*This document is an English translation of the 2024 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.

2024 Guide to Entrance Examination

Graduate School of Engineering,
The University of Tokyo

Department of Nuclear Engineering and Management

Master's Program, Doctoral Program

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

Tel: +81-3-5841-6015
Tel: +81-3-5841-2900 (English speaking staff)
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Website: http://www.n.t.u-tokyo.ac.jp

(Notice) When the “Guide to Applicants” and “Guide to Entrance Exam” changes due to the effects of COVID-19, 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:
http://www.t.u-tokyo.ac.jp/soe/admission/general_guideline.html

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

1. Department of Nuclear Engineering and Management

This entrance examination guide contains the important information for those who are going to take an entrance examination of the Department of Nuclear Engineering and Management. This is a supplementary document to the “Guidelines for Applicants to the 2024 Master’s / Doctoral Program Graduate School of Engineering, the University of Tokyo.” This provides the information about subjects, schedules and other related materials. Please read both this brochure and the Guidelines carefully before submitting your application. Detailed information of the Department of Nuclear Engineering and Management can be found on the department’s website.

After entering the Master’s or Doctoral Program, students will be affiliated with your academic supervisor’s research laboratory. You can find the brief introduction of faculty members in the section four.

The schedule of the guidance to applicants for the Department of Nuclear Engineering and Management is below. The contents of all meetings are the same.

1) Wednesday, May 24, 2024, from 17:00 @Engineering Building 3, Lecture room 31 + online* (Guidance) & from 17:30@Engineering Building 2, Exhibition room (Poster Session by Laboratories, on-site only). Please check the details on the website (http://www.n.t.u-tokyo.ac.jp)
2) Saturday, June 3, 2024, from 15:00 @Engineering Building 3, Lecture room 32 (Guidance) + online & from 15:30@Engineering Building 2, Exhibition room (Poster Session by Laboratories, on-site only). Please check the details on the website (http://www.n.t.u-tokyo.ac.jp)

We will present an overview of the entrance examination and laboratories of the Department of Nuclear Engineering and Management at each meeting. Q&A sessions and individual consultations will be also held.

(Notice) Concerning the above schedule of the guidance, the dates, locations and implementation methods are subject to be changed. Before participation, please be sure to check the website of the department (http: //www.n.t.utokyo.ac.jp/).

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

Note:

All private information (including entries in the required documents for application and examination results) are used only for the purpose of screening and examining the educational systems and entrance exams of the University of Tokyo, and are not used for any other purpose.

※The period of application: All application data should be uploaded to the designated upload site. Upload period of application documents in online submission is from Thu, June 29 to Wed, July 5, 15:00 (Japan time).

※Written examination will be conducted on campus. Depending on the spread of COVID-19, however, there is a possibility of conducting online examinations. The announcement will be found on the website (http://www.n.t.u-tokyo.ac.jp/).

※If the number of applicants exceeds a certain number, the department will implement applicant screening based on the submitted documents. When implementing the applicant screening, only those who pass the applicant screening can take written and oral examinations. In the case of the applicant screening, the department will notify applicants by the website (http://www.n.t.u-tokyo.ac.jp/).

2. Master's Program

2-1. Examination subjects

Foreign language - English

Please submit the official score of TOEFL (TOEFL iBT, TOEFL iBT Home Edition) by Friday, August 4th. English ability of applicant is evaluated by this submitted official score. TOEFL examination will not be held on the campus of the graduate school of engineering. Those who do not have an official TOEFL score should take the exam in TOEFL iBT examination center or should take TOEFL iBT Home Edition. For more information on submitting TOEFL official score, please refer to "Notice regarding Foreign-language (English) Examinations in 2024 Graduate School of Engineering, The University of Tokyo Entrance Examinations (TOEFL score submission)."

※The deadline for submitting TOEFL scores is strictly enforced.
Please take the exam as early as possible.

※You can only submit your TOEFL score once. Submitted score cannot be replaced.

Written examination

In principle, written examination will be conducted on campus (University of Tokyo, Hongo Campus).

Specialized subjects: Mathematical problems designed to test ability to think logically and a reading comprehension examination

※Mathematical problems designed to test ability to think logically: The problems prepared for mathematics of the regular education subject by the School of Engineering are used as the problems. Examinees are requested to select and answer three of the six problems from six fields: "Primarily from the fields of Differential and Integral Calculus, Differential Equations","Series, Fourier Analysis, Integral Transform", "Vector, Matrix, Eigen Value (Linear Algebra)", "Curve and Surface", "Function Theory and Complex Number" and "Probability and Statistics, Information Mathematics, etc."

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="3">Subject</th><th>Date & time</th><th>Location</th><th>Items to Bring</th></tr>
<tr><td colspan="2">Foreign language</td><td>English
(TOEFL score submission, Submission Deadline: August 4th Fri)</td><td>—</td><td>Individual online exam location</td><td>Follow TOEFL exam guidelines</td></tr>
<tr><td rowspan="2">Written exam</td><td rowspan="2">Specialized subjects</td><td>Reading comprehension Examination</td><td>August 28 (Mon), 9:30 to 11:00 (tentative)</td><td>It will be indicated on the exam admission card which will be sent after you have applied.</td><td rowspan="2">Exam admission card, Writing tools, Watch

* You cannot bring a calculator or a watch with a calculator.</td></tr>
<tr><td>Mathematical problems designed to test ability to think logically</td><td>August 28 (Mon), 13:00 to 15:30 (tentative)</td><td>Same as above</td></tr>
<tr><td colspan="3">Survey of preferred research laboratory, guidance for oral examination</td><td>August 28 (Mon) 15:40 to 16:00 (tentative)</td><td>Same as above</td><td>Writing tools</td></tr>
<tr><td colspan="3">Oral examination</td><td>August 29 (Tue) to August 30 (Wed)</td><td>Noticed in the guidance for oral examination</td><td>Exam admission card</td></tr>
</table>

Examination dates, times, or locations are just tentative and might be changed. Please be sure to check our website (http://www.n.t.u-tokyo.ac.jp).

2-3. Others

(1) October enrollment:
The successful applicants can enroll the Master's Program from October 2023, if they can meet the requirements. If a foreign national applies for a new status of residence, the application procedure will start after notification of admission and it will take about 3 months, which would be too late for the admission date. For foreign nationals who need to apply for a new status of residence, please consider selecting "April admission".

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

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

(4) Past written examination:

Mathematical problems designed to test ability to think logically: You can find them website at http://www.t.u-tokyo.ac.jp/soee/admission/general_past.html

Reading comprehension examination: You can pick it up at the office of Department of Nuclear Engineering and Management or we'll send it to you if you order to nyushijimu@n.t.u-tokyo.ac.jp with your postal address and your name.

(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: http://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 email (nyushijimu@n.t.u-tokyo.ac.jp).

3. Doctoral Program (Application Schedule A)

3-1. Examination subjects
Primary examination

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 the examination of General subjects.

Please submit the official score of TOEFL (TOEFL iBT, TOEFL iBT Home Edition) by Friday, August 4th. English ability of applicant is evaluated by this submitted official score. TOEFL examination will not be held on the campus of the graduate school of engineering. Those who do not have an official TOEFL score should take the exam in TOEFL iBT examination center or should take TOEFL iBT Home Edition. For more information on submitting TOEFL official score, please refer to “Notice regarding Foreign-language (English) Examinations in 2024 Graduate School of Engineering, The University of Tokyo Entrance Examinations (TOEFL score submission).”

※The deadline for submitting TOEFL scores is strictly enforced.
Please take the exam as early as possible.

※You can only submit your TOEFL score once. Submitted score cannot be replaced.

Written examination

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 the examination of specialized subjects.

In principle, written examination will be conducted on campus (University of Tokyo, Hongo Campus).

Specialized subjects: Mathematical problems designed to test ability to think logically and a reading comprehension examination

※Mathematical problems designed to test ability to think logically: The problems prepared for mathematics of the regular education subject by the School of Engineering are used as the problems. Examinees are requested to select and answer three of the six problems from six fields: “Primarily from the fields of Differential and Integral Calculus, Differential Equations”,“Series, Fourier Analysis, Integral Transform”, “Vector, Matrix, Eigen Value (Linear Algebra)”, “Curve and Surface”, “Function Theory and Complex Number” and “Probability and Statistics, Information Mathematics, etc.”

Oral examination

Applicants will be given about 25 minutes (15 minutes of presentation + 10 minutes of an interview) for an oral examination. In the presentation, you have to explain your master’s thesis, or research achievement that can be alternative of your master’s thesis. You are also supposed to describe your research plan after entering the Doctoral Program.

Note:

Applicants who have graduated or are expected to graduate and awarded a master’s degree or its equivalent by September 2023, or who have been recognized as having academic abilities equal to or greater than a person who has received Master’s degree, based on individual screening of Admission Qualifications by the School of Engineering the University of Tokyo, should have about 35 minutes (20 minutes of presentation + 15 minutes of an interview) for the oral examination. This means that this oral examination is counted as both the primary oral examination and the secondary examination described below.

Secondary examination

Oral examination

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

3-2. Examination schedule

Primary examination

<table>
<tr><th colspan="3">Subject</th><th>Date & time</th><th>Location</th><th>Items to Bring</th></tr>
<tr><td colspan="2">Foreign language</td><td>English
(TOEFL score submission, Submission Deadline: August 4th Fri)</td><td>—</td><td>Individual online exam location</td><td>Follow TOEFL exam guidelines</td></tr>
<tr><td rowspan="2">Written exam</td><td>Specialized subjects</td><td>Reading comprehension Examination</td><td>August 28 (Mon), 9:30 to 11:00 (tentative)</td><td>It will be indicated on the exam admission card which will be sent after you have applied.</td><td rowspan="2">Exam admission card, Writing tools, Watch

* You cannot bring a calculator or a watch with a calculator.</td></tr>
<tr><td></td><td>Mathematical problems designed to test ability to think logically</td><td>August 28 (Mon), 13:00 to 15:30 (tentative)</td><td>Same as above</td></tr>
<tr><td colspan="3">Oral examination
*See Note</td><td>August 29 (Tue) to August 30 (Wed)</td><td>Announced after written exam</td><td>PC etc. and presentation materials for Oral exam, and admission card</td></tr>
</table>

Examination dates, times, or locations are just tentative and might be changed. Please be sure to check our website (http://www.n.t.u-tokyo.ac.jp).

*Note :

1) All applicants have to submit the document (a) before the exam:

(a) One copy of a summary of your master's thesis or alternative research achievement

- It should not exceed 4 pages of single-side A4 printing including figures and diagrams.
- Applicants ,who are expected to obtain a master's degree by March 31, 2024, should present a summary of a midterm report of your research progress.

2) Applicants who will take the extended oral examination which serves as both the primary oral examination and the secondary examination must submit the document (b) in addition to the

document (a) before the exam:

(b) One copy of master's thesis or documents which expressly provide alternative research achievement to the master's thesis. In the case of working adult, a copy of research paper may be used, but note that fragmentary work introductions and team achievements deviate from the perspective of examination.

You have to upload the electronic files (PDF file) of the document (a) and document (b) (only for those who need to do) no later than ***August 4th (Fri)***. The upload destination will be notified later on our web site (http://www.n.t.u-tokyo.ac.jp/prospective/examination/).

For the presentation, you can use presentation materials created with Microsoft PowerPoint etc. If you do not use the presentation materials created with Microsoft PowerPoint etc., you can use another material for your presentation. In that case, please let us know at the department office by email until ***August 4th(Fri)***.

If you have any further questions regarding the above, please contact the office of the Department of Nuclear Engineering and Management by email (nyushijimu@n.t.u-tokyo.ac.jp).

Secondary examination

Secondary examination is only for those who have passed the primary examination, and it is scheduled for January 2024. The detailed information will be informed to the applicants later.

3-3. Others

(1) October enrollment:
The successful applicants can enroll the Doctoral Program from October 2023, if they can meet the requirements. If a foreign national applies for a new status of residence, the application procedure will start after notification of admission and it will take about 3 months, which would be too late for the admission date. For foreign nationals who need to apply for a new status of residence, please consider selecting "April admission".

(2) Consultations with faculty:
Before applying, every applicant for the Doctoral Program **has to discuss** your research field with your prospective academic supervisor before you apply.

(3) Admitting students with full-time jobs:
Those who wish to enter the university while still being employed are required to submit upon entry to the university, a Letter of Approval (in any format) from their employer (as long as the one who approves you holds a higher position than you, then the exact position does not matter) certifying that their "in office status" does not in any way interfere with them entering the university.

(4) Past written examination:

Mathematical problems designed to test ability to think logically: You can find them website at http://www.t.u-tokyo.ac.jp/soee/admission/general_past.html

Reading comprehension examination: You can pick it up at the office of Department of Nuclear Engineering and Management or we'll send it to you if you order to nyushijimu@n.t.u-tokyo.ac.jp with your postal address and your name.

(5) Scholarships:
There are several scholarship programs and international study programs available at school of

Engineering, including Graduate School of Engineering, The University of Tokyo Doctoral Student Special Incentives Program (SEUT-RA) and Doctoral Student Support: "Fostering Advanced Human Resources to Lead Green Transformation (GX)" (SPRING GX). 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 have graduated or will graduate from the School of Engineering, the University of Tokyo, must provide the transcripts for undergraduate courses or equivalents, if he or she has not graduated from the Faculty of Engineering, the University of Tokyo.

(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 email (nyushijimu@n.t.u-tokyo.ac.jp).
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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). 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]

Kazuyuki DEMACHI (Associate Professor)

Anomaly detection and identification for nuclear security, maintenance and safety

Since the accident at the Fukushima Daiichi Nuclear Power Plant in March 2011, nuclear power plants have been recognized as an attractive target for terrorists, and the strengthening of nuclear security has been advocated all over the world. In recent years, in addition to the conventional nuclear security threats, new threats such as insiders, cyber-attacks, and stand-off attacks have emerged, and there is an urgent need to strengthen nuclear security. In order to solve this problem, it is necessary to develop human resources who have a high degree of expertise in AI and other knowledge, and to develop human resources who have flexibility and adaptability to the ever-changing social situation. Especially in nuclear security at nuclear power plants, flexible cooperation with nuclear safety is essential. Our laboratory aims to strengthen the nuclear security and safety of nuclear plants. In particular, we are developing technology for "anomaly detection & identification" by applying deep learning. The main research themes of recent years are the following (1) and (2), but we will also flexibly develop other technologies.

(1) A technology that detects in real time abnormal behavior such as sabotage and theft of nuclear material that could lead to an accident at a nuclear power plant by analyzing surveillance camera videos using deep image learning techniques.
(2) Technology that applies time-series data analysis using deep learning methods to plant data and monitoring data of dynamic equipment operations in nuclear plants to detect and identify failures, defects, and cyber-attacks at an early stage.

[Deep learning, nuclear security, nuclear safety, anomaly detection & identification]

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]

Shuichi HASEGAWA (Professor)

Creating innovation Using Photon and Isotopes

Photonic technologies, such as laser and X-rays, have made remarkable progress, including laser spectroscopic analysis, photonuclear reactions, laser cooling, and ion beam control. Mass spectrometry using electromagnetic fields is also becoming more sophisticated. We are therefore conducting research to systematize these advanced technologies in terms of manipulation and detection at the single atom level. For example, by manipulating ions by laser, we visualize individual ions. By controlling their internal states, a quantum computer using ion traps has been realized, and we are conducting research aimed at extending the scalability of the qubits. Furthermore, by using high-energy photons (X-rays), we aim to generate radionuclides for medical use by nuclear reactions, and to apply the X-ray technology to nondestructive inspection of social infrastructures. Research is being conducted to apply these advanced technologies to a wide range of fields, including nuclear engineering, quantum information processing, nuclear medicine, tracer applications, environment, and nuclear security.

Since apparatus to realize these technologies do not exist in the world, many of them are designed and fabricated in our laboratory, starting from numerical simulations. There is something of interest for everyone, so please join us in our research.

[Nuclear fuel cycle, Isotope engineering, quantum information processing, medical isotopes, trace isotope analysis, Atomic, molecular and optical science]

Kenichi ISHIKAWA (Professor)

First-principles calculation of ultrafast intense laser-matter interaction

We study the interaction of lasers with atoms, molecules, and solids using quantum-mechanical first-principles calculation. We are interested in the many-electron dynamics triggered by a laser pulse and the nuclear dynamics induced by the electron dynamics. These are relevant with biological effects of radiation, control of chemical reactions, petahertz electronics, and advanced laser material processing. We actively collaborate with Vienna University of Technology, LMU Munich, Max Planck Institute of Quantum Optics, FERMI free-electron laser, and RIKEN.

[Laser, Photon and quantum technology, Quantum optics, Ab initio simulations, Laser material processing, Digital photonic production]

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]

Naoto KASAHARA (Professor)

Note: No new student will be accepted.

Design by analysis for energy plants

Energy plants are complex systems related with thermal-fluid-structural mechanics. Understanding of essential mechanism of multi-physics phenomena will lead to development of systematic models on thermal load - structural response - material strength in plants. These enable superior design which can satisfy both plant safety and economics.
Most of them are joint research programs with external companies. They will give you educational chance to learn academic research organization and project management.
Through concrete research on structural design of fast breeder reactors, students can learn rational and general methodologies applicable to other fields.
[Structural analysis, High temperature strength, Seismic strength, Nuclear structural engineering, Fast reactor]

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]

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.

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 Analysis, Isobar separation, nuclide analysis, earth environment, Iodine isotopes, Uranium isotopes, Radiocarbon dating]

Shuichiro MIWA (Associate Professor)

Engineering Innovation through Multiphase flow

Multiphase flow, defined as a simultaneous flow of several phases, is observed in various disciplines, including engineering devices, nature, and even in human bodies. The phenomenon is highly complex and takes place in different spatial and temporal scales with deformable interfacial boundaries. One of the forms of multiphase flow, known as gas-liquid two-phase flow, is particularly important for the design and operation of energy/ chemical systems, including nuclear reactors.

Our laboratory aims to develop models applicable for various two-phase flow systems, including next gen. reactors, through experimental, computational, and theoretical approaches. Joint research with industries and collaborative works with research groups across the globe are currently ongoing. Research projects in our group are subdivided into three folds:

(1) Experimental approach: Understanding two-phase flow dynamics in tight-lattice rod-bundle geometry, passive safety system, flow-induced vibration, and air entrainment system through fundamental experiments.
(2) Data-driven approach: Development of two-phase flow fields analysis using AI techniques (pattern recognition, object detection, GAN), accidental analysis using RNNs.
(3) Numerical approach: Development of constitutive equations utilized in system analysis codes, blood flow simulation using multi-dimensional CFD through collaboration with medical experts.

Our focus is to strengthen the traditional model development approach through fundamental experiments while adopting state-of-the-art techniques such as AI and numerical simulations to deepen the understanding of multiphase flow.

We are looking forward to having zealous and passionate students eager to learn and grow professionally through multiphase flow research!

[Two-phase flow, Nuclear thermal-hydraulics, Machine Learning, Next Gen. Reactors, Reactor Safety]

Yuya MORIMOTO (Visiting Associate Professor)

Attosecond Electron-beam Imaging

We are developing novel imaging techniques to visualize ultrafast phenomena occurring on the atomic scale. We use ultrashort electron beams and ultrashort pulsed lasers. By developing an attosecond electron microscope, we will visualize ultrafast phenomena with Angstrom resolution, for example, the ultrafast motion of electrons in an initial step of a chemical reaction. Our research activities range from theoretical studies on electron beam generation and its scattering, design of electron guns, electrodes, and electromagnetic lenses using simulation software, design and development of ultra-high vacuum devices, observation of ultrafast phenomena using ultrashort electron beams, development of novel light sources with various wavelengths using intense femtosecond lasers, and manipulation of electron beams by light waves. Our research is conducted at RIKEN in Wako, Saitama.

[Electron Microscopy, Ultrashort laser, Physical chemistry, Light-matter interaction]

Kenta MURAKAMI (Associate Professor)

Safety Management to cope with unexperienced behavior of complex systems

The design of a safe nuclear system is based on the assumption events that have yet to be experienced, such as ageing degradation, natural hazards, and accidents. Deep insight into the physical phenomena involved is required, but it is impossible for a single expert to know every phenomenon in depth. Therefore, the systemic approach to manage the interaction between human, technologies, and organization to improve safety continuously.

The technical area in which I specialize is the development of experimental methods to evaluate the effects of complex interactions between materials and radiation to assess the integrity of structural materials and nuclear fuels. Using this area as a starting point, I have been working on the development of methods for integrated risk-informed decision making for improvement of nuclear safety.

Students in our laboratory take one of a complex behavior found in nuclear energy systems that are difficult to model, and analyze it using a variety of methods (including microscopy techniques such as in-situ observation, and information technology such as natural language processing). I work with Prof. Sekimura, Prof. Nakayama, Prof. Chen, and others, and it is possible to experience long-term internships at JAEA and other institutions, as well as planning and organizing international conferences. Let's cultivate the ability to handle a wide range of scales from materials to systems based on integrated engineering.

[integrated risk-informed decision making, *in-situ* observation, irradiation design, safety, materials]

Shinichi NAKAYAMA (Project Professor)

Note: No new student will be accepted.

Science and communication of Geological Disposal of High-level Radioactive Waste

Assurance and demonstration of safety of deep geological disposal (DGD) of high-level radioactive waste (HLW) and emergency response to a nuclear accident are the topics of my research, and in particular, how aspects of these topics feed into the development of appropriate nuclear regulations.

Geological disposal as a method of managing HLW is an internationally accepted approach, however it remains a controversial issue when it comes to public opinion. The safety of such a project has to be demonstrated over extremely long timescales (often > 100,000 years), which goes way beyond the time frames for the safety of conventional engineering projects. Then, perhaps more crucially, this assurance of safety needs to be well communicated to a public who are not familiar with the appropriate technical background. Whilst scientists and technical experts may well be in agreement that DGD of HLW is the best way to deal with our nuclear legacy, this does not automatically mean that the public will agree.

Public acceptance of emergency response actions is similar in nature to that of gaining acceptance for DGD of HLW; scientific solutions may be given and agreed upon by experts, for, say, which route to take in the event of an evacuation, however, people often may not agree with or will not necessarily adhere to the pre-prepared solutions. We begin in this respect by attempting to verify and validate the scientific arguments necessary for emergency response provision.

Collaborating with Prof. Saito in respect to scientific aspects of DGD, Prof. Sekimura, Prof. Chen and Prof. Murakami will join discussions on safety and communication.

[geological disposal, emergency response, technical communication, nuclear regulation]

Koji OKAMOTO (Professor)

Severe Accident, Nuclear Safety and Visualization

In the Severe Accident of Nuclear Power Plant, melted fuel relocates to lower plenum with dissolving the SUS and Zircaloy structures. The phenomena are multi-physics, multi-phase, multi-dimensions, multi-chemistry, that is, huge non-linear mechanisms. For example, the accident at Fukushima-Daiichi NPP has lots of unknowns and unresolved issues. In order to operate the nuclear plant safely, the non-linear severe accident phenomena have to be known. In our laboratory, the thermal-hydraulic phenomena related to the Severe Accident had been studied with experiment and numerical simulation. These results had been applied to international collaborative research, R&D for next generation nuclear reactor and decommissioning activity of Fukushima Daiichi.

"Visualization" is the key technology on 21 century. The huge amount of data will be visualized to understand the complex phenomena and/or to resolve the core mechanism of the complex systems. The laser and high-speed camera will resolve the invisible world with quantitative information. We are the world top class laboratory for quantitative visualization.

In the Nuclear Safety, Visualization and Severe Accidents are the key system. The complex huge system, e.g. Nuclear Power Plant, will be resolved using the visualization technology. The Nuclear Energy will be a promising source of energy to help the world, especially developing countries. However, public understandings will be needed, especially in Japan. Using the visualization technology, we will provide an open access of the Nuclear Energy.

We really need a trailblazer for the complex future.

[Visualization, Nuclear safety, Severe accident]

Marco Pellegrini (Project Associate Professor)

Multi-Phase Flow CFD for Severe Accident Phenomena Investigation

Computational Fluid Dynamics has achieved outstanding results in single phase turbulence applications in the past years, and it is currently challenging the multi-phase and multi-physics world. CFD has the capability to study physics at the small-scale level, hence it is intrinsically independent on the geometry and the problem conditions, which is a key in nuclear application and severe accident in particular.

Severe accidents are dominated by complex phenomena at extremely large temperature and harsh conditions which make it hard for researchers to assess experimentally the overall behavior. Multi-Phase CFD represents a powerful tool for the understanding of the SA phenomena and for the design of safer and more economical reactors, with wider acceptance by the community.

[Nuclear safety, Computational Fluid Dynamics, Multi-physics, Severe accident]

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 managemen, 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)

Development of state-of-the-art multi-physics simulation technologies towards construction of a physics-based digital twin

My group develops advanced multi-physics simulators. My group is conducting research in the fields of nuclear engineering, environment & energy engineering, materials processing, and food & drug formulation engineering. In addition, my group are studying on verification & validation of computer simulation results, the integration of multi-physics simulation and data science, and computer graphics based realistic visualization of physic simulations. Finally, these technologies are integrated to develop a physics-based digital-twin. In the field of nuclear engineering, various physical models are developed to elucidate the phenomena of severe accidents. I believe that my simulator can precisely simulate complex phenomena such as severe accidents, and finally can gain important knowledge for rapid recovery from accidents. I expect that students positively propose new idea and will incorporate their own techniques into their studies (e.g., visualization through computer graphics, video editing, and parallel computing). I warmly welcome ambitious and highly motivated students who can improve their skills and knowledge positively. I can positively support my students to obtain brilliant accomplishments.

[Multiphysics simulation, digital twin, powder, multiphase flow, computer graphics]

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]

Naoto SEKIMURA (Professor)

Note: No new student will be accepted.

Safety and resilience of complex systems, Nuclear materials engineering, Codes and standards for nuclear safety, Ageing management of light water reactors, Maintenance engineering of complex systems, Multi-scale simulation of radiation damage in nuclear materials, Systems engineering for nuclear fuels, Knowledge-base for international nuclear community

Safety of nuclear power plant systems has become most important topic of research both from hardware integrity and management of complex systems. Multi-scale simulation and experimental studies on microscopic and macroscopic behaviors of nuclear materials under very severe conditions including energetic neutron irradiation are also the major research topics. I have been leading national projects for ageing management of nuclear reactors components and materials with other universities, national laboratories and industries. Our group is also working on international projects on safe long term operation of nuclear systems and seismic safety through intensive collaboration with IAEA and OECD/NEA.
[Safety and knowledge management for nuclear systems, Multiscale modeling of materials]

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 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]

Hiroyuki TAKAHASHI (Professor)

Radiation measurements and instrumentation

Radiation measurements are very important in many science and technology areas. We develop quantum radiation detectors for various applications in many areas such as medical imaging, industrial imaging, basic science, etc. Microfabrication techniques, microelectronics and computer hardware techniques, and simulation calculations are effectively used in our research.

[Radiation measurements, Gamma-ray imaging, Environmental radiation, Neutron detectors, Signal processing]

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 are induced by ionizing radiations? Revealing “individuality” to utilize advantages and to overcome disadvantages.

Many issues in nuclear engineering are related to ionizing radiation. The advantages and disadvantages of ionizing radiations are both sides of the same coin. They are based on underlying standard features and regarded as the “individuality” of ionizing radiations. By understanding their “individuality” and managing them adequately, we can utilize them in many practical fields such as cancer therapy and material development.

One of the standard features is very instant energy deposition to matter. Due to this, various changes are suddenly and locally induced. We have been investigating phenomena occurring within one microsecond in correlation with stable changes in chemical structure and material surface after a long time.

Examples of more specific research topics are as follows:

- Experimental system development for observation of the fast phenomena (construction of hardware and graphical programming with LabVIEW)
- Influences of seawater or metal oxide nanoparticles on water radiolysis
- Initial process of radiation damage to DNA and its inhibition by additives
- Utilization of radiation energy in the production of ammonia (contribution to green sustainable chemistry)
- Atomic-oxygen-induced microstructural change on the surface of polymeric material used in spacecraft

Background of the topics is cancer therapy, water chemistry in nuclear systems, green sustainable chemistry, and decommissioning of Fukushima Daiichi Nuclear Power Station. Other than the above topics, we try to accept others that students are interested in as much as possible.

[Radiation effect (physicochemistry, chemistry, and biochemistry), water chemistry in nuclear reactors, cancer therapy, industrial application of radiation, interface]

Notice for Examination
~The 2024 Master's / Doctoral Program
Graduate School of Engineering, the University of Tokyo~

1. Examination Dates

Examinations will be held from August 28 (Monday) through September 1 (Friday), 2023.
(For details on times and location of the examination subjects, refer to the "Guide to Entrance Examination" of the department you are applying to.)

2. Examination Location

Refer to the "Campus Map for the Examination" [see the attached paper].
(1) The actual place of the examination subjects for applicants will be posted on the School of Engineering website and each department website until 10:00 a.m. on August 25 (Friday), 2023.
Confirm the specified place for the examination subjects beforehand.
(2) Applicants should arrive at the specified place for the examination subjects 20 minutes prior to the scheduled examination time.
For the examination of specialized subjects (専門科目(専門学術)), also refer to notifications from the department you are applying to.

3. Items to Bring

(1) Examination admission card
(2) Black pencils (or black mechanical pencils), an eraser, a pencil sharpener (a desktop type is not allowed), a watch (watches with functions other than time measurement are not allowed).
(3) **Use of electronic devices such as cell phones is strictly prohibited throughout the examination, even if you only use it as a watch. Make sure to completely deactivate any sound alerts and/or alarm settings, turn off the phone's power, and put it in your bag before you enter the examination room. Do not take it out in the examination room.**
(4) For other items to bring for the examination of specialized subjects (専門科目(専門学術)), refer to notifications from the department you are applying to.
(5) Other items as instructed at the time the Examination admission card is issued.

4. Notice during Examination of Regular Education Subjects (一般教育科目(一般学術))

(1) Follow the instructions from the proctor during the examination.
(2) You cannot leave the examination room after the start of the examination.
(3) The Examination admission card must be kept on your desk at all times during the examination.
(4) Applicants cannot take home the answer sheets or the problem booklets after the examination.
(5) Do not leave the room until instructed to do so by the proctor.

5. The Secondary Examination for Applicants to the Doctoral Program

The secondary examination will be held between late January and mid-February 2024.
Applicants will be advised of Examination dates and locations regarding secondary examinations for the department they are applying to later.

6. Miscellaneous

(1) The Examinee Numbers of successful applicants will be posted on the website of the School of Engineering at approximately 4 p.m. on September 7 (Thursday), 2023.
(http://www.t.u-tokyo.ac.jp/en/soe/admission/general-fee).
(2) The School will not accept telephone calls, fax, e-mail, and other inquiries regarding the results of the examinations.
(3) After the application process is complete, applicants must report immediately in case of change of your mail address or telephone number for contact.
(4) For inquiries, contact: Graduate School Team, Administrative Division, School of Engineering, the University of Tokyo.
daigakuin.t@gs.mail.u-tokyo.ac.jp, 03-5841-6038、7747