy sources and reducing greenhouse gas emissions.