

## Doctoral Program in Intelligent and Mechanical Interaction Systems

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### ■ Doctor of Philosophy in Engineering

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#### Program Educational Objectives

The Doctoral Program in Intelligent and Mechanical Interaction Systems investigates engineering systems based on mathematical models representing the complex phenomena of humans, society, and nature, as well as theories in various fields such as mathematics, physics, and informatics working in harmony to contribute to the real world. This program cultivates high-level researchers and professionals capable of discovering and solving relevant problems from a broad perspective. Such individuals are characterized for possessing extensive knowledge, a robust ethical view, and advanced research skills in the field of engineering.

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<b>Graduate Profile</b>	Students develop advanced knowledge and skills in the field of Intelligent and Mechanical Interaction Systems, in addition to a wide range of engineering knowledge, academic abilities, and an ethical perspective appropriate for high-level researchers and professionals in the field of engineering. Therefore, students will be able to contribute to the development of academia and society by conducting cutting-edge research and producing original results that target and solve relevant problems in the field of engineering.
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## Diploma Policy

The degree of Doctor of Philosophy in Engineering 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
<b>Knowledge and Skills</b>	1. Knowledge creation competence: Ability to create new knowledge that can contribute to future society	① Are there any research findings that can be considered new knowledge? ② Can 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	① Can you make and implement long-term plans for critical challenges? ② Can 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	① Can 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? ② Do 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	① Can you set attractive and compelling goals? ② Are 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	① Do you have strong awareness and motivation to contribute to international society and international activities? ② Have you obtained adequate linguistic skills for international information collection and action?

	Competences	Evaluation perspectives
<b>Knowledge and Skills</b>	<p>6. Research skills: The ability to set cutting-edge research themes in the field of Intelligent and Mechanical Interaction Systems, conduct the research independently, produce original results, and present them internationally.</p>	<p>① To be able to set a cutting-edge research topic in the field of Intelligent and Mechanical Interaction Systems and develop advanced skills for carrying out the research.</p> <p>② To be able to carry out cutting-edge research and produce original outcomes in the field of Intelligent and Mechanical Interaction Systems.</p> <p>③ To be able to present and discuss research outcomes in English at international conferences.</p>
	<p>7. Specialized knowledge skills: The ability to develop the academic skills suitable for high-level researchers and professionals in the field of engineering, in addition to advanced knowledge and operational capability in the areas of Intelligent and Mechanical Interaction Systems</p>	<p>① To possess a wide range of expertise in the field of Systems and Information Engineering.</p> <p>② To acquire advanced and specialized knowledge in the areas of Intelligent and Mechanical Interaction Systems, and to apply such knowledge for research and problem-solving.</p>
	<p>8. Ethical skills: Ability to build an ethical and psychological view appropriate for high-level researchers and professionals in the field of engineering.</p>	<p>① To fully understand and comply with research and engineering ethics.</p> <p>② To obtain ethical knowledge of research involving human subjects and fully understand and implement the procedures necessary for such research.</p>

<p><b>Guidelines for Assessing Learning Outcomes</b></p>	<p>The evaluation of learning outcomes is conducted through achievement evaluation based on the Achievement Evaluation Criteria Table, in order to objectively assess and verify the level of competence acquisition in accordance with the Diploma Policy at each stage. The stages and methods of the achievement evaluation are as follows.</p> <ul style="list-style-type: none"> <li>- In Research in Intelligent and Mechanical Interaction Systems A, students will present their research outcomes, with performance evaluated based on the clarity, rigor and depth of their presentations.</li> <li>- In Research in Intelligent and Mechanical Interaction Systems B, students will present the results of their thesis dissertation for evaluation. Students who have published peer-reviewed papers may apply for early completion and undergo screening by the evaluation committee.</li> <li>- In Research in Intelligent and Mechanical Interaction Systems C, students participate in a preliminary evaluation of their thesis dissertation.</li> <li>- Achievement Evaluation is confirmed by the student's supervisor thorough review of the student's Achievement Evaluation self-check.</li> <li>- To be awarded the degree, students must pass a final examination of the Achievement Evaluation, conducted by the Achievement Review Board, which verifies the evaluation plan prepared by the supervisor in accordance with the Standards of Achievement Level Assessment.</li> </ul> <p>&lt;Criteria for the final examination&gt;</p> <ol style="list-style-type: none"> <li>1. (Generic competences) The student should have acquired knowledge creation skills, management skills, communication skills, leadership skills, and international skills appropriate for a graduate of the Doctoral Program in Intelligent and Mechanical Interaction Systems.</li> <li>2. (Research ability) The student should be able to demonstrate advanced research skills in the field of Intelligent and Mechanical Interaction Systems. They should be able to set up cutting-edge research topics independently, carry out the research, produce original outcomes, and present these results internationally.</li> <li>3. (Specialized knowledge) The student should have obtained knowledge and academic skills appropriate for high-level researchers or professionals in the area of engineering; and specialized knowledge and operational ability in the field of Intelligent and Mechanical Interaction Systems.</li> <li>4. (Ethical view) The student should have acquired an ethical perspective and ethical knowledge appropriate for high-level researchers and professionals in the area of engineering; and profound ethical reasoning related to the field of Intelligent and Mechanical Interaction Systems.</li> </ol>
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<p><b>Evaluation Criteria for Degree Theses/ Dissertations</b></p>	<p>A thesis is accepted if it satisfies all of the following criteria.</p> <p>&lt;Criteria for thesis examination&gt;</p> <ol style="list-style-type: none"><li>1. The dissertation should provide a clear description of the significance and positioning of the research in the engineering field; and should be based on the understanding of international research trends and previous research in related fields.</li><li>2. The dissertation should contain original research outcomes that contribute to the development of the engineering field and should be suitable for publication in an academic journal paper.</li><li>3. The reliability of the research results should be verified in detail.</li><li>4. The discussion of the research results should be reasonable, and the conclusions should be based on objective evidence.</li><li>5. The background, purpose, methods, results, discussion, and conclusions of the dissertation should be summarized and organized in a format suitable for a doctoral thesis.</li></ol> <p>&lt;Required standards for thesis submission, the system of review board members, evaluation method, and review items&gt;</p> <p>The doctoral dissertation review board shall consist of one chief reviewer and at least four sub-reviewers. The chief reviewer must be a faculty member of the degree program in charge of supervising the research, and at least two sub-reviewers must be members of the graduate school faculty.</p> <p>The review board must not be formed exclusively by faculty members from the degree program in Intelligent and Mechanical Interaction Systems. It should include at least one reviewer from a different category comprising other degree programs, different research groups, and external reviewers.</p> <p>The doctoral dissertation review board evaluates the thesis following the criteria for degree dissertation to provide a pass/fail judgment. The dissertation will be approved when it is deemed to have reached a doctoral dissertation level regarding the five evaluation items described above, including an oral exam in the judgment.</p>
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## Curriculum Policy

The curriculum is organized to cultivate researchers able to discover and solve problems relevant to our society from a broad perspective. Courses are designed to cover areas of system design, human-machine-robot systems, measurement and control engineering, communication systems, as well as a wide range of basic knowledge and ethical perspective in the areas of engineering, science, and technology.

<p><b>Curriculum Design Framework</b></p>	<p>The primary goal of the curriculum is to develop advanced research abilities in the field of Intelligent and Mechanical Interaction Systems, including general and specialized knowledge, ethical view, and research competences. The curriculum is supplemented, if necessary, by Degree Programs' Common Courses, Interdisciplinary Foundation Courses, and Graduate General Education Courses.</p> <ul style="list-style-type: none"> <li>- Students acquire the Competence of knowledge creation mainly through Special Research Courses including: Research in Intelligent and Mechanical Interaction Systems A, B, C, Research Paper Presentation Workshops (Research Paper Presentation Workshop in Intelligent and Mechanical Interaction Systems I, II and International Conference Paper Presentation Workshop in Intelligent and Mechanical Interaction Systems), and Collaboratory Research Workshops (Collaboratory Research Workshop in Intelligent and Mechanical Interaction Systems III, IV).</li> <li>- Management skills are obtained through Research in Intelligent and Mechanical Interaction Systems courses and Research Proposal Writing Workshops (Research Proposal Writing Workshop in Intelligent and Mechanical Interaction Systems III, IV).</li> <li>- Communication skills are trained through Research in Intelligent and Mechanical Interaction Systems courses, Research Proposal Writing Workshops, and presentation at academic conferences.</li> <li>- Leadership skills are gained mainly through Research in Intelligent and Mechanical Interaction Systems courses, Research Paper Presentation Workshops, Collaboratory Research Workshops, Research Proposal Writing Workshops, teaching assistant experience, and participation in extracurricular activities.</li> <li>- An international perspective is achieved through Research in Intelligent and Mechanical Interaction Systems courses, English workshops, and International Conference Paper Presentation Workshops.</li> <li>- Research skills are obtained through Research in Intelligent and Mechanical Interaction Systems courses, Research Paper Presentation Workshops, and Research Proposal Writing Workshops.</li> <li>- Specialized knowledge is accomplished through Research in Intelligent and Mechanical Interaction Systems courses, Research Paper Presentation Workshops, and Collaboratory Research Workshops.</li> <li>- An ethical view is gained mainly through Research in Intelligent and Mechanical Interaction Systems courses and e-learning programs on ethics.</li> </ul>
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<p><b>Teaching and Learning Methods</b></p>	<ul style="list-style-type: none"> <li>- After enrollment, students will be guided by their supervisors to identify socially and academically relevant research problems and think about how to solve them on their own.</li> <li>- Each student will learn independently more specialized knowledge and skills while working on their research tasks. In addition, by taking advantage of the multiple supervisor system students will be able to receive guidance from sub-supervisors of different areas of expertise beyond the boundaries of the degree program and develop their abilities to analyze problems from a broader perspective.</li> <li>- Students are instructed to present the obtained research findings at seminars and academic conferences and publish research papers in academic journals. Evaluation of the students' performance will provide hints to improve and further develop their research.</li> <li>- Concurrently, each student conducts an Achievement Evaluation self-check periodically. Therefore, students are encouraged to acquire the lacking knowledge or skills to complete the program successfully.</li> </ul>
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**Admission Policy**

<p><b>Desired Student Profile</b></p>	<p>We seek candidates who possess mathematical skills, English language skills, and mathematical thinking ability necessary for developing cutting-edge research. Students are expected to be able to acquire research skills, specialized knowledge, and the ethical view needed to contribute to academia and society as high-level researchers and professionals in the field of Intelligent and Mechanical Interaction Systems.</p>
<p><b>Student Selection Process</b></p>	<p>A variety of candidates are selected through internal admission selection, general entrance examination, and special entrance examination for working candidates. An oral examination is required regardless of the examination category.</p> <ul style="list-style-type: none"> <li>- The internal admission selection process allows candidates who are expected to complete the Master's Program in Intelligent and Mechanical Interaction Systems to proceed to the doctoral program. Such candidates are expected to include those who possess strong fundamental abilities and research skills and are expected to be employed by the Research Fellowship for Young Scientists by the Japan Society for the Promotion of Science (DC1 or DC2) and those suitable for early completion of the doctoral program.</li> <li>- The general entrance examination selection process allows candidates who possess a certain level of research skills and complementary abilities to join the doctoral program. Those candidates are expected to complete the program within the standard period.</li> </ul>

<p><b>Student Selection Process</b></p>	<p>– The special entrance examination for working candidates allows working applicants to join the doctoral program.</p> <p>This process evaluates the achievements and experience acquired as a functional member of society in addition to research skills and complementary abilities. This examination is conducted according to the Admission Policy and to the candidate's personal plan, which provides different alternatives such as completing the program while working, using the extension system which allows completing the course beyond the standard period to finish the program, or using the early completion program which allows finishing the program in one year.</p>
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**Learning Support Framework**

<p><b>Academic Support</b></p>	<p>To support students' independent and advanced learning in the Doctoral Program, multiple initiatives are implemented. The Achievement Evaluation self-check allows students to visualize their research progress and learning outcomes, enabling academic supervisors to provide targeted guidance. The Global Multi-Mentor System (GMMS) offers opportunities for interaction with external researchers, promoting multifaceted critique and discussion that advance the quality and rigor of student's research. The “Learning × Career” Hybrid Support System (LCHS) fosters students' motivation for research by facilitating exchanges with corporate researchers and alumni, while also supporting the development of specialized career paths alongside their Doctoral Program.</p>
<p><b>Opportunities for Peer Interaction</b></p>	<p>In the Doctoral Program, interaction among students is actively promoted to enhance learning motivation and elevate the quality of research. In graduate seminars, students present their research, engage in discussions with peers, and cultivate communication skills and critical thinking. Both the Global Multi-Mentor System (GMMS) and the “Learning × Career” Hybrid Support System (LCHS) are designed to engage multiple students simultaneously, fostering information exchange and mutual intellectual stimulation. Collectively, these activities strengthen peer effects, contributing to a more dynamic and collaborative research environment.</p>
<p><b>Opportunities for Student-Faculty Interaction</b></p>	<p>At the University of Tsukuba, structured opportunities for interaction with faculty members are provided to support the research activities of Doctoral Program students. In graduate seminars, students present their research outcomes and receive feedback and questions from faculty, thereby refining the focus, methodology, and logical structure of their studies. In group projects conducted in the Laboratory Work course, students collaborate under faculty supervision to address research tasks and develop practical research skills. The Graduate School Roundtable provides a forum for open exchange of opinions between faculty and students, facilitating consultations on both research activities and career planning. Furthermore, through the Global Multi-Mentor System (GMMS) and the “Learning × Career” Hybrid Support System (LCHS), faculty collaborate with external researchers and industry professionals to provide students with multidimensional guidance and mentorship.</p>

### Approaches to Assuring and Enhancing Educational Quality

To ensure the quality of education in the Doctoral Program and promote continuous improvement, multiple systems and mechanisms have been established. For newly appointed faculty members, Faculty Development (FD) programs provide support for enhancing teaching abilities, including guidance on educational content and instructional methods. In addition, regular faculty training sessions including FD focused on achievement evaluation, are conducted to further elevate the quality of educational activities. The Achievement Evaluation Committee evaluates students' learning outcomes and examines both the validity of the curriculum and the appropriateness of academic supervision. Furthermore, a PDCA Committee continuously monitors and improves all educational activities, incorporating feedback provided by industry representatives, obtained during poster presentation sessions. Through these coordinated efforts, the quality of education is maintained, and the framework for achieving the program's learning objectives is strengthened.