Doctoral Program in Engineering Sciences

Doctor of Philosophy in Engineering

Program Educational Objectives

In the diverse areas ranging from substances, materials, devices to measurement technologies, the Doctoral Program in Engineering Sciences is designed to cultivate outstanding researchers who base themselves on their sufficient fundamental abilities in science and possess the deep knowledge and rich creativity to address diverse problems in reality, as well as such researchers and highly specialized professionals who have the applied engineering ability and the ability to make use of it to create original technologies and cultivate potential younger talents.

Graduate Profile	Outstanding researchers who base themselves on their sufficient fundamental abilities in science and possess the deep knowledge and rich creativity to address diverse problems in reality in leading-edge engineering, as well as highly specialized professionals who possess the advanced research and development ability to contribute to the society <Subprogram in Applied Physics> Human resources who lead research, technological development and engineering practice at the world's level in the areas of applied instrumentation, nanotechnology and electronic devices founded on the natural science around physics; researchers who possess outstanding research and development abilities with rich creativity or highly specialized professionals with advanced specialized knowledge and abilities <Subprogram in Materials Science> Human resources who possess the research ability necessary as an independent researcher with the deep knowledge in the areas of expertise in materials engineering such as quantum physics of solid state, theoretical quantum physics and materials physics, and materials chemistry and biomaterials engineering; researchers capable of carrying out advanced research and highly specialized professionals possessing the advanced research ability to contribute to the society <Subprogram in Materials Science and Engineering> Researchers of the National Institute for Materials Science supervise research as Graduate School faculty members to train human resources in the areas of materials engineering, such as metal and ceramic materials engineering, nanomaterials engineering, organic and biomaterials engineering, engineering physics, and semiconductor materials engineering; researchers who have very creative, outstanding abilities in research and development and highly specialized professionals who possess advanced applied engineering ability and the ability to make use of it to contribute to various social issues as experts of materials engineering.

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
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. Fundamental engineering ability: Knowledge and academic abilities appropriate to researchers or highly specialized professionals in the areas of engineering	If a clear description of the nature of the research content and specialized knowledge is provided to the uninitiated or those from different areas and not just one's own area

	Competences	Evaluation perspectives
Knowledge and Skills	7. Basic academic abilities: Solid basic academic abilities indispensable for applied studies in the areas of engineering	If advanced mathematical knowledge and abilities widely used in engineering were gained
	8. Specialized knowledge: Advanced specialized knowledge required for applied studies in the areas of engineering and associated areas	If a wide range of specialized knowledge in the areas of engineering and the advanced techniques for conducting leading-edge research were gained
	9. Ethical view: High ethical view required of researchers or highly specialized professionals in the areas of engineering	If researcher ethics, engineer ethics, and human research ethics as well as formalities and/or procedures necessary for research were sufficiently understood
	10. Practical insight and problem-solving ability: Insight and problem-solving ability required to solve problems in practice in the areas of engineering and associated areas	①If leading-edge research tasks were appropriately set up and research was carried out with the accomplishment of ingenious results ②If the presentation and communication abilities to debate with experts in the world were gained
Guidelines for Assessing Learning Outcomes	<Subprogram in Applied Physics> Learning outcomes are evaluated by objectively confirming and evaluating them using the "Achievement Evaluation Table (Rubric)". Following the doctoral dissertation review, the final examination will be conducted via oral questioning according to the following guidelines: – During the final examination, oral questioning will assess the research objectives, methods, and progress outlined in the doctoral dissertation (special research), confirming the candidate's ability to apply knowledge, management skills, communication skills, and teamwork capabilities. – The final examination will include oral questioning in a foreign language to confirm the candidate's ability to provide appropriate responses. – The final examination will include an oral examination on fundamental engineering skills, basic academic abilities, and specialized knowledge to evaluate the candidate's ability to provide appropriate responses. – The final examination will include an inquiry regarding research ethics to confirm the candidate's thorough understanding. – The final examination will include an oral examination on issues within the engineering field to confirm the candidate's ability to provide appropriate responses.	

Guidelines for Assessing Learning Outcomes	<Subprogram in Materials Science> The evaluation of learning outcomes is carried out using an Achievement Evaluation Sheet, which serves as a rubric to systematically verify and assess the acquisition of competences as defined by the diploma policy at each stage of the program. Each year, presentations given in the Doctoral Seminar are evaluated by the primary advisor along with several faculty members to determine the progress and level of competence acquisition. In the final year, a public presentation of the doctoral dissertation is conducted, followed by a comprehensive review of the research by a Thesis Examination Committee consisting of the primary advisor and at least three sub-examiners. This process concludes with a final achievement assessment, which serves as the final examination for completion of the doctoral program. <Subprogram in Materials Science and Engineering> – Learning outcomes will be assessed by confirming and evaluating the level of mastery of competences based on the degree awarding policy using an “Achievement Assessment Table (rubric)”. – Through Research in Materials Science and Engineering IA, I B, IIA, IIB, IIIA, and IIIB and Seminar in Materials Science and Engineering I and II, students' research achievements, basic skills, expertise, and research planning ability are evaluated from a variety of perspectives. – During the dissertation defense, including the preliminary examination, the content of the doctoral dissertation will be evaluated by a chief supervisor and three or more co-supervisors. At least one supervisor will be invited from outside this subprogram, and the evaluation will be conducted from a broad perspective. In addition to written review, the final evaluation will include a public oral presentation, ensuring a world- level of research, the high quality of the dissertation, and objectivity of the evaluation.

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】 Preliminary review, thesis review and the final exam are administered in accordance with the method defined by each Subprogram. 1) Subprogram in Applied Physics Prior to the receipt of a degree thesis, to determine the acceptance of the submission, the degree thesis is preliminarily reviewed. The thesis review board administers thesis review and final exam. 2) Subprogram in Materials Science 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 does an evaluation to see if the student possesses the academic abilities and knowledge that become the foundations of all areas of materials engineering and the specialized knowledge of any of the areas of materials engineering and has successfully carried out research with outstanding results while solving the tasks that he/she independently set out in any of the areas of materials engineering through the review of dissertation and the final exam or the confirmation of academic abilities. 3) Subprogram in Materials Science and Engineering Prior to the receipt of a degree thesis, to determine the acceptance of the submission, the degree thesis is preliminarily reviewed. The thesis review board administers thesis review and final exam. 【Review items】 1. The setup of research tasks and the selection of research methods must be appropriate. 2. The interpretation of results and the development of line of reasoning before reaching the conclusion must be appropriate and unequivocal. 3. The preceding researches related to research tasks must be grasped and understood with appropriate appraisal and citation. 4. With adherence to research ethics, the obtained results and conclusions must be verifiable by third parties. 5. Academic significance must be internationally identifiable in the outcomes of research tasks.

Evaluation Criteria for Degree Theses/ Dissertations	【Level standards required for the degree thesis】 All of the above evaluation items and the criteria defined by each Subprogram must be met. 1) Subprogram in Applied Physics Before a dissertation review board is opened, one first-author dissertation must be available to be published or posted in an academic journal. The dissertation passes as a doctoral dissertation with the final exam included in the judgment. 2) Subprogram in Materials Science The curriculum objectives defined in article 2, clause 3 of the school rules of Graduate Education at University of Tsukuba must be fulfilled. With this fulfillment, the dissertation passes as a doctoral dissertation with the final exam or the confirmation of academic abilities included in the judgment. 3) Subprogram in Materials Science and Engineering A dissertation for degree grant meeting all of the above evaluation items passes as a doctoral dissertation with the final examination included in the judgment.

Curriculum Policy

The curriculum is designed to cultivate researchers and highly specialized professionals in the areas of applied instrumentation, nanotechnology and electronic devices, and the areas of quantum physics of solid state, theoretical quantum physics, materials physics, and materials chemistry and biomaterials engineering, etc., and the areas of materials engineering such as metal and ceramic materials engineering, nanomaterials engineering, organic and biomaterials engineering, engineering physics, and semiconductor materials engineering.

Curriculum Design Framework	The curriculum is organized to help students gain specialized knowledge and abilities on the world's high level standards in the areas of engineering. <Subprogram in Applied Physics> – Research is supervised from multifunctional points of view by way of a system of multiple supervisory faculty members. With this, the curriculum cultivates solid fundamental abilities and the deep specialized fundamental abilities founded on them and seeks to help students develop practical insight and the ability to act as well as the ability to solve problems. – In the seminars opened for Research in Applied Physics, students are mandatorily required to make presentations to a wide variety of audiences from different areas and not just one's own area. For the presentations, students are encouraged to use English to develop the presentation and communication abilities that allow them to debate with experts in the world. – With internship, overseas research dispatch, etc., students learn to develop a broad point of view and also the international insight to prepare them to be active worldwide.

Curriculum Design Framework	<Subprogram in Materials Science> – The Subprogram is formed by the four areas of “quantum physics of solid state”, “theoretical quantum physics”, “materials physics” and “materials chemistry and biomaterials”. However, the subjects that students should take to complete the Subprogram are only the “Research IIIA, IIIB, IVA, IVB, VA and VB” (18 credits in total), which are the required subjects of each area. In these subjects, in addition to the research activities according to each student's theme for doctoral dissertation creation, students are required to make a research presentation once a year in “Doctoral Program Seminar”, in which the students and faculty members in the major participate, and use English in this presentation to be trained to present research progress and have debates in English. – By this, students gain advanced specialized knowledge and the insight, problem-solving ability and communication ability required to actually solve problems. – To gain a wide perspective not limited to the deep specialized knowledge in specific areas, students are encouraged to take Major Subjects in the Master's Program, specialized subjects of other Programs or Courses, and Graduate General Education Courses. <Subprogram in Materials Science and Engineering> – Students learn under an international and intellectually stimulating research environment at a materials research institute. The curriculum is organized to develop specialized knowledge, basic knowledge in associated areas, the insight that enables students to draw up and set up research plans for new proofs of concept, skills of experimentally or theoretically carrying out drawn and set up research plans, high ethical view in research activities, and the English communication ability capable of internationally providing research outcomes through academia or paper presentations and capable of open and natural debates with overseas researchers. – As subjects that should be taken to achieve this commitment, the curriculum offers “Research IA and IB”, “Research IIA and IIB” and “Research IIIA and IIIB” (18 credits in total), as well as “Seminar I” and “Seminar II” (2 credits in total). – In “Research” which is pursued under a leading and international research environment, students are engaged in advanced research activities for doctoral dissertation creation. – In “Seminar”, students are trained to present research progress and have debates in English. In addition, to gain a wide range of knowledge in the areas of engineering, students are encouraged to take the Master's Program subjects “Nanomaterials I” and “Nanomaterials II” in which faculty members provide discussion of their respective area of research.

Teaching and Learning Methods	Students take special research subjects to meet the fundamental abilities indispensable for the understanding and expansion of the advanced engineering areas of specialty and the necessity of organizing a degree dissertation containing the world's level outstanding research outcomes appropriate to a doctoral degree. <Subprogram in Applied Physics> – Through “Research in Applied Physics IIIA, IIIB, IVA, IVB, VA and VB”, students gain the fundamental abilities indispensable for the understanding and expansion of the advanced areas of specialty in the areas of applied instrumentation, nanotechnology and electronic devices, as well as the highly specialized fundamental abilities required of these areas' researchers or highly specialized professionals, practical insight and ability to act, wide perspective, problem-solving ability, and the presentation and communication abilities to debate with experts in the world. <Subprogram in Materials Science> – Through “Research IIIA, IIIB, IVA, IVB, VA and VB” in the four areas of “quantum physics of solid state”, “theoretical quantum physics”, “materials physics” and “materials chemistry and biomaterials”, students gain the abilities to set up tasks in their own right, then independently carry out research and understand the significance, outcomes and position of the research theme as well as the ability to provide information in English. <NIMS Subprogram in Materials Science and Engineering> – In “Research in Materials Science and Engineering IA, IB, IIA, IIB, IIIA and IIIB”, students are engaged in the world's leading edge research and development in the areas of metal and ceramic materials engineering, nanomaterials engineering, organic and biomaterials engineering, engineering physics and semiconductor materials engineering, and thereby gain the high fundamental abilities and ethical view in research activities as well as the advanced specialized knowledge in the area, the skills to carry out research plans and the ability to solve tasks. – In “Seminar in Materials Science and Engineering I and II” , students present their respective researches and have debates in English and thereby gain the ability to internationally present research outcomes and the communication ability.

Admission Policy

Desired Student Profile	We seek candidates who have interests in engineering sciences, the robust disciplinary bases gained in the master's program, sufficient communication ability, extensive and deep curiosity, strong mental capability that spares no effort to make their purposes, high ethical view, deep long-range perspective, and outstanding foresight.
Student Selection Process	The base parameters for the selection of candidates are basic academic abilities and basic knowledge as well as the deep insight based on them. Those who have the motivation and concentration for carrying out research proactively and enthusiastically are selected through an oral exam based on the master's thesis content and the post-enrollment research plan.

Learning Support Framework

Academic Support	<Subprogram in Applied Physics> – A multiple-supervisor system is in place to ensure objectivity in research guidance and to provide a framework for addressing diverse consultation needs. – A required graduate seminar for first-year doctoral students is offered. This provides an opportunity to present one's own research and listen to others' presentations, enabling students to objectively review their research and supporting its deepening. <Subprogram in Materials Science> Through a system of multiple academic advisors, the program ensures the objectivity of research supervision and provides a structure that enables students to seek guidance on a wide range of academic and research-related issues. It offers opportunities for students to participate in research presentation meetings, with financial support for travel expenses, encouraging them to present their work and objectively review their own research approaches, thereby fostering the further advancement of their studies. Intensive courses are provided to enhance students' skills in academic writing and English presentation. In addition, to broaden their perspectives and deepen their knowledge, the program organizes Materials Engineering Seminars, inviting speakers from both within and outside the university. <Subprogram in Materials Science and Engineering> All students must present their research in English at the Materials Science and Engineering Seminar once a year. The presentation is evaluated by all faculty members in the subprogram to find whether the presentation demonstrates the level of expertise appropriate for a doctoral degree, whether it addresses social issues, whether the student has the expertise in the field of materials science and has the communication skills to discuss in English.

Opportunities for Peer Interaction	<Subprogram in Applied Physics> – We offer a required graduate seminar for first-year doctoral students. This seminar incorporates a mechanism into the curriculum that promotes exchange opportunities among students across grades and organizations. Students present their own research, listen to others' presentations, and engage in Q&A sessions. – We have created a system that continuously generates opportunities for peer learning through teaching assistantships (TAs) for undergraduate lectures and experiments. – Student gatherings held at the Faculty of Science provide opportunities for students to interact across disciplines. <Subprogram in Materials Science> The program integrates opportunities into the curriculum for students to participate in research presentation meetings beyond their own academic year. Through Q&A sessions and discussions at these events, students are encouraged to engage with peers from different cohorts, fostering interaction and collaboration across year levels. In addition, by implementing a Teaching Assistant (TA) and tutor system, as well as promoting student-led projects, the program creates a sustainable framework that continuously generates opportunities for peer learning. Furthermore, it provides occasions for interdisciplinary interaction by encouraging participation in student gatherings organized by academic institutes and research centers, enabling students to exchange ideas and build networks across diverse academic fields. <Subprogram in Materials Science and Engineering> A social meeting is held after the student seminar to encourage interaction among students. In addition, poster presentation opportunities are provided for master's students to encourgage their interaction with doctoral students.

Opportunities for Student–Faculty Interaction	<Subprogram in Applied Physics> – Student gatherings held at the Faculty of Science provide opportunities for students to interact across disciplines. – In the graduate seminar, students present and engage in Q&A sessions not only with their primary and secondary advisors but also in front of other faculty members, facilitating interaction with both their advisors and other faculty. – An annual graduate student-faculty discussion meeting is held to promote interaction between students and faculty. <Subprogram in Materials Science> The program provides opportunities for students to engage with faculty members from different areas of expertise through gatherings organized by academic institutes and research centers. All faculty members involved in the degree program participate in events such as the master's thesis presentation meeting, creating a setting where students can interact and exchange ideas not only with their own advisors but also with other faculty members. In addition, an annual meeting is held to promote open dialogue and strengthen communication between students and faculty. <Subprogram in Materials Science and Engineering> A social meeting is held after the student seminar to promote interaction between faculty and students.

Approaches to Assuring and Enhancing Educational Quality

<Subprogram in Applied Physics>

– By having all faculty members participate in the doctor's thesis presentation meeting, the program ensures that the quality of education is thoroughly reviewed. Any areas identified for improvement are then discussed by the program's steering committee, and necessary actions are taken to enhance the overall educational program.
– Questionnaires are conducted after lectures (specialized subjects, specialized foundation subjects, etc.) to inform verification and improvement.
– Syllabus checks are conducted annually, primarily by academic affairs committee members. Quality is ensured by prompting faculty to make revisions or improvements as necessary.

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