2021 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

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Tel: +81-3-5841-2900 (English speaking staff)
Email: nyushijimu@n.t.u-tokyo.ac.jp
Website: http://www.n.t.u-tokyo.ac.jp
(Notice) Depending on the situation of the spread of new coronavirus (COVID-19) infection, contents of 2021 Guide to Entrance Examination (application procedure, examination date and place, screening method, examination subject, etc.) are subject to be changed. When changed, the department will inform the possible applicants in the website of the department (http://www.n.t.utokyo.ac.jp/). Please be sure to regularly check it when making the application.
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 2021 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 five.

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.

Location: School of Engineering, the University of Tokyo, 7-3-1, Hongo, Bunkyo-ku, 113-8656, Tokyo

1) Tuesday, May 21, 2020, from 17:00 (online guidance by ZOOM). Please check the details on the website (http://www.n.t.u-tokyo.ac.jp)
2) Saturday, June 6, 2020, from 15:00 @ Engineering Building 3, 2nd floor, Lecture room 32 (Guidance) & from 15:30 @ Engineering Building 2, Exhibition Room (Poster Session by Laboratories)

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 (online, etc.) are subject to be changed. Before participation, please be sure to check the website of the department (http://www.n.t.u.tokyo.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

For further detailed information about research activities of respective laboratories, or if you wish to take any professor’s advice, please contact the office of the Department of Nuclear Engineering.

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: Upload period of application documents in online submission is from Wed, July 1 to Wed, July 8, 15:00 (Japan time). (For postal mail, the postmark is valid on the last day and the mail must arrive by Tue, July 14)

※ The department will announce application availability by Application Schedule B on Thursday, October 1, 2020 in 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/).

※ Depending on the spread of COVID-19, there is a possibility of conducting online examinations. Please prepare and secure the listed items beforehand by yourself in “Guidelines for Applicants to the 2021 Master’s / Doctoral Program, Graduate School of Engineering, the University of Tokyo.” In the case of online exam, the details will be announced on the website (http://www.n.t.u-tokyo.ac.jp/).
2. Master’s Program

2-1. Examination subjects

Written examination

(1) General subjects: Foreign language - English

Please submit the official score of TOEFL® (TOEFL PBT®, TOEFL iBT®, TOEFL iBT® Special Home Edition) by Wednesday, August 5th. English ability of applicant is evaluated by this submitted official score. This year, TOEFL ITP® 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 TOEFL iBT® Special Home Edition. For more information on submitting TOEFL® official score, please refer to "Notice regarding Foreign-language (English) Examinations in 2021 Graduate School of Engineering, The University of Tokyo Entrance Examinations (TOEFL score submission)."

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

The problems prepared for mathematics of the regular education subject by the School of Engineering are used as the problems. Additionally, in the mathematical problems designed to test ability to think logically, the problems will be changed to adopt the method of answering three problems (examination time for one problem: 40 minutes), instead of adopting the selection method in the past examinations (examinees select multiple problems and answer them). The problems of the regular education subject in the past examination are found in the following website. And this year, the problems will be given from three fields: Mathematics 1 (Primarily from the fields of Differential and Integral Calculus, Differential Equations), Mathematics 2 (Primarily from the fields of Linear Algebra), and Mathematics 3 (Primarily from the fields of Complex Function Theory).

http://www.t.u-tokyo.ac.jp/soee/admission/general_past.html

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>
<thead>
<tr>
<th>Subject</th>
<th>Date &amp; time</th>
<th>Location</th>
<th>Items to Bring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written exam for Foreign language (TOEFL score submission, Submission Deadline: August 5th Wed)</td>
<td>—</td>
<td>Individual online exam location</td>
<td>Follow TOEFL exam guidelines</td>
</tr>
<tr>
<td>(In case of online exam) Network connection test (exam environment check)</td>
<td>August 22 (Sat), 13:00- (tentative)</td>
<td>Individual online exam location</td>
<td>—</td>
</tr>
<tr>
<td>Written exam for Specialized subjects: Mathematical problems designed to test ability to think logically</td>
<td>August 23 (Sun), 9:00 to 12:00 (tentative)</td>
<td>It will be indicated on the exam admission card which will be sent after you have applied.</td>
<td>Exam admission card, Writing tools, Watch</td>
</tr>
<tr>
<td>Reading comprehension Examination</td>
<td>August 23 (Sun), 13:00 to 15:00 (tentative)</td>
<td>Same as above</td>
<td>* You cannot bring a calculator or a watch with a calculator.</td>
</tr>
<tr>
<td>Survey of preferred research group</td>
<td>August 23 (Sun) 15:10 to 15:30 (tentative)</td>
<td>Same as above</td>
<td>Writing tools</td>
</tr>
<tr>
<td>Oral examination</td>
<td>August 24 (Mon) to August 28 (Fri)</td>
<td>Noticed beforehand</td>
<td>Exam admission card</td>
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</tbody>
</table>

Please visit our website (http://www.n.t.u-tokyo.ac.jp) or check the notice board of the Department of Nuclear Engineering and Management located on the second floor of the Engineering Building No.3 before the examination. Examination dates, times, or locations are just tentative and might be changed.

### 2-3. Others

1. **September enrollment:**
   The successful applicants can enroll the Master’s Program from September 2020, if they can meet the requirements. If you wish to start from September 2020, you have to contact the department office before you apply.

2. **Consultations with faculty:**
   If you need to ask about research fields of the Master’s Program, you can ask faculty in advance. If you wish to do so, please contact via the office of Department of Nuclear Engineering and Management.
(3) Research group affiliation:
   After being accepted, students will be affiliated with one of the research groups according to
   their entrance examination scores.

(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 come to the department office to get it, or we'll
   send it to you if you order to nyushijimu@n.t.u-tokyo.ac.jp

   A copy of past written examination is included among the documents distributed at the
   guidance.

(5) Scholarships:
   There are several scholarship programs and international study programs available at the
   School of Engineering. If necessary, please contact the office of the Department of Nuclear
   Engineering and Management. 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) Online exam environment
   If a sufficient number of PCs are available to rent out, the department will lend Windows OS PC
   required to take TOEFL iBT® Special Home Edition to the people living in Japan and thinking of
   taking the exam for this department. If interested, please contact the department office by email
   (nyushijimu@n.t.u-tokyo.ac.jp) (up to around 5 units can be rented). Also, if the specialized
   subjects or oral examination will be conducted by online, and if an enough number of WEB
   cameras are available, the department can lend it to the people living in Japan. Please contact
   the department office by e-mail as well (up to about 10 units can be rented).

(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).
3. Doctoral Program (Application Schedule A)

3-1. Examination subjects

Primary examination

Written examination

(1) General 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 the examination of General subjects.

Please submit the official score of TOEFL® (TOEFL PBT®, TOEFL iBT®, TOEFL iBT® Special Home Edition) by Wednesday, August 5th. English ability of applicant is evaluated by this submitted official score. This year, TOEFL ITP® 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 TOEFL iBT® Special Home Edition. For more information on submitting TOEFL® official score, please refer to “Notice regarding Foreign-language (English) Examinations in 2021 Graduate School of Engineering, The University of Tokyo Entrance Examinations (TOEFL score submission).”

(2) Specialized subjects: Mathematical problems designed to test ability to think logically and a reading comprehension 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.

The problems prepared for mathematics of the regular education subject by the School of Engineering are used as the problems. Additionally, in the mathematical problems designed to test ability to think logically, the problems will be changed to adopt the method of answering three problems (examination time for one problem: 40 minutes), instead of adopting the selection method in the past examinations (examinees select multiple problems and answer them). The problems of the regular education subject in the past examination are found in the following website. And this year, the problems will be given from three fields: Mathematics 1 (Primarily from the fields of Differential and Integral Calculus, Differential Equations), Mathematics 2 (Primarily from the fields of Linear Algebra), and Mathematics 3 (Primarily from the fields of Complex Function Theory).

http://www.t.u-tokyo.ac.jp/soee/admission/general_past.html

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 2020, 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>
<thead>
<tr>
<th>Subject</th>
<th>Date &amp; time</th>
<th>Location</th>
<th>Items to Bring</th>
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<tbody>
<tr>
<td>Written exam</td>
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<tr>
<td>Foreign language English</td>
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<td>Follow TOEFL exam guidelines</td>
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<td>Submission Deadline: August 5th</td>
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<tr>
<td>Written exam</td>
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<tr>
<td>Specialized subjects</td>
<td>August 23 (Sun),</td>
<td>It will be indicated on the exam admission card which will be sent after you have applied.</td>
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<tr>
<td>Mathematical problems designed</td>
<td>9:00 to 12:00</td>
<td></td>
<td>Exam admission card, Writing tools, Watch</td>
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<tr>
<td>to test ability to think logically</td>
<td>(tentative)</td>
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<td></td>
<td>August 28 (Fri)</td>
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Please visit our website (http://www.n.t.u-tokyo.ac.jp) or pay attention to the information on the notice board of the Department of Nuclear Engineering and Management located on the second floor of the Building No.3 before the examination. Examination dates, times, or locations are just tentative and might be changed.

*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, 2021, should present a summary of a midterm report of your research progress.

2) Applicants who will take the extended oral examination which is counted 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. These documents will be returned later.

You have to send the document (a) and document (b) (only for those who need to do) in both paper medium and electronic medium (USB etc.) storing the electronic file (PDF file) by mail to arrive no later than **August 14 (Fri)**, to the office of Department of Nuclear Engineering and Management.

For the presentation, you can use a PC projector. If you do not use the projector, you can also use another material for your presentation. In that case, please let us know at the department office by **August 14 (Fri)**

The necessary information such as format will be notified to the applicants by mail in July from the department office, which you have to follow when you prepare the document.

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 2021. The detailed information will be informed to the applicants later.

3-3. Others

(1) September enrollment:
The successful applicants can enroll the Doctoral Program from September 2020, if they can meet the requirements. If you wish to start from September 2020, you have to contact the department office before you apply.

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

(3) Admitting students with full-time jobs:
Full-time employees of educational, academic research institutions or companies can enroll in the Doctoral Program with keeping your current employee’s status. Please contact the department office for the details.
(4) 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). For more information, please contact the office of the Department of Nuclear Engineering and Management. 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

(5) Past written examination:

   English: Nondisclosure because past TOEFL examinations are not disclosed.

   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 come to the department office to get it, or we'll send it to you if you order to nyushijimu@n.t.u-tokyo.ac.jp

   A copy of past written examination is included among the documents distributed at the guidance.

(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) Online exam environment

   If a sufficient number of PCs are available to rent out, the department will lend Windows OS PC required to take TOEFL iBT® Special Home Edition to the people living in Japan and thinking of taking the exam for this department. If interested, please contact the department office by email (nyushijimu@n.t.u-tokyo.ac.jp) (up to around 5 units can be rented). Also, if the specialized subjects or oral examination will be conducted by online, and if an enough number of WEB cameras are available, the department can lend it to the people living in Japan. Please contact the department office by e-mail as well (up to about 10 units can be rented).

(8) 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).
4. Introduction of the faculty 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**

As one of the expected solutions for the safe design and operation of nuclear power plants, the further improvements of nuclear materials and fuels are indispensable. We deal with research and development of materials for fusion reactors, advanced fission reactors (Generation IV), and current light water reactors (LWR). The main aspects are to reveal fundamental mechanism of the degradation process under extreme environments, such as irradiation, corrosion and hydrogenation, in Fe-based and Zr-based alloys. Developments of high-performance materials and testing methods are also of our interest. The following techniques are currently applied: microscopy like TEM, HVEM, TEM-accelerator, SEM/EBSD etc.; mechanical tests like advanced expansion-due-to-compression (A-EDC) test, tensile, creep and nano-hardness etc.; and computer simulations like FEM and MD.

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

**Dongyue CHEN** (Project Lecturer)
**Ageing Management and Performance of Nuclear Materials**

Ageing degradation of nuclear materials is one of the key issues for the safe operation of nuclear power plants. As an important step to achieve reliable and proactive ageing management of nuclear materials, we combine both experimental and modeling measures to study their ageing mechanisms at multiple scales. Our interests focus on the key materials in reactors, for example core structural materials, reactor pressure vessel steels and fuel cladding materials. State-of-the-art techniques, such as in-situ TEM (Transmission Electron Microscopy) and APT (Atom Probe Tomography), are utilized to observe the evolution of irradiation defects. First-principal modeling is preformed for the comparison with experimental results, and the algorithms for the quantitative analysis of experimental data are also investigated.

[ Ageing management, Nuclear materials, Irradiation defects ]

**Kazuyuki DEMACHI** (Associate Professor)
**Abnormal sign detection for nuclear security, maintenance, radiation therapy**

We are researching and developing technologies for "prediction detection of abnormalities" by applying Deep Learning for nuclear security and maintenance of nuclear power plants and medical imaging.

1) Technology to detect malicious or dangerous behaviors leading to sabotage, accident or injury by analyzing surveillance camera image in real-time.
2) Technology to detect the failure of dynamic equipment such as pumps and turbines before abnormalities appear prominently on the monitoring signal.
3) Technology to predict the sudden motion of tumor, in order to prevent normal tissues from unexpected exposure by sudden outings from irradiation range.

[ Deep learning, anomaly sign detection, nuclear security, nuclear maintenance, medical imaging ]
Experimental and Numerical Nuclear Thermal-Hydraulics for Nuclear Safety and Severe Accidents

Experimental methods and the instruments have reached to very advanced levels recently. In parallel, the computational methods gained tremendous capacity and have become capable of simulating more complicated systems than before by employing sophisticated modeling techniques that are widely employed for nuclear reactor technologies. Validation is the only way to interconnect the real-world and computational world. For robust modeling, validation of the digital world against high-quality experimental data (diverse, multi-dimensional, high-resolution, and accurate) is extremely needed. To enhance nuclear safety and the understanding of nuclear accidents, we perform experiments and numerical simulations related to nuclear thermal-hydraulics. We use and develop advanced visualization and measurement techniques for fluid flow and heat flow (PIV, PIV/TSP, Shadowgraphy, etc.) diagnostics to acquire high-quality data. The computational tools such as OpenFOAM (Open-source computational fluid dynamics tool), and their models validated with experiments to enhance our understandings of the thermal-hydraulics mechanisms prevalent in the nuclear power plant systems and other energy systems. Why don’t you challenge the computational and real worlds with state-of-art techniques?

[ Nuclear Thermal-Hydraulics, Nuclear Safety, Severe Accident, Particle Image Velocimetry (PIV), OpenFOAM ]

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)**  
Applied Laser engineering for controlling atomic systems

We are interested in developing a novel advanced system utilizing single atom control technologies, which are based on atomic, molecular and optical physics. Atoms efficiently absorb photons with energies corresponding to electronic transitions. Difference of the number of neutrons changes the energies of the transitions, which is called isotope shifts. Laser isotope separation is one of the examples making use of such technologies. Photon has also momentum, which can control motion of atoms. Recent progress of the technique, laser cooling, visualizes single atoms. Laser cooling leads atomic ions forming Coulomb crystal of ions. These laser techniques can expand the possibilities of handling nucleus of atoms and molecules. Combinations of Lasers and Isotopes are applicable to not only nuclear engineering, but also medicine, tracer technique, forensic science, and more. We also construct experimental apparatus by ourselves. Let us enjoy Lab life with us!  
[ Laser spectroscopy, Laser analysis, Laser cooling, Isotope separation, Isotope analysis, Nuclear fuel cycle, Isotope engineering, 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, 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]

**Naoto KASAHARA (Professor)**  
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（Associate 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

Accelerator Mass Spectrometry (AMS) can analyze extremely rare long-lived radio isotopes such as $^{10}\text{Be}$ (half life = 1.36×10$^6$ yr), $^{14}\text{C}$ (5,730 yr), $^{26}\text{Al}$ (7.2×10$^5$ yr), $^{36}\text{Cl}$ (3.01×10$^5$ yr), $^{129}\text{I}$ (1.57×10$^7$ yr). These rare isotopes form special isotope systems with their stable isotopes which have precise information about earth environment system. Most famous isotope system is the $^{14}\text{C}/^{12}\text{C}$ system well known to be used for dating. Our laboratory has a 5MV tandem accelerator and developed multi-nuclide AMS system of which the performance retains world’s top level. While we are applying AMS to various interdisciplinary research fields from archaeological to earth environmental sciences, recently we especially focus on the $^{129}\text{I}/^{127}\text{I}$ system. As iodine has a close relation with organic matter and is often found with important carbon reservoir such as methane hydrates and soils, we consider $^{129}\text{I}/^{127}\text{I}$ system is an important clue to elucidate the total carbon dynamics.

[Ion beam, AMS, Isotope geochemistry, Radioisotope environment assessment]

Masashi OHNO（Associate Professor）
Innovative analysis of nuclear material using superconducting radiation sensors

Our academic objective is to realize a new innovative high-energy-resolution spectroscopy for nuclear structure investigations, radioactive or non-radioactive nuclide identifications, material analyses, and radiotherapy. For example, non-destructive analysis of nuclear materials for safeguards and nuclear forensic requires to improve accuracy and sensitivity. The precision spectroscopy of hard X-ray and gamma ray from the nuclear materials is powerful tool for the identification of the plutonium, uranium, actinide and their decay products. However it needs to resolve their X-ray or gamma ray peaks in the complex spectrum of around 100keV region, which cannot be resolved by the conventional detectors. Therefore, we have developed the superconducting radiation sensor with the ultra-high energy resolution. Now our research group has already obtained the world top energy resolution in high-energy gamma-ray region and also, tried to measure gamma-rays from fission products with this superconducting detector.

[Superconductivity, Nanotechnology, Gamma-ray spectroscopy, Charge particle therapy]
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.

Takumi SAITO（Associate Professor）
Chemistry for nuclear waste disposal and environmental behaviors of radionuclides

It is the duty of our generation to settle the issue of nuclear waste disposal. Geological disposal is the only feasible option for high-level wastes or spent fuels, where various basic research and R&D are still needed. Chemistry of radionuclides is a key foundation to realize a well-accepted disposal project. Thus, we are pursuing understanding and modeling of the chemistry that governs the migration of relevant radionuclides in subsurface environments, which is often called “natural barrier”, using sophisticated spectroscopy, chromatographic techniques, and computer simulation. 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 has an interest in the issue of nuclear waste disposal are welcomed, no matter what academic backgrounds they have.

Mikio SAKAI（Associate Professor）
Advanced modeling for granular and multi-phase flows

My group develops world-leading multiphysics models for computational granular dynamics, namely, innovative models for solid-fluid and solid particle-elastic body interaction problems. We encounter these problems in various fields including nuclear engineering, chemical engineering, etc. Numerical studies on the problems are challenging since these were hardly simulated because of the complicated phenomena and excessive calculation cost. In nuclear engineering, we perform a simulation of nuclear vitrification process and core relocation in severe accident. In chemical and mechanical engineering, new industrial application models are developed to simulate a complex multi-phase flow. Thus, our research topics become wide ranging. At present, we develop new models to perform the simulations by using Lagrangian-Lagrangian or Eulerian-Lagrangian approaches. Our original technologies become important in engineering and science.

[ Computational granular dynamics, Discrete element method, Multiphysics modeling ]
Takeshi SATO (Associate Professor)
Multielectron dynamics in intense laser fields

High field physics and attosecond science are rapidly progressing, in which dynamics of electrons in matters are directly measured and even controlled, using ultra-short high-intensity laser pulses. We are developing state-of-the-art theoretical and computational methods to solve time-dependent Schrödinger equation of multielectron systems interacting with intense laser fields, aiming at ab initio study of nonlinearly nonperturbative phenomena such as tunneling ionization, high harmonic generation, and nonsequential multiple ionization.

[High field physics, Attosecond science, Wave function theory, Density functional theory, Quantum chemistry]

Naoto SEKIMURA (Professor)
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]

Shunichi SUZUKI (Project Professor)
Decommissioning of Fukushima Dai-ichi NPP and project management

In order to complete the decommissioning of Fukushima Dai-ichi NPP, we need to challenge and overcome the difficulties which no one has ever experienced. The key technology for decommissioning of the accident plants is how to solve the unsteady state problems caused by remarkable changes of environment, circumstances and the states of the plant condition with the lapse of time.

Main theme of this course is finding the tasks and their solutions for decommissioning through evaluation of phenomena which may occur in the future and also though making the scenario with experiments such as material and thermal-hydraulic tests.

This course will not only deepen your skill & knowledge on decommissioning, but also give you an opportunity to understand the importance of the project management and the way of System Thinking for a complex world which you will face in the future.

[Decommissioning, System dynamics, Risk assessment, Resilience engineering]
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 (Project 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]

Mitsuru UESAKA (Professor)
Development and application of advanced and compact accelerators/lasers for Nuclear Engineering and Medical Physics

We are developing advanced and compact accelerators/lasers such as S-band photocathode RF electron gun and linear accelerator (linac), portable 950 keV/3.95 MeV X-band (9.3GHz) linac X-ray source for on-site inspection of social and industrial infrastructures, 3.95 MeV linac-based neutron source for water inspection in bridge and on-site Fukushima nuclear fuel debris analysis. 35 MeV linac gamma-ray source for medical radioisotope production are under design. We have developed 6 MeV X-band linac for dynamic tracking X-ray pinpoint cancer therapy, and fiber laser accelerators for dynamic observation of radiation-induced DNA damage/repair process is under development. Further, we are performing research on advanced and precise radiation treatment planning. RI (Radio Isotope) imaging, R&D based medical physics are performed. Students can join the International collaboration with IAEA (International Atomic Energy Agency) on research and education.
[Compact accelerator and laser, RI (Radio Isotope) imaging, R&D based medical physics, Industrial/societal infrastructure on-site inspection, On-site Fukushima Nuclear Fuel Debris Analysis]
Science and technology (S&T) give us a promising future and the society and public receive the full benefit of the S&T; presently, we have found they are things of the past. The true value of S&T is appreciated only by the way of how they interrelate to the society. Context of S&T includes notions of uncertainty, imagination and unknowns.

It is required for contemporary S&T to go into how they are accepted by the society and how they can serve for society. Our research topics are: 1) to simulate the S&T (to know phenomena); 2) to clarify the positive and negative features (to assess risks); 3) to establish reasonable and logical criteria for utilizing the S&T for public welfare (to make good decisions). Underlying baselines are academic field that deals with lack of knowledge and unknown phenomena (i.e., uncertainty).

Thermal-hydraulic simulations, for example, tell us what would actually happen. Statistical science provides us of a methodology for decision-making under uncertain situations if enough information is appropriately obtained. Risk assessment works as a bridge of the simulation and the decision-making, and is a tool to understand the core of the system safety. Risk assessment and related issues are promising research field and exactly where researchers and engineers are really needed.

[ Risk assessment, Simulation, Decision-making problem, Nuclear safety ]

Shinichi YAMASHITA (Associate Professor)
What are induced by ionizing radiations? Utilization of advantages and overcome of disadvantages.

Many problems in nuclear engineering are related to ionizing radiations, however, they can be useful tools in practical fields such as cancer treatment, material processing, and so on. Advantages and disadvantages of ionizing radiations are both sides of the same coin, and are originated from or related to its “individuality”. We have been mainly investigating fast phenomena induced just after passage of ionizing radiations within a microsecond (a millionth second). Ionizing radiations deposits their energies to matter instantaneously within a femtosecond (a quadrillionth second), and then, several fast changes are induced. Our investigation on the “individuality” of ionizing radiations enables us to inhibit this change if it is not desired or to enhance it if it is favored. Examples of more specific research topics are as follows:
- Experimental system development for observation of the fast phenomena
- Initial process of radiation damage to DNA and its inhibition by additives
- Influences of seawater or metal oxide nanoparticles on water radiolysis

Background of the topics are cancer therapy, water chemistry in nuclear systems, and decommissioning of Fukushima Daiichi Nuclear Power Station, etc. We try to accept not only the above topics but also 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 ]