*This document is an English translation of the 2027 Guide to Entrance Examination in Japanese. The Japanese version shall be the authorized version; the English translation for reference only and includes the additional information for international students.

2027 Guide to Entrance Examination

Graduate School of Engineering,
The University of Tokyo

Department of Nuclear Engineering and Management

Master's Program, Doctoral Program

(Application Schedule B)

Contact address:

Department of Nuclear Engineering and Management
Graduate School of Engineering, the University of Tokyo
7-3-1, Hongo, Bunkyo-ku, Tokyo 113-8656, Japan

Email: nyushijimu@n.t.u-tokyo.ac.jp
Website: https://www.n.t.u-tokyo.ac.jp/prospective

(Notice) When the “Guide to Applicants” and “Guide to Entrance Examination” changes, the department will inform the possible applicants in the Graduate School website and the department website. Please be sure to regularly check it when making the application.

Graduate School of Engineering:

https://www.t.u-tokyo.ac.jp/study-at-utokyo/soe/apply/guideline

Department of Nuclear Engineering and Management:
https://www.n.t.u-tokyo.ac.jp/prospective

1. Department of Nuclear Engineering and Management

The guide to entrance examination (this document) contains important information for those who are going to take an entrance examination of the Department of Nuclear Engineering and Management (Application Schedule B). This is a supplementary document to the “Guidelines for Applicants to the 2027 Master’s / Doctoral Program Graduate School of Engineering, the University of Tokyo.” **Please read both documents carefully** before submitting your application. Detailed information about the Department of Nuclear Engineering and Management can be found on the department’s website.

The entrance examination is conducted for the Master’s program and the Doctoral Program. This guide provides information about subjects, schedules and other related materials.

After entering, the students will be affiliated with their academic supervisor’s research laboratory. You can find the brief introduction of faculty members in the later part of this guide. Note that no students of master’s program will be accepted in some laboratories in the Application Schedule B.

The guidance to applicants will be held online. Introduction of Department of Nuclear Engineering and Management, an overview of the entrance examination, and introduction of laboratories of the department will be presented. Q&A sessions and individual consultations will be also held. Detailed information is available on the department web site.

If you have any questions or need further information about the examination, please contact us via e-mail at: nyushijimu@n.t.u-tokyo.ac.jp

The period of application:

All application data should be uploaded to the designated upload site.
Upload period of application documents is from Friday, November 27, 2026 to Thursday, December 3, 2026, 15:00 (JST).

Note: Examination results used in the admissions selection process may be used to review and improve future admissions procedures and education at the University of Tokyo.

2. Master's Program

2-1. Examination subjects

Foreign language - English

Please submit the official score of TOEFL (TOEFL iBT, or TOEFL iBT Home Edition) or TOEIC (L&R).

[How to submit]

TOEFL iBT/TOEFL iBT Home Edition: Follow the instruction found in "FY 2027 Graduate School of Engineering Entrance Examinations Guidelines for Submission of TOEFL Scores".

TOEIC L&R: Upload a Digital Official Score Certificate or a scanned copy of a paper-based Official Score Certificate for a TOEIC test taken in January 2025 or later to the online application system. If you upload the Digital Official Score Certificate, register the URL of the Digital Official Score Certificate to the WEB Application System. If you upload the scanned Official Score Certificate, send the original Official Certificate to the Administration Office of the Department of Nuclear Engineering and Management by the submission deadline.

[Submission Deadline]

Tuesday, January 19, 2027.

The deadline for submitting TOEFL/TOEIC scores is strictly enforced.

Written examination

Written examination will be conducted on campus (The University of Tokyo, Hongo Campus).

Mathematics

※3 problems from the fields of "Differential equation", "Linear Algebra", and "Probability, Statistics and other".

A reading comprehension examination

Oral examination

Applicants will be given about 20 minutes for an interview about their basic knowledge and motivation for research, and so on.

2-2. Examination schedule

<table>
<tr><th colspan="2">Subject</th><th>Date & Time</th><th>Venue</th></tr>
<tr><td>Foreign language</td><td>English (TOEFL or TOEIC)</td><td>-</td><td>-</td></tr>
<tr><td rowspan="2">Written examination</td><td>Mathematics</td><td>January 22 (Fri.)
10:00 - 12:00</td><td rowspan="3">It will be indicated on the exam admission card which will be sent after you have applied</td></tr>
<tr><td>Reading Comprehension</td><td>January 22 (Fri.)
13:30 - 15:00</td></tr>
<tr><td colspan="2">Survey of preferred research laboratory, guidance for oral examination</td><td>January 22 (Fri.)
15:00-15:20</td></tr>
<tr><td>Oral examination</td><td></td><td>January 23 (Sat.)</td><td>Noticed in the guidance for oral examination</td></tr>
</table>

- Examination dates, times, or locations are just tentative and might be changed. Please be sure to check the department website.
- Items to bring to written exam.: Exam admission card, black pencils (or black mechanical pencils), an eraser, a pencil sharpener (a desktop type is not allowed), mechanical pencil leads, a watch (watches with functions other than time measurement are not allowed). The bringing of ballpoint pens is not permitted.
- Items to bring to oral exam.: Exam admission card.

2-3. Others

(1) Admission period
The successful applicants enroll the Master's Program from April 2027.

(2) Consultations with faculty:
If you need to ask about research fields of the Master's Program, you can ask faculty. You can find a contact address on the faculty member page of the department website.

(3) Research laboratory affiliation:
After being accepted, students will be affiliated with one of the research laboratories according to their preference and entrance examination scores. The results of the assignment will be notified via document or e-mail after the announcement of acceptance, and **we will not respond to inquiries regarding assignment results**.

(4) Past written examination:
Sample examination questions for written examination are available.

A reading comprehension examination: You can pick it up at the office of Department of Nuclear Engineering and Management or request it by postal mail. If you wish to receive it by postal mail, please request it using the following web form:
https://forms.gle/eFS2wtCMcckT2di59.

Mathematics: You can refer the past examination of School of Engineering:
https://www.t.u-tokyo.ac.jp/study-at-utokyo/soe/apply/past-question
Please note that the field of problems are different.

(5) Scholarships:
There are several scholarship programs and international study programs available at the School of Engineering. You can also find further information on the website of OIS (Office of International Students of School of Engineering).
OIS: https://ois.t.u-tokyo.ac.jp/index.html

(6) Other:
If you have any further questions or concerns about the entrance examination, please contact the office of the Department of Nuclear Engineering and Management by e-mail (nyushijimu@n.t.u-tokyo.ac.jp).

3. Doctoral Program

3-1. Examination subjects

Foreign language - English

Applicants who have completed or are expected to complete a master's program of the University of Tokyo, do not have to take this examination.

Please submit the official score of TOEFL (TOEFL iBT, or TOEFL iBT Home Edition) or TOEIC (L&R).

[How to submit]

TOEFL iBT/TOEFL iBT Home Edition: Follow the instruction found in “Y 2027 Graduate School of Engineering Entrance Examinations Guidelines for Submission of TOEFL Scores”.

TOEIC L&R: Upload the Digital Official Score Certificate or Scanned paper-based Official Score Certificate to the WEB Application System. If you upload the Digital Official Score Certificate, register the URL of the Digital Official Score Certificate to the WEB Application System. If you upload the scanned Official Score Certificate, send the original to the Administration Office of the Department of Nuclear Engineering and Management.

[Submission Deadline]

Tuesday, January 19, 2027.

The deadline for submitting TOEFL/TOEIC scores is strictly enforced.

Written examination

Written examination will be conducted on campus (The University of Tokyo, Hongo Campus).

Applicants who have completed or are expected to complete a master's program of the School of Engineering, the University of Tokyo, do not have to take this examination.

Mathematics

※3 problems from the fields of “Differential equation”, “Linear Algebra”, and “Probability, Statistics and other”.

A reading comprehension examination

Oral examination

Applicants will be given about 35 minutes (20 minutes of presentation + 15 minutes of an interview) for an oral examination. In the presentation, you must explain your master’s thesis, or research achievement that can be alternative to your master’s thesis. You are also supposed to describe your research plan after entering the Doctoral Program.

3-2. Examination schedule

Subject		Date & Time	Venue
Foreign language	English (TOEFL or TOEIC)	-	-
Written examination	Mathematics	January 22 (Fri.) 10:00 - 12:00	It will be indicated on the exam admission card which will be sent after you have applied
	Reading Comprehension	January 22 (Fri.) 13:30 - 15:00	
Oral examination		January 25 (Mon.)	Announced after written examination

- Examination dates, times, or locations are just tentative and might be changed. Please be sure to check the department website.
- Items to bring to written exam.: Exam admission card, black pencils (or black mechanical pencils), an eraser, a pencil sharpener (a desktop type is not allowed), mechanical pencil leads, a watch (watches with functions other than time measurement are not allowed). The bringing of ballpoint pens is not permitted.
- Items to bring to oral exam.: Exam admission card, Mobile PC (for presentation).

*Note :
All applicants must submit the document (a) and (b) before the examination:

(a) One copy of a summary of your master's thesis or alternative research achievement
・It should not exceed 4 pages of A4 printing including figures and tables.

(b) One copy of master's thesis or documents which expressly provide alternative research achievement to the master's thesis. For working professionals, a copy of research paper may be acceptable, but note that the submission will be evaluated from the perspective of being equivalent to a master's thesis. Fragmented description of work or achievements as a team member will not meet the perspective of examination.

You have to upload the electronic files (PDF file) of document (a) and document (b) no later than ***January 18 (Mon), 2027***. The upload destination will be notified on the department website.

For the presentation, you can use presentation materials created with Microsoft PowerPoint etc. If you do not use presentation materials for PC projector, you can use supplemental material for your presentation. In that case, please let us know at the department office by e-mail (nyushijimu@n.t.u-tokyo.ac.jp) by ***December 18 (Fri)***.

3-3. Others

(1) Admission Period:
Applicants admitted under Application Schedule B will enroll in April 2027.

(2) Consultations with faculty:
Applicants for the Doctoral Program **must discuss the research field with prospective academic supervisor** before the application.

(3) Admission of working professionals:
Working professionals, which are employed as regular staff of a research institution or a company, may admit to the university while still being employed. The working professionals are required to submit a Letter of Approval in any format. The certifier may be any supervisor, regardless of position.

(4) Past written examination:
Sample examination questions for written examinations are available.

A reading comprehension examination: You can pick it up at the office of Department of Nuclear Engineering and Management or request it by postal mail. If you wish to receive it by postal mail, please request it using the following web form:
https://forms.gle/eFS2wtCMcckT2di59

Mathematics: You can download via webpage of School of Engineering:
https://www.t.u-tokyo.ac.jp/study-at-utokyo/soe/apply/past-question

(5) Scholarships:
There are several scholarship programs and international study programs available at School of Engineering. You can also find further information on the website of OIS (Office of International Students of School of Engineering.)
OIS: http://ois.t.u-tokyo.ac.jp/index.html

(6) Transcripts for undergraduate courses or equivalents
Applicants who graduated from a faculty other than Faculty of Engineering, The University of Tokyo must submit transcripts of their undergraduate academic records (including the liberal arts curriculum) at the time of application. However, those who have completed (or will complete) the master program of the School of Engineering, The University of Tokyo are not required to submit them.

(7) Other:
If you have any further questions or concerns about the entrance examination, please contact the office of the Department of Nuclear Engineering and Management by e-mail (nyushijimu@n.t.u-tokyo.ac.jp).

4. Introduction of the faculty members and their research

The following is a list of faculty members and outline of their research. Please visit the department's website and check also their laboratory's website, faculty's theses etc. Post-graduate students of our department will be supervised by one of the faculty members below.

Hiroaki ABE (Professor)

Nuclear Materials, Fuels and Related Discipline

Development of materials and related analysis techniques are indispensable for the expected solutions for the safe design and operation of nuclear power plants. We deal with the research and development of materials for fusion reactors, advanced fission reactors (Generation IV), and light water reactors (LWRs) including Accident Tolerant Fuels (ATFs). Our main targets are to reveal the fundamental mechanism of the degradation process under extreme environments, such as irradiation, corrosion, and hydrogenation, in Fe-based and Zr-based alloys. Developments in high-performance materials and new testing methods are also of our interest. The following techniques are currently applied. (a) Microscopy like TEM, HVEM, TEM-accelerator, SEM/EBSD, etc.; (b) mechanical tests like advanced expansion-due-to-compression (A-EDC) test, tensile, creep, and nano-hardness, etc.; and (c) computer simulations like FEM and MD.

[Fission, Fusion, Nuclear materials, Nuclear fuels, Extreme environment, Degradation mechanism, Radiation effects]

*No master's program students are acceptable in Application Schedule B.

Kazuyuki DEMACHI (Project Professor)

Nuclear AI Engineering

Japan's nuclear industry has accumulated extensive data over many years for maintenance, safety measures, and stable plant operation. Leveraging these data assets gives the industry strong potential to become a central hub for an AI-driven industrial revolution in Japan. However, at present, although individual AI technologies are highly advanced, development efforts remain sporadic—often limited to simply replacing existing technologies with AI.

The Demachi Laboratory has launched the field of "*Nuclear AI Engineering*" with the aim of developing AI technologies that are truly essential for the future of nuclear energy.
A defining feature of the laboratory's approach is the heterogeneous fusion of four types of AI—recognition, prediction, control, and generation—to create entirely new AI models.

Recently, with the aim of enabling the introduction of online maintenance in nuclear power plants, the laboratory has been developing:

① Inverse estimation AI models for failed plant equipment (recognition + generation)

② Normal recovery operation AI models for plant abnormalities (prediction + control)

③ Work-support information presentation AI models (recognition + generation)

④ Maintenance documentation generation AI models (recognition + generation)

Furthermore, to strengthen physical protection systems against evolving and expanding nuclear security threats, the laboratory is developing:

⑤ Malicious-behavior detection AI models for nuclear security (recognition + generation)

⑥ Scenario-generation AI models for BDBT (Beyond Design Basis Threat) events (recognition + generation)

[Heterogeneous AI fusion, Online maintenance, Enhancement of nuclear security]

Yasumasa FUJII (Professor)

Energy systems analysis for policy and technology assessment

Fujii laboratory has been working on the research topics of the feasibility analysis of various alternative energy supply technologies, and policy evaluation for international energy security and environmental issues using a global energy system model built with large-scale mathematical programming on the computers. Moreover, research topics of energy management, such as institutional design of deregulated electricity markets and optimal strategy planning of energy procurement under uncertainty, have also been investigated using variety of analytical techniques of stochastic dynamic programming, financial engineering, and multi-agent simulation with reinforcement learning.

In Fujii laboratory, since we try to find the solutions for the energy problems of 100 years and for the social system which is not realized yet, we welcome students who have the interest to learn various fields, and those who have strong imagination to consider the future of foreign countries.

[Energy economic systems, Technology and policy assessment, Optimization, Stochastic programming]

*No master's program students are acceptable in Application Schedule B.

Shuichi HASEGAWA (Professor)

Pioneering New Engineering through Quantum Control Technology

The technology of the interaction between matter and light—such as laser radiation and X-rays—has undergone remarkable advancement. A prominent example is the realization of quantum computers using ion traps, which quantum-mechanically control the internal states and motion of ions; further development in this field is highly anticipated. Our laboratory has been performing research in the following areas:

- Ion Trap Technology

To advance ion-trap quantum computing, expanding the number of quantum bits (qubits) is a critical requirement. Consequently, we are researching fabrication processes for three-dimensional electrodes utilizing micro-machining technologies.

- Ultra-trace Isotope Spectroscopic Analysis

Isotope analysis is indispensable in fields such as environmental science, geochemistry, and the nuclear fuel cycle. To meet these needs, we aim to establish technologies for the ultra-high-precision detection of "difficult-to-measure" nuclides.

- X-ray Nondestructive Testing (NDT) Technology

As social infrastructure continues to age, there is a growing need for diverse methodologies to evaluate structural integrity. By generating high-energy X-rays from portable electron accelerators, we aim to establish unprecedented nondestructive testing technologies.

- Isotope Control for Medical Radionuclides

The use of medical radionuclides for cancer treatment is necessitating isotope-level control. We are working to establish elemental technologies and evaluate the effects of isotope enrichment in targets for various radionuclide production methods.

These cutting-edge technologies are expected to be utilized in a wide range of fields, including nuclear energy, quantum information processing, medicine, tracer applications, environmental science, and nuclear security. Driven by the ambition to create what does not yet exist in the world, we engage in the entire process from simulation and design to fabrication, aiming for real-world implementation. We welcome anyone with an interest in these fields to join us in our research endeavors.

[Quantum Computing, Ultra-trace Radionuclide Analysis, X-ray Nondestructive Analysis, Isotope Process Engineering, Nuclear Fuel Cycle Engineering, Atomic, Molecular, and Optical (AMO) Science]

Kenichi ISHIKAWA (Professor)

Laser × Quantum × First-Principles Calculations

We conduct theoretical and first-principles studies to elucidate quantum phenomena induced by intense ultrashort laser and free-electron laser pulses. Our research focuses in particular on the quantum dynamics of electrons in atoms, molecules, and solids driven by laser fields. To this end, we develop state-of-the-art first-principles computational methods. Through these efforts, we aim to pioneer transformative technologies, including attosecond science for observing, understanding, and controlling ultrafast electron motion; laser-processing simulators that support advanced semiconductor manufacturing; and petahertz-scale electronic devices. Our group actively pursues international collaborative research with leading institutions worldwide, including TU Wien, Max Planck Institute of Quantum Optics, Max Born Institute, FERMI free-electron laser facility, Shanghai Jiao Tong University, and RIKEN.

[Laser, Attosecond science, Quantum technologies, Atomic physics, Condensed matter, First-principles calculations, Semiconductors, Laser processing]

Jinya KATSUYAMA (Project Associate Professor)

The safety associated with long-term operated nuclear reactors

Materials and welding are important for manufacturing, and appropriate maintenance and management to ensure the safety of nuclear facilities and components.

In order to ensure the safety of light water reactors which has been operated for long term, we are researching methods for predicting the material degradation of reactor pressure vessels and nuclear piping, which are the most important safety-related components composed of the pressure boundary, through deeper understanding the degradation mechanisms and so on. Additionally, we are conducting research and development to accurately evaluate weld residual stress, which is important for assessing the structural integrity of nuclear components, taking material variations caused by welding into account. Moreover, we are developing a probabilistic evaluation method that integrates the above technologies with the aim of risk-based decision-making related to maintenance and management, and proceeding practical applications of the probabilistic evaluation method.

The accident of Fukushima Daiichi Nuclear Power Plants provided an opportunity to refocus the importance to assess failure behavior of reactor components with complicated geometry due to relocation of fuel materials, and to assess the safety of reactor system considering their failure behavior.

We are proceeding research and development on evaluation methods related to above topics in collaboration with the Japan Atomic Energy Agency.

[Material, Welding, Ageing degradation, Probabilistic structural integrity assessment, Nuclear safety]

*No master's program students are acceptable in Application Schedule B.

Ryoichi KOMIYAMA (Professor)

Quantitative analysis of energy security

Energy security is a key agenda to address for sustaining socioeconomic activities under various structural and contingency risks such as the depletion of fossil fuel and energy supply disruption. In order to formulate effective technical and political measures for enhancing energy security under those risks and constraints, we need to comprehensively understand economics and international energy market as well as the engineering aspect of energy technology. The research theme in our group is to develop a mathematical and computational energy-economic model to analyze the optimal strategy for the deployment of energy technologies and to discuss energy policy firmly based on the simulated results derived from the model.

[Energy security, Energy-economic model, Mathematical optimization, Econometrics]

*No master's program students are acceptable in Application Schedule B.

Hiroyuki MATSUZAKI (Professor) (The University Museum)

AMS, isotope system, Earth environmental system

Development of Accelerator Mass Spectrometry (AMS) and other ion beam analysis systems, and their application studies are conducted in our laboratory.

Several special but extremely rare isotopes produced by the cosmic-ray interaction or the artificial fission reaction hold significant information about past climate variation and materials dynamics on the earth. We are reading and understanding this information by means of Accelerator Mass Spectrometry (AMS). For example, analysis of Iodine-129 in natural archive such as ice core, coral and sediments elucidates space-time variation of iodine isotope system. Radiocarbon dating (C-14 dating) is also one of AMS applications.

We are also developing novel techniques for the analysis of new nuclides yet detected ever., e.g., Laser Photo Detachment (LPD) system. This is entirely new technique of the isobar suppression which could enable detection of Ni-59, Sr-90, Cs-135. Recently we developed U-236 detection system using Time Of Flight (TOF). Since U-236 is a good indicator of the fission of U-235, it is important for the environmental assessment of nuclear facilities or nuclear accidents. It is also expected to be applied to the identification of nuclear source/activity.

Recently we started to empirical research for the quantum beam fusion system.

Because we have a 5MV tandem accelerator and beam line system, various experimental studies using ion beam based on creative ideas are possible. Let's enjoy the development of new method with the accelerator/ion beam engineering and exploration of new research field.

[Accelerator Mass Spectrometry, Ion beam, Laser Photo Detachment, quantum beam fusion, nuclide analysis, earth environment, Iodine isotopes, Uranium isotopes]

Shuichiro MIWA (Associate Professor)

Nuclear Thermal-hydraulics; Thermal-Fluid Engineering x AI; Next-Generation Reactor Safety;

The world around us is filled with fascinating and complex phenomena, such as gas–liquid two-phase flows in which different phases interact in rich and dynamic ways. Understanding these multiphase flows is essential for advancing next-generation nuclear reactors and for designing high-performance heat-exchange systems that will support a carbon-neutral society. In our laboratory, we combine hands-on experiments and physical theory with state-of-the-art artificial intelligence (deep learning and machine learning) and advanced numerical simulations—including CFD, SPH, MPH, and MPM—to explore and solve problems ranging from fundamental fluid physics to real-world engineering applications.

From Theory to Industry Application: Three Research Approaches

1. **AI & Data-Driven Research** We develop innovative methods using deep learning/ machine learning to instantaneously predict and analyze complex fluid dynamics and heat transfer problems. Our goal is to pursue "next-generation engineering" that protects system safety-such as predicting plant accidents before they happen from thermal-hydraulic approach.
2. **Challenges in Next-Generation Energy (Experimentation & Modeling)** We tackle core themes for future energy infrastructure, including next-generation reactors and passive safety systems. By clarifying thermal-hydraulic and structural response etc., we design safer and more efficient systems.
3. **Multi-Scale Numerical Analysis (Engineering & Industrial Application)** Utilizing high-performance computing (HPC), we apply large-scale CFD and particle-based simulations to investigate thermal-fluid phenomena across a wide range of spatial and temporal scales—from full-plant system behavior to millimeter-scale interfacial and multiphase dynamics. This multi-scale computational framework allows us to bridge fundamental physics with practical engineering design, enabling students to experience how advanced simulation technologies are used to solve real-world energy and safety challenges.

A Global Network Moving Society Forward

The defining characteristic of our lab is our bridge between academia and industry.

- International Collaboration: We actively engage in joint research and exchange programs with leading overseas universities and institutions. Students have ample opportunities to discuss their work with top global researchers at international conferences and seminars, honing a truly global perspective.
- Industrial Impact: We maintain strong partnerships with domestic plant manufacturers, electric power companies, and engineering leaders. The true thrill of this lab is experiencing firsthand how your research results are directly reflected in cutting-edge product development and next-generation safety standards.

Message to Prospective Students

Our laboratory offers a unique environment in which students can develop a deep understanding of physical phenomena through hands-on experimentation, while also engaging with the forefront of AI and advanced numerical simulation. This combination equips you with both the scientific foundation and the technological skills needed to tackle some of the most important challenges in energy and safety engineering. There is a special excitement in discovering the physical laws hidden within complex natural phenomena and in transforming that knowledge into technologies that benefit society. I look forward to exploring these frontiers together with you, and to supporting your growth as a scientist and engineer as you take on the challenge of the unknown.

[Gas-Liquid Two-Phase Flow, Nuclear Thermal-Hydraulics, Machine Learning (AI), Particle Method Simulation, Next-Generation Nuclear Reactors, Industry-Academia Collaboration]

Kenta MURAKAMI (Associate Professor)

Management of Plant Life thought Multiscale Physics

Research themes are modeling of material behaviors in nuclear systems and its interaction with humans and organization, and development of advance nuclear materials.

Our research is being used to formulate standards for the long-term operation of existing nuclear power plants and to assess the impact of nuclear accidents. We welcome master students who wish to work in the nuclear industry in Japan or overseas.

Students of doctoral programs will be assigned one of the following themes and will be asked to work on their research independently.

1) Irradiation embrittlement of reactor pressure vessels
2) Irradiation degradation of PWR biological shielding wall
3) Degradation of BWR pedestal concrete during severe accident
4) Probabilistic assessment for emergency preparedness with earthquake and nuclear accidents
5) Development of high entropy alloys for nuclear

[Nuclear Engineering, Multiscale Physics, Safety Management]

[integrated risk-informed decision making, *in-situ* observation, irradiation design, safety, materials]
*No master's program students are acceptable in Application Schedule B.

Yukie NAGAI (Associate Professor)

Shape modeling for creating value from radiation 3D measurements

Industrial X-ray CT scanning has been widely adopted in the manufacturing industry as a non-destructive three-dimensional measurement technology. By adding information and interpretation to measurement data, CT scanning can create value beyond simple shape acquisition, as exemplified by digital twins. However, measurement data are affected by various types of disturbances, and therefore must be refined into more accurate and higher-quality data in order to be effectively utilized.

Based on the belief that appropriate algorithms for improving and utilizing measurement data can further enhance their value, our laboratory develops data processing technologies for three-

dimensional scan data of substantial objects, with a particular focus on X-ray CT scanning.

In addition, the value of an object is strongly influenced by how it is perceived by the user. To elucidate the effects of objects on human sensation and perception, we also aim to develop design technologies that incorporate sensory aspects by linking shape measurement data with quantitative sensory data.

Our research is based on a wide range of academic fields, including shape modeling, computer science, applied mathematics, and measurement science. We conduct our research using advanced measurement facilities such as SPring-8 and Talbot–Lau interferometers. Our mission is to cultivate technologies and human resources that contribute broadly to society. We welcome students who are motivated to contribute to society, are eager to take on new challenges, and are curious to explore new research fields.

[3D scanning, X-ray CT, Shape modeling, Programming]

Takumi SAITO (Professor)

Nuclear Waste Management: A Key for Sustainable Use of Nuclear Energy

It is the duty of our generation to settle the issue of nuclear waste disposal. This is so in particular when we achieve so-called carbon neutral society with nuclear, for which its own sustainability is required. Geological disposal is the only feasible option for high-level wastes or spent fuels, where various basic research and R&D are still needed. In my group, we tackle this problem by understanding and modeling the chemistry of radionuclides that governs their migration in subsurface environments (“natural barrier”) and the behaviors of various engineered barriers, using sophisticated spectroscopy, chromatographic techniques, and computer simulation. In addition, we perform various research on transport of radionuclides through heterogeneous host rocks. Knowledge obtained through the research has been applied to the modeling of chemodynamics of radionuclides released from the accident of the Fukushima Daiichi nuclear power plant in soils. Any students who have interests in nuclear waste management, or relevant processes, ranging from molecular-scale reactions to macroscopic transport, and aim to tackle together this difficult issue of nuclear waste disposal, which arise at the interface of the use of nuclear energy and the environments, are highly welcomed, no matter what academic backgrounds they have.

[Nuclear waste disposal, Radionuclide transport, Geochemistry, Actinide chemistry]

Mikio SAKAI (Professor)

Reproducing Reality in Virtual Space: Toward the Realization of Digital Twins

Many of the products that shape our daily lives are manufactured through processes involving “powders,” assemblies of microscopic particles. At the Sakai Laboratory, we develop original software that integrates world-leading multi-physics simulation with artificial intelligence to reproduce the behavior of such powders across scales—from individual particles to entire industrial plants—pushing into scientific and technological frontiers that have yet to be explored. Our research covers a broad range of fields that underpin modern society, including nuclear decommissioning, environmental and energy plants, fine ceramics, and the production of food and pharmaceuticals. Through large-scale collaborations with industry and international research projects, the laboratory functions as a global hub connecting researchers and engineers from Japan and around the world. Simulation results are visualized using highly realistic 3DCG, enabling intuitive understanding of complex physical phenomena, much like watching a scene from a movie. Students are encouraged to apply their own strengths and interests—such as programming, numerical analysis, computer graphics, AI, and data science—to create new research themes and open up new possibilities. We welcome ambitious and curious students who are eager to challenge unexplored domains with cutting-edge technologies. Join us in a research experience that, years from now, you will be able to look back on and say with pride, “That was truly a fulfilling and inspiring time.”

[Digital Twin, Multiphysics Simulation, Artificial Intelligence, Data Science]

Kazuyuki SAKAUE (Associate Professor)

Light/Quantum beam science and applications

Light/quantum beam is widely used in society. Lasers as light are probably installed in the PC or smartphone you are looking at on your screen right now, while radiation as quantum beams supports social activities such as medical care and infrastructure diagnosis, and synchrotron radiation obtained from quantum beams is used to develop various new products. Light and quantum beams may seem to be two different fields, but in semiconductor manufacturing, for example, the wavelength of exposure light is becoming shorter, and EUV (extreme ultraviolet light: wavelength of 13.5 nm) is beginning to be used. This is an area that can already be called radiation. The two fields is expected to get closer. To develop this new combined field, we will expand the application by pioneering new light and quantum beam sources through lasers, accelerators, their fusion, and by miniaturizing accelerators. Recently, we have also been working on applications to laser processing.

Our laboratory has just started up, and we will design and build research devices using lasers and accelerators. You can learn a wide range of fields such as accelerator science/optical science/vacuum technology/materials science/optical and quantum beam applications. Let us enjoy this chance to build systems filled with your own ideas together.

[Light/Quantum beam, Accelerator, Laser, Quantum beam application, Laser processing]

Takeshi SATO (Associate Professor)

Theory and simulations of light-matter interaction

Our laboratory conducts theories and simulations of the interaction between light and matter. We are a world-leading laboratory in the field of attosecond science, which aims at directly measuring and controlling the electron motion in materials with ultrashort pulses and high intensity lasers. My research themes can be classified into three: theory, implementation, and applications. First, we are developing original theories for accurately solving the time-dependent Schrodinger equation to describe light-matter interactions. With theory, you can make a breakthrough using papers and pencils only. Second, you will be trained for both new and old computer skills including C++, Fortran, and python in our group. With computer implementation, you can connect theory with reality. Appealing in the third topic, applications, is that you can use original theory and codes to predict real-world experiments. We are also developing new theories and methods for simulating quantum dynamics on a quantum computer. Please join us if you like math, physics, chemistry, programming, or simulations, or if you are interested in the theory of light-matter interactions, quantum mechanics, or quantum computer, or if you want to challenge the fusion of physics and machine learning.

[Light-matter interaction, Quantum Chemistry, Solid-state Physics, Quantum Computer, Machine Learning]

Kenji SHIMAZOE (Associate Professor)

Quantum Sensing and Instrumentation for Radiation Science

We develop novel quantum sensing and instrumentation for medical physics, environmental applications and nuclear science, which visualizes unknown physical phenomenon and information.

X-ray low-dose photon counting CT, next generation PET (positron emission tomography) and Compton imaging, radio-theranostics technology with new radioisotopes, X-ray and neutron imaging and analysis, radiation detectors for decommissioning and monitoring, research on atomic nucleus and radiation generation, new measurement method based on quantum entanglement, photon-radiation integrated technology with nanoparticles (quantum dot) are one of our research topics. We build new radiation science and medical diagnosis and therapy utilizing atom and atomic nucleus. We welcome ambitious students interested in those fields to work together.

[Quantum Imaging, Quantum measurement, Quantum sensor, Radiation Detection and Measurement, X-ray and Neutron Imaging, Medical Diagnosis and Therapy, Medical Physics]

Takashi TAKATA (Professor)

Deepening of Risk and Utilizing of Risk on Decision Making in Engineering Issue

We have no engineering system with absolute safety. Accordingly, A qualitative and quantitative understanding of risk on the system will be one of the most key issues to discuss its safety and to make a decision concerning with an application of the system.

Since a nuclear power plant is a huge and complex engineering system, intrinsic risks in the plant include large uncertainties and numerous scenarios. Hence, a ratiocinative methodology will be of importance to clarify the risks. We have been developing the methodology based on experimental approaches as well as numerical simulation technology.

So as to utilize an engineering technology efficiently, one needs two-sided characteristics of; one's credible expertise and a sense of overall balance. Accordingly, we have also investigated a qualitative characteristic of the information concerning with the risk, which is obtained in the risk assessment, and its elemental role on decision making.

[Risk assessment, Thermal-hydraulics, Numerical simulation, Uncertainty, Decision making, Nuclear safety]

Shinichi YAMASHITA (Associate Professor)

What Happens When Radiation Interacts with Matter? — From Understanding to Control

Radiation transfers energy to water and materials, inducing a wide variety of changes. Understanding and controlling these changes can improve the safety and reliability of nuclear systems.
At the Yamashita Lab, we investigate radiation-induced processes, from the earliest interactions between radiation and matter to the resulting chemical species and material changes. By combining time-resolved spectroscopy (pulse radiolysis), chemical analysis, and computational simulations, we seek to elucidate the fundamental processes underlying water radiolysis and reactor water chemistry, while also exploring potential applications in life and medicine, materials, and energy. We also develop new measurement techniques and integrated measurement systems using LabVIEW.

Examples of research topics:
- Water radiolysis at metal oxide nanoparticle interfaces
- Simulations of radiation-induced chemical reactions in reactor water chemistry
- Formation and control of DNA damage, including radioprotection and radiosensitization
- Ammonia synthesis using radiation energy
- Development of nanomaterials and scintillators for radiation detection
- Advancement of pulse radiolysis, time-resolved spectroscopy, and measurement systems

Research topics are not limited to these examples and can be tailored to each student's interests and strengths. We welcome students who are eager to think independently and engage in research through trial and error. We always welcome lab visits and inquiries. For more information about specific research topics and lab life, please visit the Yamashita Lab's website.

[Radiation chemistry, reactor water chemistry, water decomposition, radiolysis, nanoparticles, life and medicine, energy conversion]