Facultad de Ciencias Básicas

10 Años dm2a Doctorado en Modelamiento Matemático Aplicado

Programa de Doctorado
Modelamiento Matemático Aplicado

Academic Committee

Summary

The Doctorado en Modelamiento Matemático Aplicado, offered by the Universidad Católica del Maule (Talca, Chile) since 2016, is an academic program aimed at training researchers with competencies in interdisciplinary research, using mathematics as a methodological foundation for the study and modeling of natural, social, and technological phenomena of scientific interest.

The program is distinguished by:

1. **Interdisciplinary training grounded in mathematical rigor**, articulated through four research lines focused on understanding natural, social, and technological phenomena.
2. **Academic staff with an international trajectory**, characterized by high-impact scientific productivity and the successful acquisition of internally and externally funded research projects.
3. **Accreditation by CNA-Chile for 6 years (until November 2028)**, ensuring the quality of the training process and enabling access to national doctoral scholarships, international research stays, and participation in scientific conferences.

Duration and Curriculum

Duration: 4 years (8 semesters).

Competency-based curriculum structured around disciplinary, research, and general training activities:

- Advanced courses in mathematical modeling, numerical methods, and applied statistics.
- Training in ethical principles and good academic practices.
- English and scientific writing courses aimed at the effective dissemination of research outcomes.
- Research seminars focused on the development of the doctoral research project.
- Progressive development of the doctoral dissertation (2 years), with continuous academic supervision.
- Evaluation milestones: Qualifying Examination and Final Dissertation Defense.

Research Lines

1. **Public Health and Biomedicine:** Modeling the distribution, frequency, and control of factors associated with health and disease processes in populations.
2. **Pattern Recognition:** Theoretical models of machine learning and data analysis for solving complex technological problems.
3. **Silvoagricultural Systems:** Modeling phenomena in forestry, agronomy, and animal sciences with a sustainability-oriented approach.
4. **Ecological Systems:** Study of population abundance and distribution, biodiversity, and biological interactions among species and their environment.

Each research line is composed of researchers from the corresponding disciplinary context, together with mathematical modelers who provide the methodological foundation needed to ensure the rigor and coherence of Applied Mathematical Modeling within the program.

1 Graduate Profile

Graduates of the Doctorado en Modelamiento Matemático Aplicado will be capable of generating knowledge in the factual sciences and their associated technologies, with the purpose of broadening the understanding of phenomena underlying contemporary challenges and their potential solutions.

They are expected, within interdisciplinary teams or research networks, to participate in or lead projects that contribute to advanced human knowledge connected to relevant social, productive, and environmental problems of scientific interest at the national or global level, through mathematical modeling and the use of computational and statistical techniques.

The distinctive hallmark of the program's graduates will be the integration of their ability to work collaboratively, respect the ethical and scientific consensus of the institutional contexts in which they operate, and demonstrate socio-environmental responsibility in both their approaches and proposals.

2 General Objective and Specific Competencies

General Objective of the Program

To train researchers for the interdisciplinary creation of knowledge that supports solutions to scientific or technological problems, through a methodological use of the construction, analysis, and interpretation of mathematical models of natural or social processes.

Specific Competencies

- To theorize about natural, social, or technical phenomena of scientific interest through the construction, analysis, and interpretation of mathematical models within interdisciplinary research contexts.
- To analyze systems of meaningful mathematical objects using logical-deductive formalism, disciplinary knowledge, and representation or computational tools, in order to generate meaningful interpretations of the represented reality.

3 Research Lines

Public Health and Biomedicine: Major health challenges are associated with the emergence and persistence of diseases, intensified by insufficient control over key environmental and social determinants such as economic inequality and the consequences of climate change. Public Health and Biomedicine is a multidisciplinary research area aimed at understanding population-level, pathogenic, and environmental processes related to the development and spread of diseases of interest. This research line seeks to provide valid evidence to support the development or reformulation of protection and risk-reduction policies, according to the demographic, geographic, and cultural characteristics of communities and their territories. Mathematical models play a central role in this line, as they enable the detection of patterns characterizing the distribution, frequency, association, prediction, and control of factors and/or agents linked both to individual homeostasis and to the presence of disease in populations.



Dr. Luis Pastenes , lpastenes@ucm.cl, Coordinator



Pattern Recognition: The production of high-quality goods and services increasingly requires process optimization through the implementation of precise, non-invasive, and automated digital technologies and applications. Pattern Recognition is a discipline devoted to understanding and reproducing the complex coordinated activity of the human sensory organs and brain in identifying objects from the environment through the interpretation of information. In this context, this research line focuses on creating, refining, or adapting theoretical models of artificial learning and data analysis, and on how such improvements enable the solution of complex technological problems for regional and national industry. Mathematics provides the language and analytical argumentative methods necessary for communication and research in Pattern Recognition, while multiple scientific disciplines converge in this field, including engineering, psychology, neuroscience, and biology, among others.

Dr. Ruber Hernández, rhernandez@ucm.cl, Coordinator

Silvoagricultural Systems: The challenges posed by global climate change to food production and the forestry sector demand adaptive responses in productive systems. Silvoagricultural Systems directs its research toward the study of phenomena related to forestry, agronomy, animal production, and natural resources, addressing problems and proposing socially and environmentally sustainable solutions. This research line examines relevant phenomena by integrating knowledge and expertise from disciplines connected to environmental, social, and economic dimensions, adopting a systemic and holistic approach. Constructing mathematical models of phenomena within this line constitutes an important tool for the a priori evaluation of explanatory hypotheses, potentially complementing and/or justifying costly experimental efforts that contrast theoretical advances with empirical evidence.



Dr. Marcos Carrasco, mcarrasco@ucm.cl, Coordinator



Ecological Systems: Current conditions of global climate change, overexploitation of natural resources, and environmental pollution represent serious threats to biodiversity and sustainable development. Ecological Systems as a field of study is aimed at understanding population abundance and distribution, biological interactions among species, biodiversity, and the mutual adjustments and regulatory processes between living organisms and their environments. Research in this line integrates different disciplines depending on the level of organization and context addressed, with the objective of contributing fundamental ecological knowledge, conserving biological diversity, and safeguarding the health of the country's natural resources. Ecological systems are studied through the analysis of processes and causal structures regulating their biotic and abiotic components, where the anticipatory and predictive tools provided by mathematical modeling are fundamental.

Dr. Nelson Velásquez, nvelasquez@ucm.cl, Coordinator

4 Faculty

The academic staff of the Doctorado en Modelamiento Matemático Aplicado is composed of core faculty members and affiliated collaborators from different faculties and research centers of the Universidad Católica del Maule, consistent with the interdisciplinary nature of the program.

Faculty members hold international trajectories, demonstrate high-impact scientific productivity, and have experience in the acquisition and execution of internally and externally funded research projects.

4.1 Core Faculty Members

Nº	Name	Academic Degree	Email
Public Health and Biomedicine			
1	Erix Hernández Rodríguez	Doctor en Ciencias (Química-Física) y Doctor en Ciencias Médicas	ehernandez@ucm.cl
2	M. Beatriz Cancino Faure	Doctora en Biotecnología	bcancino@ucm.cl
3	Juan Pablo Gutiérrez Jara	Doctor en Modelamiento Matemático Aplicado	jgutierrez@ucm.cl
4	Rodrigo Gutiérrez Aguilar	Doctor en Modelamiento Matemático Aplicado	rgutierreza@ucm.cl
Pattern Recognition			
5	Ruber Hernández García	Doctor en Ciencias de la Informática	rhernandez@ucm.cl
6	Marco Mora Cofré	Doctor en Ciencias de la Computación	mmora@ucm.cl
7	Ricardo Barrientos Rojel	Doctor en Ciencias de la Computación	rbarrientos@ucm.cl
8	Sara Cuadros Orellana	Doctora Ciencia de los Alimentos	scuadros@ucm.cl
9	Carolina Marchant Fuentes	Doctora en Estadística	cmarchant@ucm.cl
10	Karina Vilches Ponce	Doctora en Ciencias de la Ingeniería con Mención en Modelación Matemática	kvilches@ucm.cl
Silvoagricultural Systems			
11	Marcos Carrasco Benavides	Doctor en Ciencias Agrarias	mcarrasco@ucm.cl
12	Enrique Mundaca Ortega	PhD in Ecology & Biodiversity	emundaca@ucm.cl
13	Rodrigo Andler Osorio	Doctor en Biotecnología	randler@ucm.cl
14	Sergio Espinoza Meza	Doctor en Ciencias Silvoagropecuarias y Veterinarias	espinoza@ucm.cl
15	Alejandro Rojas Palma	Doctor en Ciencias de la Ingeniería con Mención en Modelación Matemática	amrojas@ucm.cl
Ecological Systems			
16	Nelson Velásquez Soto	Doctor en Ciencias Mención Ecología y Biología Evolutiva	nvelasquez@ucm.cl
17	Felipe Moreno Gómez	Doctor en Ciencias Mención Sistemática y Ecología	fmoreno@ucm.cl
18	José Mesquita Neto	Doctor en Biología Vegetal	jmesquita@ucm.cl
19	Fernando Córdova Lepe	Doctor en Matemática	fcordova@ucm.cl
20	Moisés Bravo Gaete	Doctor en Matemáticas	mbravo@ucm.cl

4.2 Affiliated Faculty

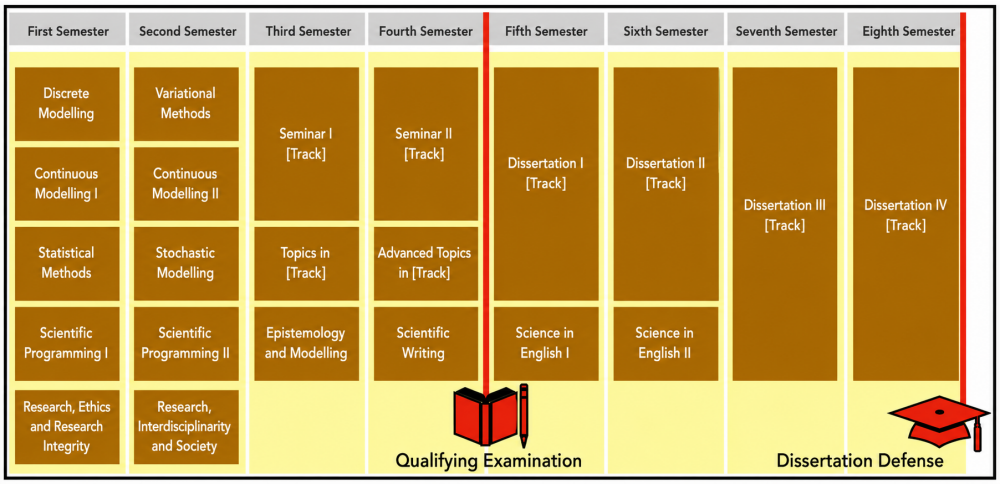
Nº	Name	Academic Degree	Email
1	Victor Osores Escalona	Doctor en ciencias aplicadas con mención en ingeniería matemática	vosores@ucm.cl
2	Leidy Lara Díaz	Doctora en ciencias aplicadas con mención en ingeniería matemática	lelara@ucm.cl
3	Diego Maldonado Montiel	Docteur en Informatique	dmaldonado@ucm.cl
4	Ledyz Cuesta Herrera	Doctora en Modelamiento Matemático Aplicado	lcuesta@ucm.cl
5	Felipe Lillo	Doctor of Philosophy	flillo@ucm.cl
6	Ariel Arencibia Rodríguez	Doctor en Ciencias Agrarias, Genética y Biología Molecular	aarencibia@ucm.cl
7	Diego Muñoz Campos	Doctor of Philosophy	dmunozc@ucm.cl
9	Luis Pastenes Opazo	Doctor en Ciencias Silvoagropecuarias y Veterinarias	lpastenes@ucm.cl
8	Gerard Olivar Tost	Doctor en Ciencias Matemáticas	golivar@ucm.cl

5 Curriculum

The training pathway of the Doctorado en Modelamiento Matemático Aplicado has a theoretical duration of four years (eight semesters), with an average time-to-degree of approximately nine semesters. The curriculum integrates disciplinary, research, and general training.

During the first year, students complete foundational mathematics courses with a theoretical-practical approach, focused on the construction, analysis, and interpretation of dynamic and statistical models in discrete and continuous time. Elements of spatiality, control, and stochasticity are also incorporated through high-performance analytical and computational tools, together with training in ethics and good academic practices, promoting interdisciplinary work.

From the second year onward, within one of the four research lines of the program, students deepen their disciplinary foundations (*Elements of [Research Line]*), actively participate in the weekly research seminar, and advance in the formulation of their doctoral project (*Seminar I–II [Research Line]*). The project is presented and defended in a public act (Milestone I: Qualifying Examination). This process integrates an epistemological perspective on interdisciplinary mathematical modeling and strengthens written and oral competencies necessary for the proper dissemination of future research outcomes.



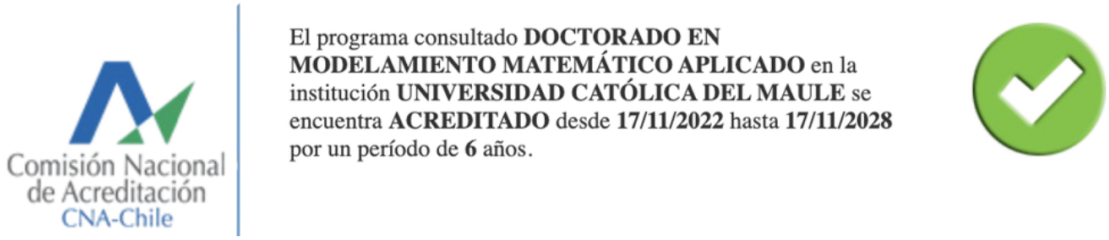
The Research Project (Doctoral Dissertation) is structured analogously to the cycle of application, execution, and closure of an externally funded research project, considering the allocation of resources for its development and the commitment to scientific productivity. This process unfolds through Dissertation I–IV courses, ensuring the progressive advancement of doctoral research (over two years), with continuous academic supervision.

This stage culminates in the submission of the Final Research Project Report, consisting of a scientific report of the results obtained. Once approved by the evaluation committee, the work must be orally presented and defended in a Public Defense.

6 Scholarships and Benefits

The Doctorado en Modelamiento Matemático Aplicado has been accredited by the National Accreditation Commission of Chile (CNA-Chile) from November 17, 2022 to November 17, 2028, for a six-year period, positioning it at the advanced level.

In addition to guaranteeing high-quality doctoral training, this accreditation allows students—once formally admitted or enrolled as regular students—to apply annually for the National Doctoral Scholarship of the National Agency for Research and Development (ANID). This scholarship includes funding for living expenses and tuition fees. Awardees may also apply for complementary benefits such as International Cotutelle Doctorates, Scholarship Extensions, Operational Expenses, and International Doctoral Internships.



7 Admission Requirements

- Completed and signed Application Form available in the Information section.
- EFSET Certificate.
- Official document certifying the award of a Master's degree, or a letter from the program director (or thesis supervisor) certifying the feasibility of graduation prior to the start of the academic year of admission.
- High-resolution images of National ID / Passport and Birth Certificate, as applicable by nationality.
- Official undergraduate (and, if applicable, graduate) transcripts, duly legalized and issued by the institution of origin, including grade conversion to the Chilean 1–7 scale.
- Certificate of undergraduate class ranking indicating the applicant's position within their graduating cohort and the total number of students, corresponding to the same degree submitted in the application.
- Two letters of recommendation from academics holding a Ph.D., attesting to the applicant's aptitude for graduate studies (sent to rgutierreza@ucm.cl).

- Statement of Purpose (maximum one page) addressing questions such as: Why do I want to enter the program? Why should I be admitted? What do I expect from the program? How do I envision my contribution to society after graduation?
- A one- or two-page document identifying a problem, research question, or area of interest connected to one of the program's research lines.

Admission preferably requires holding a Master's degree in Mathematics, Applied Mathematics, Mathematical Engineering, or related fields, whether national or international. Applicants with a Master's degree in basic sciences or engineering sciences may also apply, provided they demonstrate solid mathematical training and a clear connection with one of the program's research lines, as evaluated by the Academic Committee.

Exceptionally, applicants with outstanding academic backgrounds and scientific production in collaboration with core faculty members may be admitted by unanimous agreement of the Academic Committee and research line coordinators.

Additionally, the program offers one annual supernumerary position, allowing exceptional admission of outstanding students without a Master's degree. This position is intended for Bachelor's degree holders ranked within the top 10% of their graduating cohort, sponsored by a core faculty member, and who demonstrate research vocation through publications or verifiable scientific experience. Admission requires unanimous approval by the Academic Committee.

Information and Contact

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Dr. Nelson Velásquez	Research Track Coordinator	nvelasquez@ucm.cl
Dr. Moisés Bravo	Mathematical Training Coordinator	mbravo@ucm.cl
Ms. Claudia Quijada	Administrative Assistant	cquijada@ucm.cl

10 Años

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