

# Advanced Science and Technology | Department of Mathematics

## Algebra



### Research Themes

- \*Representation Theory, Algebraic Lie Theory
- \*Number Theory, Arithmetic of Automorphic Form

Prof.

**TERAI Naoki**

■ Research Themes

Combinatorial Commutative Algebra

Assoc. Prof.

**SUZUKI Takeshi**

■ Research Themes

Representation theory/  
Combinatorics/Lie theory/  
Integrable systems

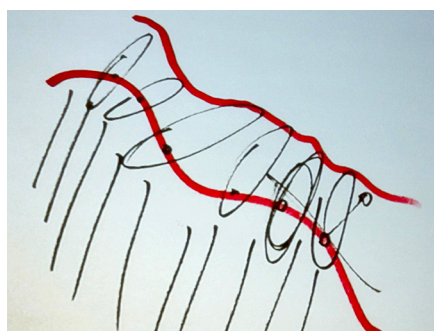
Asst. Prof.

**ISHIKAWA Yoshihiro**

■ Research Themes

Automorphic forms / Hodge theory/  
Zeta integral/Relative representations/  
Covering groups

## Geometry



Geometry is the study of figures, which are technically called manifolds.

Differential geometry is the field of the precise study of the shape of manifolds, using cues such as curvature and the behaviour of geodesics of (Riemannian) manifolds. Here geodesics are generalisations of straight lines in Euclidean space. On the other hand, topology is the field of the study of topological properties of manifolds by mapping algebraic invariants onto them.

The basic algebraic invariants, for instance, are fundamental groups, homotopy groups, homology groups and cohomology groups.



Prof. **KONDO Kei**

■ Research Themes

Global Riemannian geometry (especially geodesic theory)/Non-smooth analysis/Exotic structures/Minimal submanifolds from aspects of PDEs/Origami

Prof. **JINZENJI Masao**

■ Research Themes

Geometry/Mathematical Physics/ Fundamentals of Condensed Matter Physics

Prof. **TORII Takeshi**

■ Research Themes

Algebraic Topology/Homotopy Theory

Assoc. Prof. **MONDEN Naoyuki**

■ Research Themes

Mapping class group/ 4-dimensional topology

# Analysis



We study various problems concerning differential equations, probability theory, functional analysis, dynamical systems, and statistics from the point of analysis.



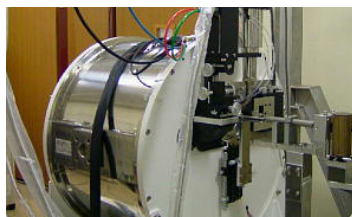
Prof. OSHITA Yoshihito

■ Research Themes  
Nonlinear PDE

Assoc. Prof. UEHARA Takato

■ Research Themes  
Complex analysis/Dynamical system

## Quantum Structural Physics in Correlated Matter



In recent years, it is known that topological insulators, topological semimetals, etc. undergo large physical property changes in small electric and magnetic fields, related to the even-oddity of wave functions and bands. However, its creation requires control of the Fermi surface, control of spin-orbit interaction, and control of space and time reversibility. We create and study pure topological materials by means of quantum structural physics.



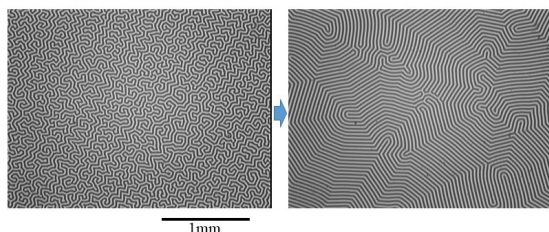
Prof. NOGAMI Yoshio

■ Research Themes  
Quantum structural physics/  
Topological insulators

Assoc. Prof.  
KONDO Ryusuke

■ Research Themes  
Quantum structural physics/  
Topological insulators

## Quantum Physics in Correlated Matter



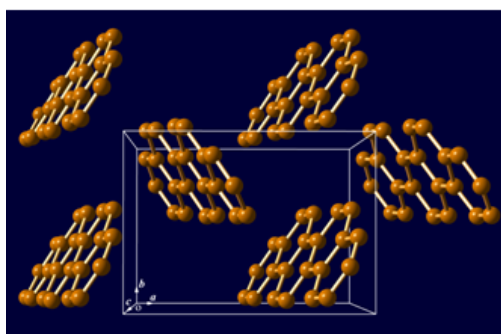
Space-time chaos and nonequilibrium pattern formation in magnetic materials. Spin-wave Relaxation.



Prof. MINO Michinobu

■ Research Themes  
Spin-Wave/Magnetic domain  
structure/Chaos

## Physics in Advanced Functional Materials



Novel magnetism and superconductivity in molecular materials.

Development of superconductor and magnetism in molecular materials, layered compounds and van der Waals compounds.

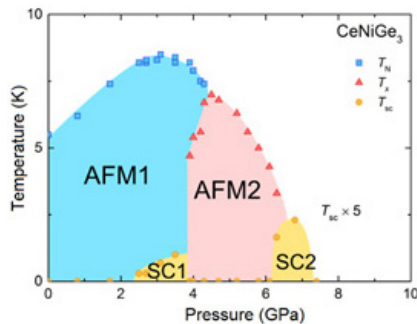
Prof. IKEDA Naoshi

■ Research Themes  
Solid state physics/  
Magnetism/Superconductivity

Assoc. Prof.  
KAMBE Takashi

■ Research Themes  
Solid state physics/  
Magnetism/Superconductivity

# Materials Physics in Extreme Environments



The properties of material under extreme conditions, such as under high pressure and high magnetic field, exhibit unconventional and anomalous characteristics. Our research group is dedicated to investigating the unexplored states of matter under these extreme conditions. In order to accomplish this objective, we are actively developing the advanced experimental techniques. We are seeking the original research using the advanced experiment techniques.

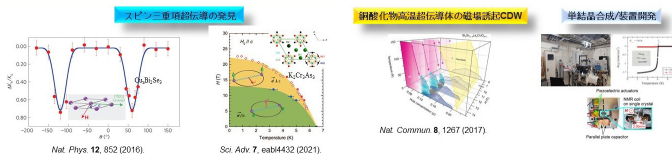
**Prof. KOBAYASHI Tatsuo**

**Research Themes**  
Solid state physics/Magnetism/  
Superconductivity

**Assoc. Prof. ARAKI Shingo**

**Research Themes**  
Solid state physics/Magnetism/  
Superconductivity

# Low Temperature Condensed Matter Physics



We use nuclear magnetic resonance (NMR) technique to study various quantum physical phenomena at low temperatures. In particular, we search for spin-triplet, topological superconductivity, and are interested in understanding the mechanism of superconductivity in various classes of materials including copper

oxides, iron pnictides, heavy fermion compounds, non-centrosymmetric materials. One of our current projects is on topological superconductors, whose surface states can be used for quantum computing. Here, the term "topological" means that the wave function describing superconductivity has a non-zero topological invariant, just as a donut where the number of hole is invariant against deformation.

**Prof. ZHENG Guo-qing**

**Research Themes**  
Topological superconductivity/  
Spin-triplet superconductor/NMR



**Assoc. Prof. KAWASAKI Shinji**

**Research Themes**  
Topological superconductivity/  
Spin-triplet superconductor/NMR

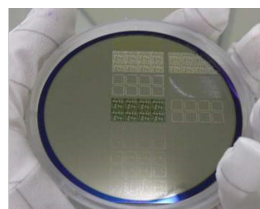
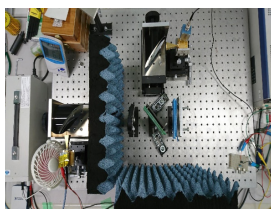


**Asst. Prof. MATANO Kazuaki**

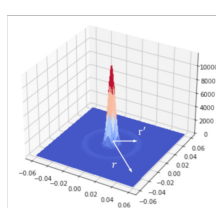
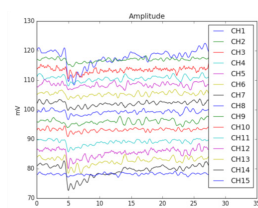
**Research Themes**  
Topological superconductivity/  
Spin-triplet superconductor/NMR



# Astroparticle Physics



We are studying the advanced analysis methods to measure the CMB polarization to search for the imprint of the cosmic inflation. We are also developing superconducting detectors to study neutrinos from the sun.



**Prof. ISHINO Hirokazu**

**Research Themes**  
Cosmic Microwave Background/LiteBIRD/  
Superconducting Detectors



# High Energy Physics



the mysteries of the universe through a variety of experiments.

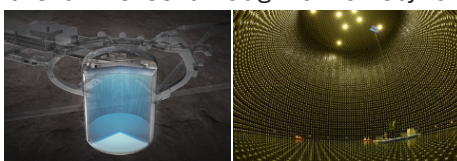


Photo courtesy of J-PARC Center and Kamioka Observatory, ICRR, University of Tokyo

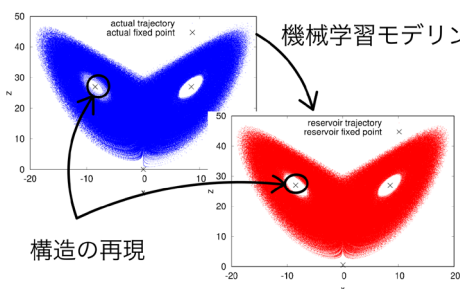
Particle physics is the study of the properties of elementary particles, which are the smallest units that make up matter, and the forces (interactions) that connect them. Particle physics is also closely connected to understanding the universe. Our laboratory promotes experimental research through accelerator experiments and astrophysical observations. In particular, we focus on particles called neutrinos and are trying to elucidate their properties and



Assoc. Prof.  
KOSHIO Yusuke

■ **Research Themes**  
Astro-particle physics/nuclear  
physics/neutrino physics/  
supernova

## Mathematical Science for Data Engineering



We develop mathematical theories (topology, dynamical systems, etc.), methods, and software for data analysis and utilization and apply them to various fields such as materials science, geology, meteorology, and life science.



Prof. OBAYASHI Ippei

■ Research Themes  
Topological data analysis/  
Persistent homology /  
Applied mathematics

Senior Assist. Prof.  
NAKAI Kengo

■ Research Themes  
Applied mathematics/  
Machine learning

## Applied Mathematics



The main research theme of our group is developing and explicating fundamental theories for mathematical models via applications of commutative algebra and probability theory to computational algebra and stochastic models.



Prof. HAYASAKA Futoshi

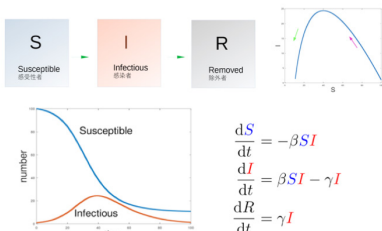
■ Research Themes  
Algebra/Commutative algebra



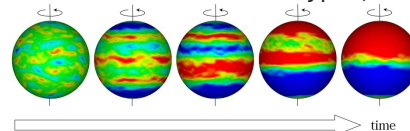
Assoc. Prof.  
KAWAMOTO Yosuke

■ Research Themes  
Probability theory/Analysis/Random  
matrices/Infinite particle systems

## Mathematical Analysis of Models



This group deals differential equations, which are often mathematical models describing natural phenomena. We investigate mathematical methods for analysing the equations and also the applications of equations. The equations involved are various types, and the methods used include analysis, dynamical systems theory, numerical analysis, and so on.



Prof. SASAKI Toru

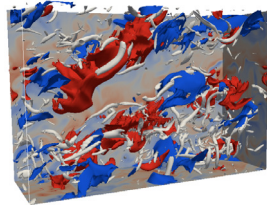
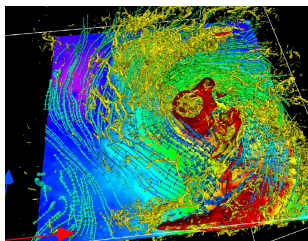
■ Research Themes  
Differential equations/Applied analysis/  
Mathematical biology



Assoc. Prof. OBUSE Kiori

■ Research Themes  
Nonlinear dynamics/Fluid dynamics

## Numerical Analysis of Flow Phenomena



Computational and data science of multi-scale and multi-physics complex flow phenomena using supercomputers; information reduction, extraction, and visualization of big data of complex flow phenomena by mathematical and scientific methods; collaborative research to understand complex flow phenomena in various fields such as astronomy, meteorology, environment, and engineering.



Prof. ISHIHARA Takashi

### Research Themes

Fluid dynamics/Turbulence physics/  
Numerical simulation/Computational  
Science/Data Science



Assoc. Prof. SEKIMOTO Atsushi

### Research Themes

Thermal fluid/Turbulence/Dynamical  
systems / Numerical simulation /  
Transport phenomena/Adjoint inverse  
analysis/Data-driven computation

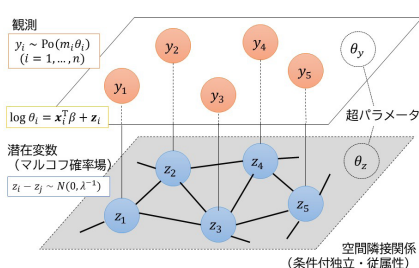
## Statistical Data Analysis



We conduct education and research on statistical theories and methodologies required to analyze data on various issues in the environmental and life sciences, natural and social sciences.

Statistical science is a fundamental technology of data analysis and machine learning, and provides the most effective means of presenting an objective view based on scientific evidence. We wish to contribute to solving various issues, with making use of drastically improving computer ability.

潜在マルコフ確率場による疾病地図データの空間解析



Prof. SAKAMOTO Wataru

### Research Themes

Computational statistics/  
Biostatistics/Statistical  
model selection



Senior Assist. Prof. TAKAGISHI Mariko

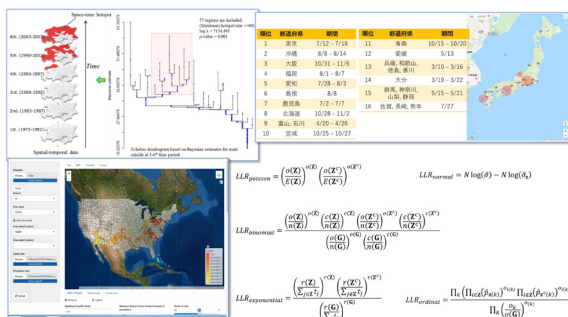
### Research Themes

Multivariate data analysis/  
Psychometrics

## Spatio-Temporal Statistics



The detection of problems such as the occurrence of infectious diseases or the mapping of natural disaster hazards is crucial and fundamental. While there are powerful and useful tools like geographical information systems (GISs) available, determining the location of space-time clusters for large quantities of spatial data or extensive time series poses significant challenges. This study aims to establish methods for identifying disease clusters or contaminant clusters, commonly referred to as hotspots, in various types of spatio-temporal data, as well as develop corresponding software.



Prof. ISHIOKA Fumio

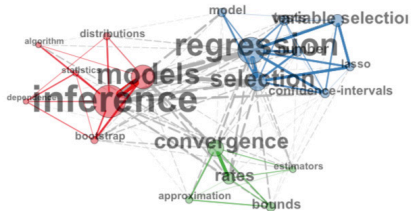
### Research Themes

Spatial statistics/Computational statistics/  
Echelon analysis/Spatial clusters/Spatial  
scan statistics/Spatial epidemiology

# Computational Statistics



Keyword Co-occurrences



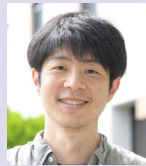
There are various types of data in data analysis. It is important to analyze obtained multivariate data, text data, picture data, and other data types. We apply and develop computational statistical approaches and methods to understand these data.



**Prof. IIZUKA Masaya**

■ **Research Themes**

Categorical data analysis/Software/  
Principal component Analysis/IR



**Senior Assist. Prof.  
OHKUBO Yusaku**

■ **Research Themes**

Life sciences/Ecology and environmental  
studies/Ecostatistics



# Advanced Science and Technology

Department of  
Computer Science

## Computer Engineering



We aim to establish new technologies of hardware and software for computer infrastructures. In computer hardware, we conduct interdisciplinary research on cutting-edge optical technologies (e.g., hologram memory and laser) and integrated circuits (VLSI) which act as the brain of computers. In computer software, we focus on the following research topics: construction methods of new operating systems (OS) and security technologies for OS, mobile devices, and IoT; technologies for supporting group collaboration with computers and networks; and interdisciplinary issues in artificial intelligence and computing technologies.



**Prof. YAMAUCHI Toshihiro**

■ **Research Themes**

Operating System/System Software/  
Computer Security/System Security/  
IoT Security



**Prof. WATANABE Minoru**

■ **Research Themes**

Information and communication/Computer  
system/Reconfigurable system/FPGA/  
Optically reconfigurable gate array

**Assoc. Prof. NOMURA Yoshinari**

■ **Research Themes**

Operating system/groupware



**Assoc. Prof. Lin Donghui**

■ **Research Themes**

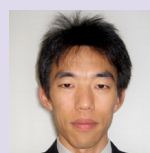
Multiagent Systems/Services  
Computing/Intelligent Computing



**Asst. Prof. KOBAYASHI Satoru**

■ **Research Themes**

Network management/  
System operation

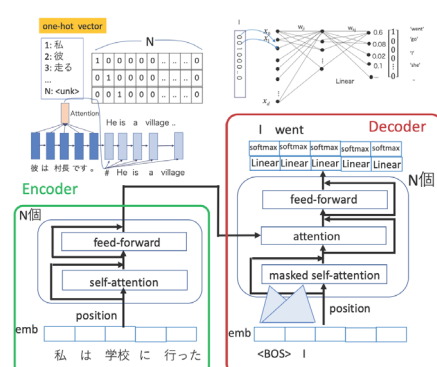


**Asst. Prof. WATANABE Nobuya**

■ **Research Themes**

Programming Language Processor/  
Parallel Processing/Hardware Design  
System/Computer Architecture/  
Reconfigurable System/FPGA/Hardware  
Design Automation/Language Processor

## Pattern Information Processing



Our research interests include basic theories of pattern recognition and understanding, and applied fields of visual information processing, language information processing, and speech information processing. As research on Pattern Information Processing, we apply methods from neuroscience and artificial intelligence such as machine learning, statistics, artificial intelligence, and data mining to design appropriate feature representations and discriminative models for images, videos, texts, and speeches.



**Prof. OKABE Takahiro**

■ **Research Themes**

Computer vision/Computational  
photography/ Image processing/  
Computer graphics



**Prof. AKASHI Takuya**

■ **Research Themes**

Artificial intelligence / Computer  
vision / Neuroscience/ Image  
recognition/ Human interface



**Assoc. Prof. TAKEUCHI Koichi**

■ **Research Themes**

Natural language processing/Deep  
neural network model/Large language  
model



**Assoc. Prof. HARA Sunao**

■ **Research Themes**

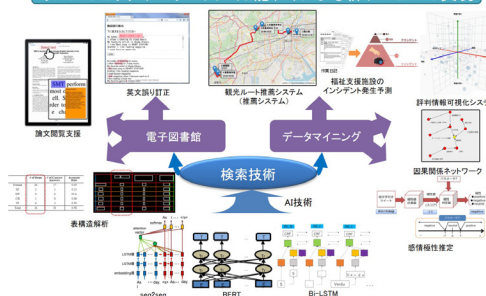
Speech processing/Signal processing/  
Spoken dialog system/Lifelogs/  
Multimodal information processing



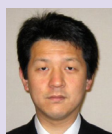
## Intelligent Design



ウェブのビッグデータ×人工知能(AI)による新サービスの実現



In the division of Intelligent Design, our research focuses on developing technologies that efficiently search for desired information and discover valuable insights from the vast amount of Big Data available on the Web, utilizing artificial intelligence and other related approaches. Additionally, we explore digital libraries that enable users to seamlessly navigate between the virtual world of cyberspace, connected by the Internet, and the physical reality. Our research also includes stream delivery technologies for multimedia information, including audio and video, with a particular emphasis on the integration of Internet broadcasting and data communications.



Prof. OHTA Manabu

■ Research Themes

Web Information Retrieval/Web Mining/  
Digital Library



Assoc. Prof. GOTOH Yusuke

■ Research Themes

Streaming Delivery in Broadcasting  
Environments/Spatial Computing



Senior Asst. Prof. MATSUDA Yuki

■ Research Themes

Internet of Things/Sensing/Information  
Network

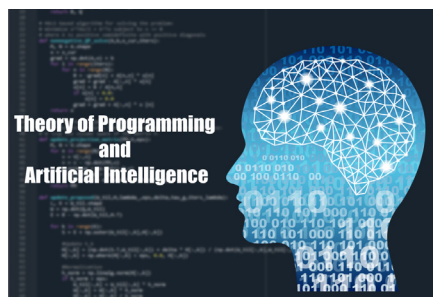


Asst. Prof. UWANO Fumito

■ Research Themes

Reinforcement Learning/Distributed Artificial  
Intelligence

## Theory of Programming and Artificial Intelligence



We conduct a wide range of research on basic theory and applications of computational intelligence, mathematical informatics, and software engineering. Specifically, we promote research on machine learning algorithms, mathematical programming, distributed algorithms, software measurement and analytics, mining software repositories, human behavior analysis, human-machine interaction, computer vision and so on.



Prof. NAKAGAWA Hiroyuki

■ Research Themes

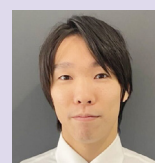
Autonomous software/  
Self-adaptive software/Agents/  
Software engineering/Requirements  
engineering/Software design



Asst. Prof. MIGITA Tsuyoshi

■ Research Themes

Computer vision



Asst. Prof. INAYOSHI Hiroki

■ Research Themes

Computer security/Privacy leakage  
detection



Prof. TAKAHASHI Norikazu

■ Research Themes

Information and mathematical  
engineering



Prof. MONDEN Akito

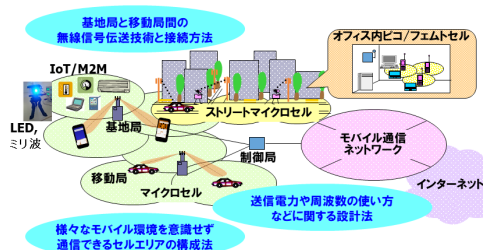
■ Research Themes

Empirical software engineering

# Advanced Science and Technology

Department of Information  
and Communication Systems

## Mobile Communications



This laboratory is working on research on new wireless technologies with the aim of realizing next generation mobile radio communication systems beyond 5G. Our major research challenges include OFDM/OFDMA and MIMO channel signal transmission to realize ultra high-speed and large-capacity systems with more than 10 Gbps, radio wave propagation and link budget technologies for seamless and flexible service area implementation. Furthermore, we are researching LED visible light communication as a new communication system, and wireless signal separation/demodulation technology aiming at the ultimate effective use of frequencies.



Prof. UEHARA Kazuhiro

### Research Themes

Mobile communication engineering



Assoc. Prof. TOMISATO Shigeru

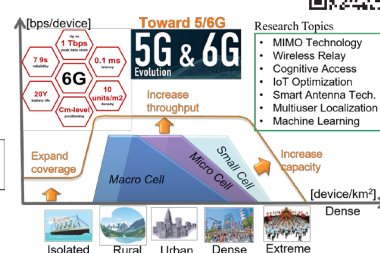
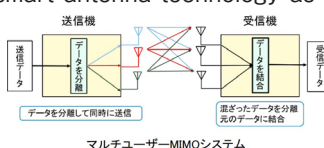
### Research Themes

Mobile communication engineering

## Multimedia Radio Systems



Our laboratory aims to 5G/6G wireless communication systems which can realize the high-speed wireless communication as "anytime, anywhere, anyone." Our research topics are most on the MIMO wireless communication system, MIMO relay, Overload MIMO system, IoT relay, smart antenna technology as ESPAR, LCX and RIS, wireless communication with machine learning, IoT devices localization. We are also developing the wireless technology for smart sensing and communication, cognitive radio, learning technique and prediction methods for wireless environment.



Prof. DENNO Satoshi

### Research Themes

Wireless communication/Signal processing/5G,6G wireless system/MIMO system/relay communications

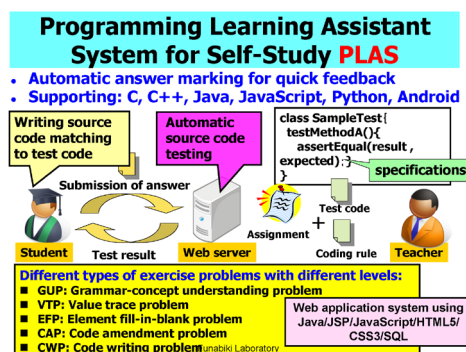


Assoc. Prof. HOU Yafei

### Research Themes

5G,6G wireless system/IoT localization/Smart antenna technology/Machine learning for wireless system

## Distributed System Design



We study practical and useful research topics in the Information Communication Technology (ICT), including programming learning assistant systems, wireless local-area networks, distributed computing systems, multimedia application systems, AR-based navigation systems, big data analysis, IoT application systems, to achieve our mission of the human resource developments for next generations. Currently, 38 international students from five countries are studying together with Japanese students in our laboratory.



Prof. FUNABIKI Nobuo

### Research Themes

Programming learning/WLAN/Multimedia/IoT application/Distributed computing system

## EMC Design



Optical and Electromagnetic Waves (OEWE) Lab studies research topics that aim to improve electrical, electronic, and telecommunication systems in speed and reliability. Our research is related to specific design technology to intentionally control and reduce unintentional electromagnetic waves, or electromagnetic noise, generated by electrical, electronic, and telecommunication equipment. Such design technology is called EMC design. EMC is short for electromagnetic compatibility

and means the ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable disturbance to anything in that environment. EMC consists of two aspects, EMI (electromagnetic interference) and EMS (electromagnetic susceptibility). The former is the ability that a system cannot interfere with other systems or subsystems. In contrast, the latter is the one that system must continue to operate correctly in the presence of interference from others or transient.



**Prof. TOYOTA Yoshitaka**

■ **Research Themes**  
Electromagnetic Compatibility (EMC)/Hardware Security/Safe and Security

## Secure Hardware Design

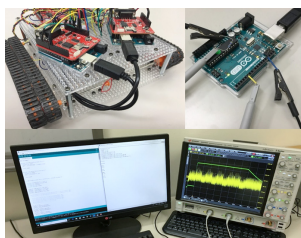


In an era where various devices are connected to the internet, and data is exchanged and stored, information security technology is essential for using services with confidence. Our research lab focuses on studying hardware design technologies.

**Assoc. Prof. IOKIBE Kengo**

■ **Research Themes**  
Hardware security / Electromagnetic information leakage / Electronics packaging / Modeling / IoT / Electromagnetic Compatibility / LiDAR

## Information Security



Consequently, securing and safeguarding communication and service delivery has become a critical issue. In our research laboratory, we are committed to the research and development of cryptography, random number generation, and related technologies. Our goal is to ensure that internet-connected devices, such as medical devices, automobiles, and smart home appliances, can operate securely and safely in this changing scenario. By applying encryption and random number techniques, we aim to provide reliable solutions that safeguard sensitive data and prevent security threats. Our research explores enhancing encryption algorithms, producing high-quality random numbers, and designing secure communication protocols. Through these endeavors, we aspire to create a dependable environment where individuals and organizations can confidently use internet-connected devices without jeopardizing their security and privacy.



**Prof. NOGAMI Yasuyuki**

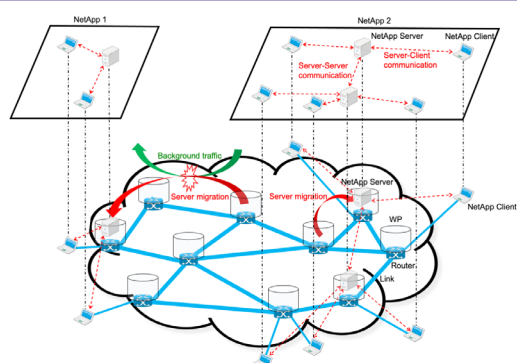
■ **Research Themes**  
Information security/Discrete mathematics/Modern cryptography/Post-quantum cryptography/Homomorphic encryption/IoT/AI-related security/Secure protocols



**Asst. Prof. KODERA Yuta**

■ **Research Themes**  
Information security/Discrete mathematics/Modern cryptography/Post-quantum cryptography/Homomorphic encryption/IoT/AI-related security/Secure protocols

# Network Systems



In the after-corona era, a remote world (decentralized society) is expected to arrive, and social and economic activities that do not require face-to-face interaction will take root as the new normal. In this research field, we focus on the Internet, which is becoming increasingly important as an ICT infrastructure supporting the new normal. We design the future Internet by predicting the services that will be needed on the Internet in the future and identifying the possibilities and limitations of various newly created technologies.



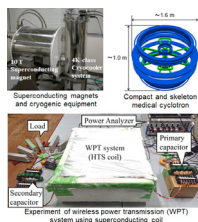
Assoc. Prof. FUKUSHIMA Yukinobu

## ■ Research Themes

Information network/Network virtualization/  
Edge computing/Knowledge-defined networking



## Applied Superconductivity Engineering



Superconducting technology is expected to contribute to our society by improving the efficiency of energy systems derived from the high current density of superconductors and creating new technologies through the application of high magnetic fields. In our laboratory, we have been developing high-efficiency and low-loss superconducting electrical devices using low-temperature superconducting wires and high-temperature superconductors (bulk and thin-film wires). We have also developed compact and/or high-field superconducting magnets for medical and/or fusion applications.

**Prof. KIM Seokbeom**

**Research Themes**

Superconductivity/  
Energy applications/  
Medical and fusion applications  
/Wireless power transmission/  
Electromagnetic field analysis



**Assoc. Prof.  
UEDA Hiroshi**

**Research Themes**

Superconductivity/  
Energy applications/Medical and  
fusion applications/Wireless power  
transmission/Electromagnetic field  
analysis



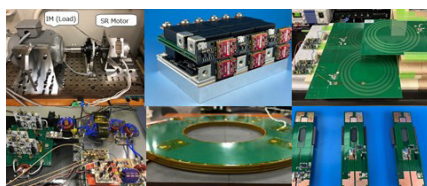
**Asst. Prof.  
INOUE Ryouta**

**Research Themes**

Superconductivity/  
Energy applications/Medical and  
fusion applications/Wireless power  
transmission/Electromagnetic field  
analysis



## Electric Power Conversion System Engineering



The following are examples of specific research topics.

- \*SR motor drive method that achieves both low torque ripple and low input current ripple
- \*High power density three-phase inverters using GaN-HEMTs for EV applications
- \*Stable resonant inductive coupling wireless power transfer system independent of manufacturing variation and magnetic interference
- \*High frequency resonant inverter for plasma generator applications
- \*Ultra-thin and low-loss coils for IH cooking heaters
- \*Rectifier-integrated printed-circuit-board winding structures

**Prof. HIRAKI Eiji**

**Research Themes**  
Power Electronics



**Assoc. Prof.  
UMETANI Kazuhiro**

**Research Themes**  
Power Electronics

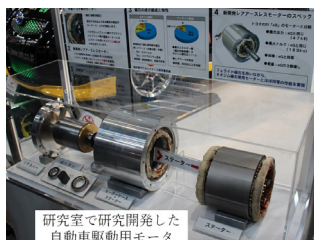


**Asst. Prof.  
ISHIHARA Masataka**

**Research Themes**  
Power Electronics



## Motor System Engineering



Currently, motors are used in a variety of locations from industry and transportation to the home, and more than half of all electricity generated in Japan is consumed by motors. Therefore, the improvement of motor efficiency is very effective in reducing energy-related carbon dioxide emissions, and is a very important research topic from the perspective of countermeasures against global warming and the depletion of energy resources. Accordingly, we are conducting research on "high performance motors" and "bearingless motors and magnetic bearings utilizing magnetic levitation" with the aim of "reducing the environmental burden caused by motors."



**Prof. TAKEMOTO Masatsugu**

**Research Themes**

Electrical machines/Generators/Electrical  
machinery/Motor drive/Power electronics



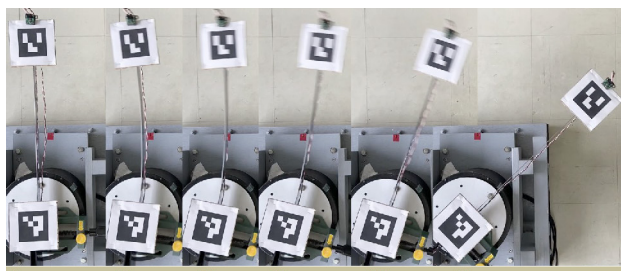
**Asst. Prof. TSUNATA Ren**

**Research Themes**

Electrical machines/Generators/Electrical  
machinery/Motor drive/Power electronics



## Electronic Control Engineering



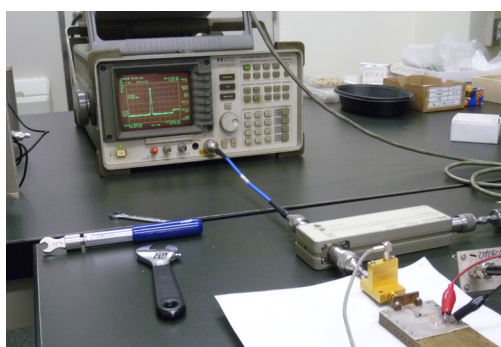
Control system optimization and its application are under research to develop theories and techniques, aiming to enhance electronic control technology widely employed in the current society.



Assoc. Prof. IMAI Jun

**Research Themes**  
Control engineering/Distributed parameter systems / Robust control

## Microwave Circuits



The microwave circuits laboratory principally conducts research on microwave circuits such as oscillators, microwave passive circuits such as power dividers/combiners, and other electromagnetic circuits for applications such as mobile communications, satellite broadcasting/communications, and wireless electric power transmissions.



Assoc. Prof. SANAGI Minoru

**Research Themes**  
Electrical and electronic engineering/  
Electronic devices and equipment/  
Microwave engineering

## Optoelectronic and Electromagnetic Wave Engineering



Research on wireless power transfer systems and devices using electromagnetic and acoustic waves, measurement systems for antenna system characteristics for mobile communications beyond 5G, network construction of IoT devices and sensor devices, medical devices using light, and sensor systems using optical fiber, etc.



Prof. FUKANO Hideki

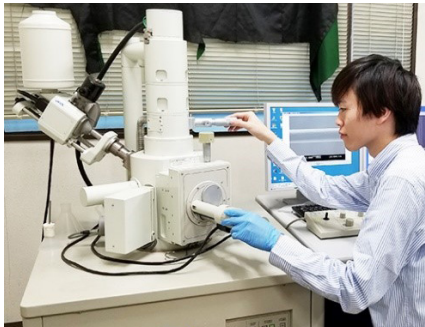
**Research Themes**  
Wireless power transfer/Electromagnetic field measurement/IoT network/Optical fiber sensor



Assoc. Prof. FUJIMORI Kazuhiro

**Research Themes**  
Wireless power transfer/Electromagnetic field measurement/IoT network/Optical fiber sensor

# Nanodevice and Materials Engineering



Semiconductors are used not only in computers, but also in various other places, such as solar cells, thermoelectric conversion devices and other power generation elements, and sensors that sense temperature and light. In addition to silicon, which is widely used today, our research targets new semiconductor materials with mechanical flexibility and excellent electrical properties, such as carbon nanotubes and semiconductive nanosheets, and we are conducting a series of research from structural control and design at the nanoscale (one billionth of a meter) to practical scale. We also perform research on defect properties and engineering in semiconducting materials.



**Prof. HAYASHI Yasuhiko**

**Research Themes**

Semiconductor/Nanocarbons/Two-dimensional materials/Flexible devices/Crystal defect and engineering



**Assoc. Prof. YAMASHITA Yoshifumi**

**Research Themes**

Semiconductor/Nanocarbons/Two-dimensional materials/Flexible devices/Crystal defect and engineering



**Asst. Prof. SUZUKI Hiroo**

**Research Themes**

Semiconductor/Nanocarbons/Two-dimensional materials/Flexible devices/Crystal defect and engineering

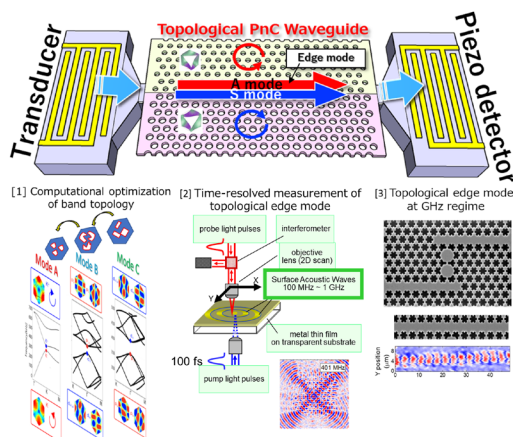


**Asst. Prof. NISHIKAWA Takeshi**

**Research Themes**

Semiconductor/Nanocarbons/Two-dimensional materials/Flexible devices/Crystal defect and engineering

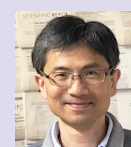
# Multiscale Device Design



**Research themes:**

- Design and application of novel artificial materials "metamaterials" that enable one to control light, electromagnetic, acoustic, and elastic waves as needed.
- Nanomaterials/devices design by first-principles and large-scale molecular simulation methods.
- Quantum-classical hybrid computation methods, machine learning, and artificial intelligence for designing the novel functionality of materials/devices.

In particular, we are currently focusing on "topological phononics" that is, as an analogy of physics on topological insulators/superconductors, a novel approach to the design of extremely efficient acoustic/elastic wave devices operating at ultra high-frequency (GHz) regimes.



**Prof. TSURUTA Kenji**

**Research Themes**

Applied physics/Nano-micro sciences/Nanomaterials engineering/Electronic materials engineering

# Advanced Science and Technology

Department of  
Intelligent Mechanical Systems

## Intelligent Systems Optimization



Our laboratory aims to develop basic theories and applications of intelligent systems optimization methodologies for supply chain management, scheduling, system science, and intelligent robotics. We are conducting research on new modeling, new optimization methods, artificial intelligence methods, efficient algorithms, modeling, analysis, and diagnosis for safe and optimized operations of large-scale industrial systems.

**Prof.  
NISHI Tatsushi**

■ **Research Themes**  
Systems optimization  
/Artificial intelligence/  
Supply chain management/  
Scheduling/Robotics



**Assoc. Prof.  
SATO Haruo**

■ **Research Themes**  
Radioactive waste  
disposal/Environmental  
dynamics/Radiation safety

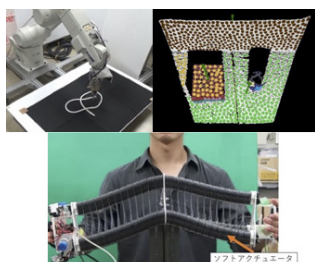


**Asst. Prof.  
LIU Ziang**

■ **Research Themes**  
Game theory/Decision  
making/Inventory  
management/Computational  
intelligence/Machine learning



## Intelligent Adaptive and Learning System



In our research field, our aim is to achieve robots capable of performing complex tasks, and we conduct fundamental research on advanced cognitive capabilities such as problem-solving, decision-making, and environment perception. Additionally, we strive for the social implementation of robots and engage in applied research in areas such as healthcare and rehabilitation.

**Prof. MATSUNO Takayuki**

■ **Research Themes**  
Surgical assistive robot/Manipulator robot

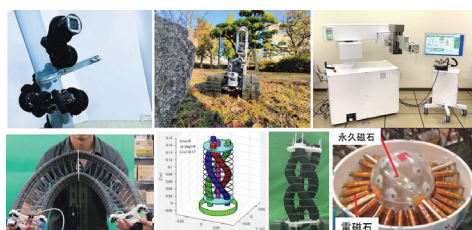


**Assoc. Prof.  
TODA Yuuichirou**

■ **Research Themes**  
Soft computing



## Biorobotics



We research and develop robots that are highly adaptable to the environment like living organisms, robots that cooperate with humans, and robots that can be applied to humans. For example, we are researching and developing a snake-like robot that can move through various environments like a biological snake, and a rescue robot for disaster response. We are also developing a remote-controlled needle-puncturing medical robot and a rehabilitation device using soft actuators.

**Prof.  
KAMEGAWA Tetsushi**

■ **Research Themes**  
Robotics/Snake robots/Rescue robots/  
Medical robots



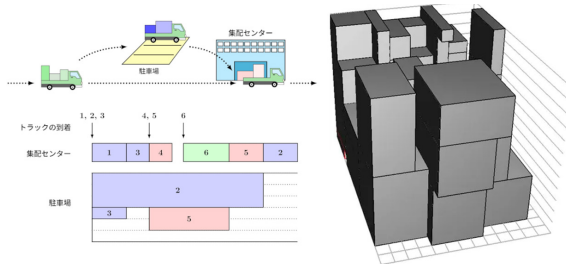
**Asst. Prof.  
SHIMOOKA So**

■ **Research Themes**  
Soft robotics/Mechatronics/Actuator/  
Medical and welfare engineering





## Production Intelligence



In the field of operations research, which is the mathematical and scientific process for better decision making for practical problems, we focus mainly on mathematical systems optimization to solve production, logistics and transportation problems. Specifically, we studies production scheduling problems in factories, stacking, premarshalling, and retrieval problems in warehouses, the three-dimensional truck loading

problem considering the retrieval order for package delivery, and so on.



**Prof.  
TANAKA Shunji**

### ■ Research Themes

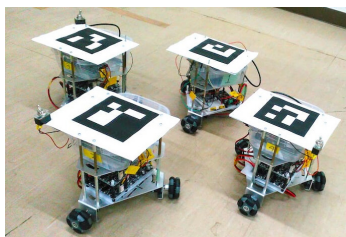
Operations research/Mathematical systems optimization/Scheduling/logistics

**Assoc. Prof.  
YANAGAWA Yoshinari**

### ■ Research Themes

Decision Modeling/Production Management/Ergonomics

## Intelligent Mechanical Control



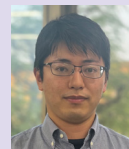
Control theory is one of the fundamental technologies supporting the current society. Its application field ranges widely from industrial apparatus to multi-agent systems. We focus on both theoretical and applied research on vast related topics including human-machine system like walking assistance device.



**Senior Asst. Prof.  
NAKAMURA Yukinori**

### ■ Research Themes

Control theory/Control engineering/ Machine learning/Data science

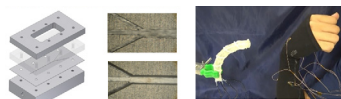
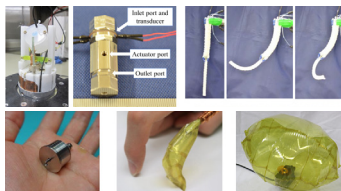


**Asst. Prof. IKEZAKI Taichi**

### ■ Research Themes

Control theory/Control engineering/ Machine learning/Data science

## Sysetm Integration



Our research is about actuators and device for mechatronics and their system applications.

- Application of micro actuators and special environmental mechanisms
- Microreactors and microfluidic devices

- High-performance smart pneumatic artificial muscles, soft mechanisms, and medical and welfare equipment applications
- Research on actuators for extreme environments and devices for space probes using film processing technology

**Prof.  
KANDA Takefumi**

### ■ Research Themes

Actuator/Sensor/Mechatronics/Softmechanism/Welfare device/Microsystem/Microreactor/Specific environment/Ultrasonics/Piezoelectricity/Microchannel



**Assoc. Prof.  
WAKIMOTO Shuichi**

### ■ Research Themes

Actuator/Sensor/Mechatronics/Softactuator/Softmechanism/Medical device/Welfare device



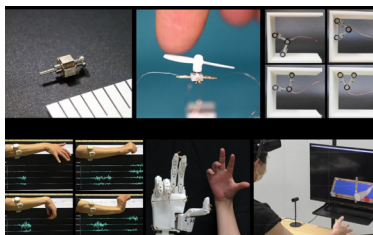
**Asst. Prof.  
YAMAGUCHI Daisuke**

### ■ Research Themes

Actuator/Sensor/Mechatronics/Softactuator/Softmechanism/Microsystem/Specific environment/Extreme environment/Spacecraft/Lunar exploration/Pneumatics/Ultrasonics/Piezoelectricity



# Mechatronic Systems

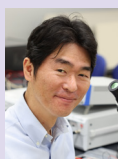


The Mechatronics Systems Laboratory is engaged in creative and fundamental research and development of new sensors and actuators, applied research and development of robot hands and medical diagnosis and measurement devices using these technologies, and research and development of peripheral technologies. In particular, we focus on sensors and actuators based on the piezoelectric effect as a driving principle, and our research ranges from basic research such as driving theory to design, development, and evaluation of new devices, as well as applied research such as robot control using these devices.

**Prof.  
MASHIMO Tomoaki**

■ Research Themes

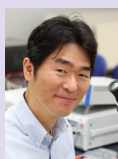
Microrobotics/Actuators/  
Sensors/Ultrasonic motors



**Assoc. Prof.  
SHIBANOKI Taro**

■ Research Themes

Microrobotics/Actuators/  
Sensors/Ultrasonic motors



**Asst. Prof.  
IZUHARA Shunsuke**

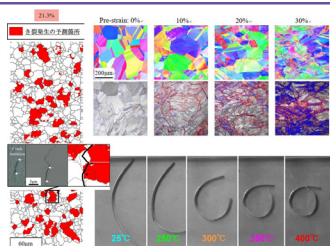
■ Research Themes

Microrobotics/Actuators/  
Sensors/Ultrasonic motors





## Structural Materials



Our research focuses on metallic materials, composite materials, and functional materials to create the required material properties by controlling their microstructures. With the motto "Seeing is believing," we emphasize the importance of observing, thinking about, and modeling phenomena by ourselves. Laboratory students have access to a variety of state-of-the-art electron microscopy systems and are able to learn micro-sampling techniques, as well as observation and analysis techniques at the atomic level.

**Prof. OKAYASU Mitsuhiro**

**Research Themes**

Structural Materials/  
Composites/Functional  
Materials/Microstructures



**Assoc. Prof. TAKEMOTO Yoshito**

**Research Themes**

Structural Materials/  
Composites/Functional  
Materials/Microstructures



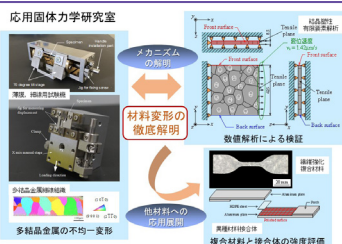
**Asst. Prof. ARAKAWA Junta**

**Research Themes**

Structural Materials/  
Composites/Functional  
Materials/Microstructures



## Applied Solid Mechanics



The target of our research is deformation, damage and fracture of various practical materials, including metallic and polymeric materials. We conduct experimental observations of nonuniform deformations for the materials and the corresponding numerical simulations in various levels.

**Prof. TADA Naoya**

**Research Themes**

Fracture /  
Damage / Deformation /  
Solid mechanics



**Assoc. Prof. UEMORI Takeshi**

**Research Themes**

Constitutive equation /  
Deformation / Numerical analysis /  
Mechanics of plasticity



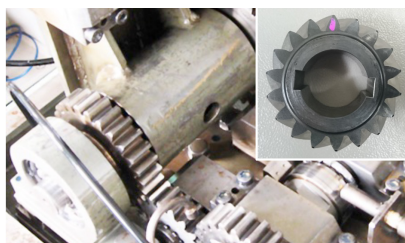
**Asst. Prof. SAKAMOTO Junji**

**Research Themes**

Fracture / Fatigue /  
Vibration / Fracture mechanics



## Machine Design and Tribology



In order to realize a carbon-neutral or decarbonized society, mechanical systems are required to be highly efficient, lightweight, and have a low environmental impact. At the mechanical design laboratory, we apply cutting-edge surface modification methods, coating methods and analysis methods to study technologies that dramatically improve the life, efficiency, and functionality of power transmission elements for EVs and various tribo-elements.



**Prof. FUJII Masahiro**

**Research Themes**

Mechanical element/Tribology/Gear/  
Fatigue strength/Low friction and  
wear/Surface modification/Coating

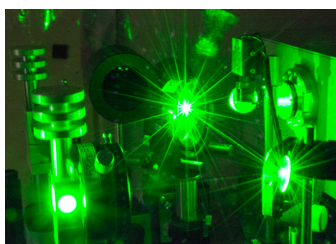


**Assoc. Prof. SHIOTA Tadashi**

**Research Themes**

Mechanical element/Tribology/Gear/  
Fatigue strength/Low friction and  
wear/Surface modification/Coating

## Nontraditional Machining



Along with the rapid progress of industrial technology, various new materials with excellent properties have been developed. Most of these materials are difficult to machine by the conventional mechanical methods, and the demand for machining of fine complicated shapes has been increased. Our laboratory is researching on high-performance and high-functional nontraditional machining methods, such as Electron Discharge Machining (EDM), Electron Beam Machining (EBM), and Laser Beam Machining (LBM) with using electric, electronic, optical energies. In addition, we are developing novel machining methods for the next generation.

**Prof.  
OKADA Akira**

■ **Research Themes**  
Nontraditional  
machining technology



**Assoc. Prof.  
OKAMOTO Yasuhiro**

■ **Research Themes**  
Laser beam  
machining/Electrical  
discharge machining



**Asst. Prof.  
SHINONAGA Togo**

■ **Research Themes**  
Electron beam  
machining/Laser  
beam machining



## Manufacturing Engineering



Studies on high efficiency, high precision, high quality, optimization, and intelligent automation of machining, which is the basic technology of manufacturing, and its peripheral technologies are carried out. In particular, advanced manufacturing technology for both machine tool users and builders is being developed through studies on not only grinding, cutting and abrasive finishing or their evaluation technology, but also further development of AI / IoT technology specialized in the field of manufacturing.



**Prof.  
OHASHI Kazuhito**

■ **Research Themes**  
Manufacturing Engineering/  
Grinding/Machining (Cutting)/  
Abrasive Machining



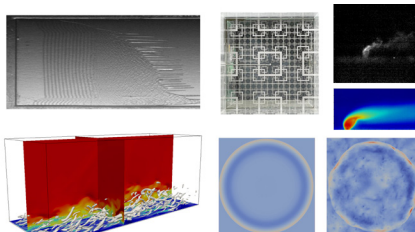
**Senior Asst. Prof.  
KODAMA Hiroyuki**

■ **Research Themes**  
Manufacturing Engineering/  
Machining (Cutting)/Grinding/  
Abrasive Machining/Data Mining

**Asst. Prof.  
KANEKO Kazuki**

■ **Research Themes**  
Mechanical Engineering/Manufacturing  
Engineering/Grinding/Machining  
(Cutting)/Abrasive Machining

## Fluid Dynamics



Understanding and controlling the forces that an object receives from the air plays an important role in industrial products such as automobiles and airplanes. The Fluid Dynamics Laboratory conducts research on fluid dynamics with the aim of contributing to the improvement of the performance of current industrial products and the development of new products. The Fluid Dynamics Laboratory conducts research on relatively slow flows, such as those assumed for wind turbines and automobiles used in wind power generation, to fast flows that reproduce the flight environment of airplanes and rockets, based on experiments, numerical calculations, and AI techniques.

**Prof.  
KOUCHI Toshinori**

■ **Research Themes**  
Aerodynamics/  
Aerospace Engineering/  
Mechanical engineering



**Assoc. Prof.  
SUZUKI Hiroki**

■ **Research Themes**  
Aerodynamics/  
Aerospace Engineering/  
Mechanical engineering



**Asst. Prof.  
TANAKA Kento**

■ **Research Themes**  
Aerodynamics/  
Aerospace Engineering/  
Mechanical engineering



## Heat Transfer Engineering



Latent heat storage/  
Heat transport/Polymer  
sorbent/Microcapsule/Droplet/  
Surface properties/Thermal radiation

The Heat Transfer Engineering Laboratory conducts research on understanding the basic phenomena of heat and mass transfer for the effective use of thermal energy and developing products with industrial needs. Specifically, we are conducting a wide range of research such as thermal energy transport and storage using latent heat, development of a new desiccant air conditioning system, investigations of droplet condensation, evaporation and freezing behavior with controlling the surface properties of an object, microcapsules containing latent heat storage materials, and numerical analysis of absorption and reflection by generation and functional thermal radiation films.

**Prof.  
HORIBE Akihiko**

■ **Research Themes**

Latent heat storage/  
Heat transport/Polymer  
sorbent/Microcapsule/Droplet/  
Surface properties/Thermal radiation



**Senior Asst. Prof.  
YAMADA Yutaka**

■ **Research Themes**

Latent heat storage/  
Heat transport/Polymer  
sorbent/Microcapsule/Droplet/  
Surface properties/Thermal radiation



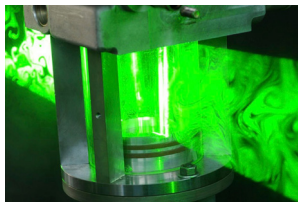
**Asst. Prof.  
ISOBE Kazuma**

■ **Research Themes**

Latent heat storage/  
Heat transport/Polymer  
sorbent/Microcapsule/Droplet/  
Surface properties/Thermal radiation



## Heat Power Engineering



Heat Power Engineering Laboratory focuses on combustion research for improving thermal efficiency and reducing harmful exhaust emissions. In-cylinder gas flow, spray and combustion processes are measured with ultra high-speed imaging, spectroscopy of emissions from chemical reactions, and lasers. Furthermore, CFD simulations are performed to predict and to elucidate those processes. Effective use of hydrogen, e-fuels and bio-fuels that contribute to carbon neutrality are also targeted.

**Prof. KAWAHARA  
Nobuyuki**

■ **Research Themes**

Thermal Engineering  
/Internal Combustion  
Engine/Combustion/Laser  
Diagnostic/Numerical Simulation



**Assoc. Prof.  
KOBASHI Yoshimitsu**

■ **Research Themes**

Thermal Engineering/  
Internal Combustion  
Engine/Combustion/Fuel/  
Compression Ignition



**Asst. Prof.  
TSUBOI Kazuya**

■ **Research Themes**

Thermal Engineering/  
Combustion Engineering  
& Science/Computational Fluid  
Dynamics





## Design of Timber Structures



Research and development of timber technologies and structural design methods for middle and high-rise timber structures.

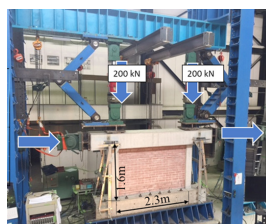
Structural design utilizing the latest wood materials such as CLT and fire-resistant timber.



Assoc. Prof.  
FUKUMOTO Kouji

■ Research Themes  
Timber Structure/Timber  
Construction/Hybrid Structure/  
Structure Design

## Aseismic Design of Structures

**Wind Resistance Group**

Wind and tidal power generation are being developed by applying flow-induced oscillations in structures such as bridges caused by wind and water currents.

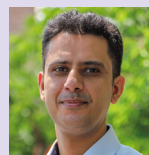
**Earthquake Resistance Group**

Our research is a combination of analytical simulation, earthquake damage surveys, and structural experiments in order to evaluate and improve the seismic performance of buildings for disaster mitigation and earthquake-resistant cities. Focusing on sustainability, we explore innovative earthquake-resistant structural systems, such as hybrid designs featuring CLT timber walls and reinforced concrete.



Prof. HIEJIMA Shinji

■ Research Themes  
Wind engineering/Vibration engineering/  
Wind power generation/Tidal current  
power generation



Assoc. Prof.  
ALWASHALI Hamood

■ Research Themes  
Seismic evaluation of buildings/seismic  
retrofit/performance assessment design/  
building structure/seismic disaster mitigation

## Design of Steel Structures



Research and education are conducted on the advanced methods of construction and maintenance of civil infrastructures. The types of infrastructures of our interest include railway, road, river, port, and soil structures such as tunnels, bridges, dams, banks. In terms of research topics, particular focuses are placed on the development of the state-of-the-art structural monitoring and nondestructive inspection techniques for the infrastructures under operation. To this end, we are developing physio-chemical models of structures, materials, and measurements, and validate the models and the monitoring/testing techniques built on them through computer simulations and experiments.



Prof. NISHIYAMA Satoshi

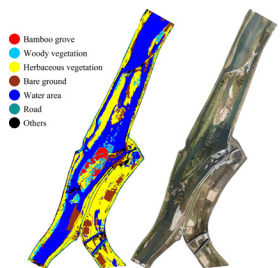
■ Research Themes  
infrastructure/construction/maintenance/  
steel structure/monitoring/nondestructive  
inspection



Assoc. Prof. KIMOTO Kazushi

■ Research Themes  
infrastructure/construction/maintenance/  
steel structure/monitoring/nondestructive  
inspection

## Hydraulic Engineering



We have conducted education and research on water flow analysis and hydraulic design methods for various hydraulic structures in rivers and coastal areas, which are related to the creation of diverse aquatic environments that can coexist with nature.

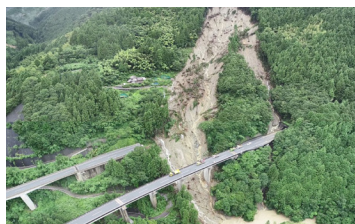


**Assoc. Prof.  
YOSHIDA Keisuke**  
■ Research Themes  
Hydraulic Engineering



**Assoc. Prof.  
AKOH Ryosuke**  
■ Research Themes  
Social Infrastructure(Civil  
Engineering/Architecture/  
Disaster Prevention)/  
Hydroengineering

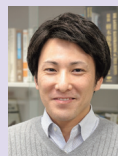
## Geotechnical and Groundwater Engineering



Study on Prediction of Slope Failure during Heavy Rainfall  
Development of Monitoring and Numerical Modeling Methods for Safety Assessment of River Levees against Seepage

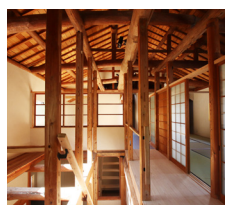


**Prof. KOMATSU Mitsuru**  
■ Research Themes  
Unsaturated soils/Analysis of seepage flow/Soil moisture



**Assoc. Prof. FURUKAWA Zentaro**  
■ Research Themes  
Geodisaster Prevention Engineering/  
Geoenvironmental Engineering/ Vegetation

## Architectural Design and Theory



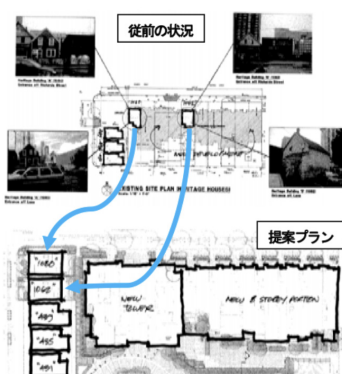
Development and Design Technical Practices of Design for Environmental Sustainability



**Assoc. Prof.  
KAWANISHI Atsushi**  
■ Research Themes  
Architectural Design/  
Architectural Theory/Design/  
Architectural Planning/Urban  
Planning



## Architecture and Urban Spatial Planning



A mechanism for inheriting a housing as a good stock from a previous generation as a living housing for future generations, handing down the culture and the community or the characteristics in the district, and how to use them, how to control new development. We are proceeding with research, keeping in mind these ideas. So far, We are doing research on from the design control method of individual architecture to architectural planning / planning history and urban spatial planning, history related to architecture and planning / legal system and its implementation, in both Japan and overseas cities.



Assoc. Prof. HORI Hirofumi

■ Research Themes

Architecture and urban spatial planning/Architecture and urban design policies/Architecture and urban landscape/Area based management/Business improvement district



Senior Asst. Prof. HASHIDA Ryohei

■ Research Themes

Architectural plan/Housing theory / Modern history

## Urban and Transport Planning



Realizing Sustainable Cities: In Japan, Sustainable cities are required in a declining birthrate and aging society. To realize safe, secure, and vibrant cities and transportation, we are researching efficient urban and transportation planning that takes into consideration the environment and people's lives.

Specifically, We are conducting research on the following topics.

- 1) traffic safety 2) public transportation planning 3) barrier-free transportation planning
- 4) clarification of the actual situation of the spongification phenomenon that occurs in the process of population decline
- 5) compact city planning 6) landscape-oriented city planning
- 7) measures for city planning in line with the history of historical and cultural civil engineering heritage that take advantage of the uniqueness of the region.

Prof. HASHIMOTO Seiji

■ Research Themes

Urban Transportation Planning/Community Development by Transportation Policy/Traffic Calming



Assoc. Prof. HIGUCHI Teruhisa

■ Research Themes

Civil Engineering History/Historical Structures Preservation and Utilization/Visual Town Planning/Disaster Prevention



Assoc. Prof. UJIHARA Takehito

■ Research Themes

Urban Planning/Urban Environment /Urban Transportation



## Wood-Based Materials



Although wood is a natural material with excellent mechanical properties, it has some weaknesses due to its biological origin. To overcome these weaknesses, previous researchers have developed various timber composite members and wood-based materials manufactured by gluing or connecting timber and small elements of wood. Now, to promote large-scale timber structure with a view to decarbonization, we will use the latest analytical and measurement techniques to provide theoretical support for fracture phenomena of existing wood-based materials and timber composite member; additionally, we will propose new combinations and forms of them on the basis of this analysis.



Asst. Prof. SUDO Ryutaro

■ Research Themes

Wood-Based Material/ Timber Engineering

## Wood Resource Utilization



Wood is significantly different from other agricultural and marine products in that, with proper management, it can store carbon over the long term. Maximizing this capability could potentially help mitigate global warming. Our laboratory is working toward further mitigating global warming by recycling wood. Additionally, we are conducting research on the effective use of wood resources by combining recycled wood with adhesive technologies.



**Prof. KORAI Hideaki**

■ **Research Themes**

Wood resources/Wood-based materials/Wood adhesion/ Recycled wood/ Carbon storage

## Design of Concrete Structures



address the goals of a sustainable society from the concrete perspective.

Concrete is the foundation of social infrastructure that supports this substance civilization. However, the act of building a structure with concrete, or the act of building concrete itself is an act that destroys the natural environment. I want to own a car, I want to travel abroad, I want to live with a flush toilet, a TV, a cooler, but I also want to protect the natural environment. Developing a sustainable society may be the answer to this contradiction of humanity. In this laboratory, we



**Prof. AYANO Toshiki**

■ **Research Themes**  
Construction material/  
Concrete engineering



**Assoc. Prof. FUJII Takashi**

■ **Research Themes**  
Construction material/  
Concrete engineering

## Urban and Building Environmental Engineering



Energy is essential for maintaining human activity. However, consuming energy not only causes global environmental issues such as global warming and energy resource depletion, but also causes local (urban) environmental issues such as heat island phenomenon and air pollution. We have been researching in our laboratory to clarify the way urban structures and the related energy systems should be built in the near future in order to realize a comfortable urban environment while maintaining a sustainable earth.

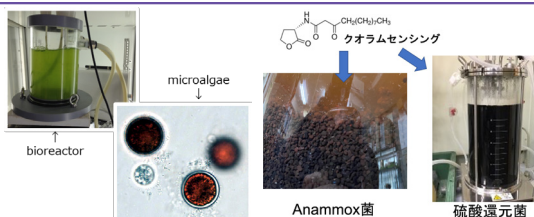


**Prof. NARUMI Daisuke**

■ **Research Themes**

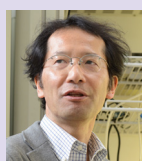
Sustainable Urban and Architectural Design/Carbon Neutral/Energy System/Heat Island

# Water Environment and Sanitation



“Water” is essential for our lives and livelihoods, and also works as a medium of transporting substances on both local and global scales. Therefore, the sustainability of our life and ecosystem can be easily threatened by the excess usage and pollution of water resources. We are doing education and researches on “water quality control technology (water treatment)” and “relationship between

material transport and aquatic ecosystems” to solve or prevent such issues for water resources. We hope to make our society safe, comfortable, and sustainable.



**Prof. NAGARE Hideaki**

■ Research Themes

Water environment/Water treatment/  
Resource recovery/Chemical substances



**Asst. Prof. HASHIGUCHI Ayumi**

■ Research Themes

Water environment/Water treatment/  
Resource recovery/Chemical substances

