Doctoral Program in Mathematics

■ Doctor of Philosophy in Science

Program Educational Objectives

The Doctoral Program in Mathematics cultivates researchers and university faculty members who can be internationally active with a wide perspective covering from pure to applied mathematics, and also social instructors in education and industry circles, etc. as well as highly specialized professionals who can apply mathematical knowledge into various areas.

Graduate Profile	Researchers who can be internationally active with a wide perspective covering from pure to applied mathematics, social instructors in education and industry circles, etc., and other human resources who can apply advanced mathematical knowledge into various areas.

Diploma Policy

The degree of Doctor of Philosophy in Science is commenced to those who have fulfilled the requirements for the completion of the Doctoral programs, as set out in the Graduate School Regulations of the University of Tsukuba and related university regulations, and who are deemed to have the following competences.

	Competences	Evaluation perspectives
Knowledge and Skills	1. Knowledge creation competence: Ability to create new knowledge that can contribute to future society	①Are there any research findings that can be considered new knowledge? ②Can we expect you to create knowledge that will contribute to future society?
	2. Management competence: Ability to plan and implement measures to identify and solve challenges from a higher perspective	①Can you make and implement long-term plans for critical challenges? ②Can you identify challenges, even in other areas of expertise, and solve them from a higher perspective?
	3. Communication competence: Ability to express the true nature of academic findings positively and clearly	①Can you explain the true nature of research content and specialized knowledge clearly and logically to researchers from different areas and to people other than researchers? ②Do you proactively share your findings with researchers and experts from your field of expertise and accurately answer questions?
	4. Leadership competence: Ability to have objectives get accomplished under your leadership	①Can you set attractive and compelling goals? ②Are you capable of building systems to realize goals and accomplish objectives as the leader?
	5. Internationality competence: Possession of a high level of awareness and motivation to be internationally active and contribute to international society	①Do you have strong awareness and motivation to contribute to international society and international activities? ②Have you obtained adequate linguistic skills for international information collection and action?
	6. Mathematical analysis ability: Ability to see the nature of issues from a higher (mathematical) perspective and analyze them mathematically	①If deep understanding was gained as to the important problems in various research realms ②If a good command of basic mathematical knowledge was gained

	Competences	Evaluation perspectives
Knowledge and Skills	7. Ability to carry out mathematical research: Ability to carry out research independently while setting up research tasks based on leading-edge advanced knowledge	①If problems are identified by oneself based on the leading-edge advanced knowledge in one's own area of expertise ②If research is carried out independently while a long-term plan is drawn up to work on its tasks
	8. Ability to solve mathematical tasks: Ability to work on tasks from a higher perspective and by using leading-edge advanced mathematical knowledge	①If the use of leading-edge advanced mathematical knowledge is actively tried ②If capable of seeing problems from a higher perspective and solving them under a long-term plan
	9. Information provision ability: Ability to provide research findings to the society through academic papers, academic lectures, etc.	①If sufficiently capable of debating on research with experts through academic papers or presentations in academia ②If one's research findings are clearly expressed to those from different areas and not just one's own area and if efforts to contribute to the society through mathematics are made
	10. Mathematical expressiveness: Ability to debate with experts in various areas inside and outside Japan	①If the ability to smoothly communicate with overseas researchers was gained ②If the ability to explain and understand was gained to make specialized debates with experts of various areas
Guidelines for Assessing Learning Outcomes	The evaluation of learning outcomes is conducted through achievement assessments based on the “Achievement Assessment Form”. This process objectively verifies and evaluates the acquisition of competences aligned with the degree conferral policy at each stage. The stages and methods of achievement assessment are outlined below. – The Doctor of Science candidate's possession of appropriate abilities is evaluated through the degree discussion session, conducted as part of the preliminary review, in addition to the degree thesis public hearing at the time of completion. – The evaluation of whether the candidate has produced research outcomes appropriate for a Doctor of Science degree is conducted through peer review of international academic papers. The final assessment of achievement in these areas is performed during the thesis examination and final examination.	

Evaluation Criteria for Degree Theses/ Dissertations	【Review board members】 Structure of thesis review board Set up with one chief reviewer and three or more sub-reviewers. 【Review method】 Prior to the receipt of a degree thesis, to determine the acceptance of the submission, the degree thesis is preliminarily reviewed. The dissertation review board administers dissertation review and the final exam or the confirmation of academic abilities. 【Review items】 1. The research theme must be clearly indicated with the presence of academic significance. 2. The preceding researches associated with the research theme must be appropriately presented. 3. The line of reasoning to reach the conclusion must be provided logically and clearly. 4. The degree dissertation must be academically contributory of high academic value in the area. 5. The thesis must have appropriate sentence expressions and thesis construction as a degree thesis. 【Level standards required for the degree thesis】 All of the above evaluation items must be met. The dissertation passes as a doctoral dissertation with the final exam or the confirmation of academic abilities included in the judgment.

Curriculum Policy

The curriculum is diversely organized with a system of education and research in the four areas of algebra, geometry, analysis and mathematics of information.

Curriculum Design Framework	Through fine research supervision according to each student's ability and the seminars in the areas of expertise, the curriculum is organized to train students to have a broad range of perspective from the foundation to application in the associated areas to leading-edge modern mathematics. – With Research in Algebra IIIA to VB, students gain advanced thinking ability for the grasping of algebraic structures. – With Research in Geometry IIIA to VB, students gain advanced thinking ability for the grasping of geometric structures. – With Research in Analysis IIIA to VB, students gain advanced thinking ability for the analysis of analytical structures. – With Research in Mathematics of Information IIIA to VB, students gain advanced thinking ability for mathematics of information. – With Internship in Mathematics III and Internship in Mathematics IV, students increase the abilities necessary for forming their future career paths.

Curriculum Design Framework	– With this area's Research IIIA, Research IIIB, Research IVA, Research IVB, Research VA and Research VB, students gain the above thinking abilities and at the same time gain the ability to carry out research while setting up research tasks independently, and the communication ability to grasp the problem awareness that those from different areas and not just one's own area have and express one's own specialized knowledge clearly to those from different areas and not just one's own area.
Teaching and Learning Methods	Carrying out leading-edge research under the advice of supervisory faculty members helps students develop the fundamental and applied abilities appropriate to a doctoral degree in science to grow to be a human resource who can conduct highly ingenious research.

Admission Policy

Desired Student Profile	He or she should possess mathematical knowledge as equivalent to a master's program completed in graduate school and have the great interest and motivation to research on mathematics and the high motivation to conduct research on leading-edge modern mathematics. In addition, we seek candidates who pursue to draw on their mathematical research abilities in the future to become a “researcher” , “educator” or “highly specialized professional” .
Student Selection Process	Selection places emphasis on the master's thesis content and post-enrollment research plan.

Learning Support Framework

Academic Support	– The graduate course “Special Research”, which provides research guidance for doctoral dissertations, is conducted with students giving presentations in the laboratory nearly every week. Within this framework, in addition to providing presentation guidance, close supervision is also given regarding research progress and time management. – By conducting the preliminary thesis review as a thesis seminar, students are provided an opportunity to receive presentation guidance from faculty members other than their primary advisor.
Opportunities for Peer Interaction	– Tea time is held before the start of the mathematics department's discussion sessions. Many students participate in these sessions, providing opportunities for interaction among students. – Graduate students serve as tutors in the “Mathematics Tutorial Workshop”, a learning support session for undergraduate students, creating opportunities for interaction between undergraduates and graduate students. – Similar events like “Mathematical Crossroads” and “RCMS Salon” are also held to provide opportunities for student interaction.

Opportunities for Student–Faculty Interaction	– Tea time is held before the start of the mathematics department's discussion sessions. Many faculty members participate in these sessions, providing opportunities for interaction between students and faculty. – Similar events such as “Mathematical Intersections” and the “RCMS Salon” are also held to provide opportunities for interaction between students and faculty.

Approaches to Assuring and Enhancing Educational Quality

- For research toward the Doctor of Science degree thesis, in addition to the thesis defense at the time of graduation, a preliminary thesis discussion session is held as part of the preliminary review process. This ensures all faculty members can confirm the academic value and provide feedback.
- At the Degree Evaluation Committee, the committee assesses students' learning outcomes and verifies the validity of the curriculum and the appropriateness of instruction.
- Course evaluation questionnaires and graduation surveys are conducted, with student feedback utilized to improve lectures.
- Competence achievement assessments are conducted twice: mid-term and upon completion. Students perform self-assessments, which are then verified by their academic advisors.