Department of Mechanical Systems Engineering
Department of Finemechanics
Department of Robotics
Department of Aerospace Engineering

Department of Mechanical Systems Engineering, Department of Finemechanics, Department of Robotics, and Department of Aerospace Engineering consist of following Core Laboratories, Cooperative Laboratories, and etc.

［The figure in parenthesis indicates the number of laboratories.］

Department of Mechanical Systems Engineering

① Core Laboratories
Functional Systems Engineering（３）, Energy Systems Engineering（３）

② Collaborative Chair (Graduate School of Biomedical Engineering)
Biomechanical Engineering（１）

③ Cooperative Laboratories
Fracture and Reliability Research Institute (FRRI)［Division of Research:2]
Strength and Reliability for Advanced Energy and Enviromental Materials (１), New Energy Systems Science (１)
Institute of Fluid Science (IFS) [Division of Research:4, Research Center:3]
Creative Flow Research Division (１), Complex Flow Research Division (２), Lyon Center(１),
Innovative Energy Research Center(２), Nanoscale Flow Research Division (１)
Institute of Multidisciplinary Research for Advanced Materials (IMRAM) [Research Center:1]
Research center for sustainable science & engineering (１)

Department of Finemechanics

① Core Laboratories
Materials Physics and Engineering (３), Nanomechanics(３), Biomechanics (２)

② Cooperative Laboratories
Fracture and Reliability Research Institute (FRRI) [Division of Research: 2]
Division of Strength Reliability for Advanced Energy and Enviromental Materials(１), Division of Advanced Electric Power Technologies (１)
Institute of Fluid Science (IFS) [Division of Research:6, Research Center:1]
Nanoscale Flow Research Division (４), Innovative Energy Research Center(１), Creative Flow Research Division (２)
Frontier Research Institute for Interdisciplinary Sciences (FRIS)［Division of Research:1]
Creative Interdisciplinary Research Division (１)
Institute of Multidisciplinary Research for Advanced Materials (IMRAM)［Research Center:1]
Division of Measurements(１)

Department of Robotics

① Core Laboratories
Robot Systems (３), Nanosystems (２)

② Collaborative Chair (Graduate School of Biomedical Engineering)
Biomechanical Engineering（１）, Biomedical Engineering for Health and Welfare（１）

Department of Aerospace Engineering

① Core Laboratories
Aeronautical Engineering(４), Astronautical Engineering (３)

② Cooperative Laboratories
Institute of Fluid Science (IFS) [Division of Research:4]
Creative Flow Research Division (２), Complex Flow Research Division (２)

③ Collaborative Laboratories [JAXA]
Next Generation Space Transportation Systems（１）

Department of Mechanical Systems Engineering

Laboratory	Professor / Associate Professor	Theme of research
Functional Systems Engineering (Micro-Nanomechanical Architectonics)	Professor Takahito ONO Associate Professor Masaya TODA	Micro/nanomechanical systems are key technologies in the fields of information technology (IT), environmental engineering and biomedical engineering. Based on nanotechnology, nanomachining and advanced integration technology, our group is developing advanced precision mechanical systems consisted of nano/micro-mechanical elements and electrical elements. The examples of our research topics are following: 1. Biological 3D nano-imaging. 2. Ultimate sensing 3. Nano electromechanical systems
Functional Systems Engineering (Nano-Precision Mechanical Fabrication)	Professor Tsunemoto KURIYAGAWA （Department assigned：Graduate school of Biomedical Engineering） Associate Professor Masayoshi MIZUTANI	Our lab aims to promote innovations of nano-precision Micro/Meso Mechanical Manufacturing (M4 process) at the frontier of manufacturing technology, including ultra-precision mechanical manufacturing technologies for various shapes, nano-precision fabrication for 3D microstructures, atom/molecule manipulation for anostructures and so on. Our goal is not only to create high-precision shapes, but also to generate functional structures on the shape by controlling the micro textures. 1. Nano-precision Micro/Meso Mechanical Manufacturing (M4 process)(Kuriyagawa, Mizutani) 2. Creation of bio-medical interface utilizing various mechanical processes (Kuriyagawa, Mizutani) 3. Creation of functional interface by Powder Jet Deposition (Kuriyagawa,Mizutani)
Functional Systems Engineering (Tribology and Nanointerface Engineering)	Professor Koshi ADACHI	The limit of performance and reliability of almost all machines are associated with friction and wear at the tribological contact interface. Therefore, we aim to understand and control them from nanoscale view points for creation of future highly-reliable and highly-functional mechanical systems. 1. Design and creation of highly-functional surface/ interface 2. Smart tribological systems by control of nanointerface 3. Friction drive systems for precision positioning
Energy Systems Engineering (Renewable Energy Conversion Engineering)	Professor Hiroo YUGAMI Associate Professor Fumitada IGUCHI	Our laboratories study two major research topics “high efficiency usage of thermal energy by thermal radiation control” and the other is “development of energy conversion devices for renewable energy resources base on solid state ionics and various mechanics” to solve global energy demand and global-scale environmental disruption to archive sustainable growth. 1. Study of thermal radiation control techniques 2. Development of solar thermal energy systems 3. Study to improve mechanical reliability and durability of Solid Oxide Fuel Cells.

Laboratory	Professor / Associate Professor	Theme of research
Energy Systems Engineering (Control of Heat Transfer)	Professor Tetsushi BIWA	Our research forcuses on understanding of various thermoacoustic phenomena to design and build advanced energy conversion systems based on acoustic gas oscillations. 1. Understanding of thermal phenomena induced by oscillatory flow 2. Development of heat engines and heat transport devices using acoustic waves 3. Development of optical measurement techniques for oscillatory flow
<Collaborative Chair (Graduate School of Biomedical Engineering) > Biomechanical Engineering (Medical Nanosystem Engineering)	Professor Tetsu TANAKA （Department assigned：Graduate school of Biomedical Engineering） Associate Professor Takafumi FUKUSHIMA	Semiconductor neural engineering is a discipline that uses semiconductor process/device/circuit technologies to further understand properties of neural systems and to create novel fusion systems of living body and machine. One of the goals in this laboratory is to establish semiconductor neural engineering and develop biomedical micro/nano integrated systems. Another goal is to educate the next generation of leaders in biomedical engineering through research including: 1. Intelligent Si neural probe and brain-machine interface 2. Fully-implantable retinal prosthesis system 3. Self-assembly technology and high performance flexible sensor 4. 3D integration technology and analog/digital LSI design
<Cooperative Laboratories> Fracture and Reliability Research Institute [Division of Strength Reliability for Advanced Energy and Enviromental Materials, FRRI] (Laboratory for Surface Midification And Interfacial Control on Strength Reliability of Materials and Structures)	Professor Kazuhiro OGAWA Associate Professor Yuji ICHIKAWA	State-of-the-arts energy materials and components have been using at high temperatures, high pressure, or high-loading environments. Therefore, nano-level cracks or defects on surface or at the interface between crystal grains or materials can affect the lifetime of the materials and components. In this laboratory, the safety and reliability researches for energy materials and components based on surface modification and interface control have been studying. 1. Degradation mechanism analysis of energy materials and components 2. Development of thermal and environment barrier coatings for improvement of reliability for structural materials and components 3. Development of room-temperature bonding technique without heat affected zone 4. Study of high accuracy non-destructive evaluation for energy materials and components
<Cooperative Laboratories> Fracture and Reliability Research Institute [New Energy Systems Science, FRRI] (Laboratory for Earth Energy Systems Reserch) (Laboratory for Energy Cycle Systems Research)	Professor Toshiyuki HASHIDA Associate Professor Kazuhisa SATO	Establishment of environment-conscious energy systems is a prerequisite for the sustainable development of our society. Our research focuses on the development of next generation energy systems for subsurface energy extraction/cycling and energy conversion, and energy-substance systems based on nanomaterials. 1. Design and development of geothermal energy extraction systems based on complex mass/heat flow model 2. Supercritical CO_2/water/rock interactions for CO_2 geological storage and its reliability assessment 3. Mechanical reliability and durability of solid oxide fuel cells (SOFCs) and secondary battery systems such as lithium-ion batteries 4. Fabrication and functionalization of novel composites reinforced by carbon nanotubes for novel energy-substance systems

Laboratory	Professor / Associate Professor	Theme of research
<Cooperative Laboratories> Creative Flow Research Division, Institute of Fluid Science (Electromagnetic Functional Flow Dynamics, IFS)	Associate Professor Hidemasa TAKANA	Our group conducts researches on multiphase plasma flow and advanced electromagnetic fluids with focusing on the clarification of their complex thermofluid interactions in spatio-temporal multiscale, establishment and optimization of the intelligent fluid flow systems, as well as their advanced applicactions to environment, energy and material fields. 1. Characterization of particle, bubble and mist plasma flows for environmental treatment. 2. Development of electromagnetic energy conversion device for high utilization of wind energy. 3. Development of advanced micro thruster with ionic liquid. 4. Innovative cellulose fiber synthesis by electrostatic multiphase flow control.
<Cooperative Laboratories> Complex Flow Research Division, Institute of Fluid Science (Heat Transfer Control, IFS)	Professor Atsuki KOMIYA	Precise and active controls of heat and mass transfer under extreme conditions such as micro/nano scale and zero-gravity environments are important for future science and technology. This laboratory has been conducting research on the fundamentals of heat and mass transfer controls using an advanced optical system, and applies them to the low emission energy system and heat transfer enhancement. Heat transfer in intra-vital condition are also investigated. 1. Evaluation of protein mass transfer and its active control 2. Development of medical devices with highly precise heat transfer control technique 3. High heat flux cooling by phase change heat transfer in microscale 4. Low CO_2 emission power generation system utilizing oceanic methane hydrate
<Cooperative Laboratories> Complex Flow Research Division, Institute of Fluid Science (Advanced Fluid Machinery Systems, IFS)	Professor Yuka IGA	In our laboratory, we are studying complex phenomenon caused by high-speed gas-liquid mixture flow in an effort to acquire the high efficiency and reliability of next-generation fluidmachinery systems by using numerical and experimental analyses. 1. Clarification of mechanism of cavitation instabilities in liquid propellant rocked engine and development of the suppression techniequie. 2. Sophisfication of cavitation model for numerical simulation 3. Investigtion of cavitation thermodynamic effect by using high-temperature and high-pressure water tunnel
<Cooperative Laboratories> Lyon Center, Institute of Fluid Science (Mechanical Systems Evaluation, IFS)	Professor Tetsuya UCHIMOTO	In order to achieve higher reliability and safety of next-generation transportation systems and energy plants, we conduct research activities on intelligent sensing. 1. Characterization of material degradation and damage by electromagnetic nondestructive evaluation method. 2. Development of high temperature sensors and their applications to online monitoring. 3. Advanced sensing with sensor fusion and inverse analysis.
<Cooperative Laboratories> Innovative Energy Research Center, Institute of Fluid Science (Energy Dynamics, IFS)	Professor Kaoru MARUTA Associate Professor Hisashi NAKAMURA	For realizing combustion system with higher exergy efficiencies, various new concept combustion technologies are studied with domestic and international collaboration partners. 1. Analysis and construction of detailed combustion kinetics with a micro flow reactor with a controlled temperature profile for automobile engine and gas turbine combustor. 2. Fundamental and applied studies on microcombustion. 3. Microgravity combustion experiments for comprehensive combustion limit theory. 4. Research and development of high temperature oxygen combustion.

Laboratory	Professor / Associate Professor	Theme of research
<Cooperative Laboratories> Innovative Energy Research Center, Institute of Fluid Science (System Energy Maintenance, IFS)	Professor Toshiyuki TAKAGI Associate Professor Hiroyuki MIKI	With sensing technique and material evaluation methods, we carry out studies of the optimization of maintenance of huge complex system as represented by energy plants and also the technology of saving energy. 1. Optimization of maintenance activities with inverse approaches and techniques for real-time sensing. 2. Development of nondestructive testing method and functional materials for quality assurance of carbon fiber reinforced composites. 3. Technique which crystallizes powder dynamically by the simultaneous operation of compression and shearing force.
<Cooperative Laboratories> Nanoscale Flow Research Division, Institute of Fluid Science (Biological Nanoscale Reactive Flow, IFS)	Professor Takehiko SATO	We carry on creation and development of next-generation medical technologies such as plasma treatments and plasma sterilization by clarifying the interaction between the atmospheric-pressure plasma flow and the living organisms from the viewpoint of the biological reaction phenomena and the nanoscale flow phenomena. 1. Biological interaction mechanism by the atmospheric-pressure plasma flow 2. Reaction flow mechanism of the gas-liquid plasma 3. Discharge and the nanoscale flow phenomena of underwater plasma 4. Development of the method for sterilization and inactivation of pathogenic microorganisms by the plasma flow
<Cooperative Laboratories> Research Center for Sustainable Science & Engineering, Institute of Multidisciplinary Research for Advanced Materials (Solid State Ionic Devices, IMRAM)	Professor Koji AMEZAWA	Our laboratory contributes to solve environmental and energy problems throughout fundamental and application researches on environmental-friendly energy-conversion devices, such as solid oxide fuel cells and lithium ion secondary batteries. In particular, focusing on solid-state ion-conducting materials, we are challenging to establish an academic discipline on “solid-state ionics”, and applying this to develop novel materials and to improve performance/reliability of the energy conversion devices. We are also working for the development of advanced *in situ* analytical techniques for solid-state ionic devices.

Note: For more detailed information, please contact the director. (Professor Hiroo YUGAMI , TEL +81-22-795-6924)

Department of Finemechanics

Laboratory	Professor / Associate Professor	Theme of research
Materials Physics and Engineering (Intelligent Sensing of Materials)	Professor Hitoshi SOYAMA	In order to realize sustainable society, researches on enhancement and evaluation of materials properties are conducting for light weighting of automobile and for extension and reliability of life time of power-and chemical-plants. 1. Research and development of mechanical surface treatments and evaluation of modified layer 2. Production of novel materials by considering biomineralization 3. Evaluation of surface modified layer by using numerical simulation and experiment
Materials Physics and Engineering (Mechanics and Material Design)	Associate Professor Yoshiteru AOYAGI	Complicated behavior of materials is calculated using multiscale plasticity that simultaneously express phenomena of different scales such as an atomic scale on microstructures and a continuum scale on macroscopic structures. Furthermore, we aim to unite the data obtained by experiment with computational research and to create new prediction 1. Creation of Practical CAE System for Prediction of Mechanical Properties Based on Microstructure of Materials 2. Simulation on Mechanical Properties of Ultrafine-Grained Metals Based on Dislocation Behavior 3. Effect of Transcrystal on Fiber Reinforced Thermoplastic Composites
Materials Physics and Engineering (Intelligent Systems Engineering)	Professor Kazuo HOKKIRIGAWA Associate Professor Takeshi YAMAGUCHI	To realize the harmonized mature society of human and nature, it is necessary to establish intelligent systems engineering which enables development of green materials and their applications to advanced mechanical systems. Our group has been developing new plant-derived materials and their composites, and studying their applications to several mechanical systems. 1. Development and applications of hard porous carbon materials made from rice bran or rice husk 2. Development of friction/wear measurement systems 3. Gait analysis and development of evaluation system for slip resistance in shoe-floor interface
Nanomechanics (Optomechanics)	Professor Kazuhiro HANE	Interaction between lightwave and micro/nano-scale mechanical structures and control of lightwave by micro/nano mechanical systems are studied. Applications are micro mirror display, laser distance sensor for autonomous cars, optical switch, compact sensor for eye examination, etc. 1. Integrated optical systems with micro/nano actuators (optical switch, optical scanner, and micro interferometer) 2. Micro optical sensors for mechatronics (displacement sensors) 3. Compact optical systems for eye examinations (Fundus photography, Cataract sensor)
Nanomechanics (Precision Nanometrology)	Professor Wei GAO Associate Professor Yuki SHIMIZU	In Precision Nanometrology Laboratory, research activities are focused on nano-scale measurement and control of multi-degree-of-freedom surface forms and machine motions by combining unique precision nanometrology technologies with advanced machining technologies and control technologies in terms of nanometric metrology, control, fabrication and their applications. 1. Multi-dimensional ultra-precision optical sensors/actuators 2. Measurement and fabrication of multi-degree-of-freedom precision surface forms and machine motions 3. Measurement and control of micro/nanom-motions

Laboratory	Professor / Associate Professor	Theme of research
Nanomechanics (Mechanics of Materials System)	Professor Hironori TOHMYOH	Based on interdisciplinary approach, we aim at comprehensively evaluating the strength and functionality of various advanced materials system, which varies from the plant in mega-scale to small materials in micro/nano scale. 1. Joining and Modification of Fine-Scale Materials for Creating Advanced Materials System 2. Nondestructive Evaluation of Materials System Using Acoustic Resonance or Electromagnetic Induction 3. Characterization of Hair and Nail for Understanding Higher-Dimensional Materials System
Biomechanics (Biodevice Engineering)	Professor Matsuhiko NISHIZAWA Associate Professor Hirokazu KAJI	Recent rapid progress in molecular cell biology generates a new field of biodevice engineering that utilizes functions of biomolecules and cells. We are developing enzymatic and cellular sensors and power devices with high sensitivity and efficiency by soft micromachining of biomaterials. Followings are our concrete research themes. 1. Enzymatic fuel cell devices 2. Medical and environmental sensors 3. Biolithography for controlling self-assembling of biomaterials 4. Molecular engineering of human / device interface 5. Hydrogel-based biohybrid machines
Biomechanics (Biological Flow Studies)	Professor Takuji ISHIKAWA Associate Professor Kenji KIKUCHI	Biomechanics is a research field to understand biological, physiological and pathological phenomena in terms of physical principles. The methodology gives novel knowledge, which has not been accessible by conventional biological, medical and chemical tools. Our group focuses on biological flow related to microorganisms and a human body, and try to overcome environmental and health problems. 1. Prediction and control of microbial flora in the intestine 2. Physiological and pathological flow in the cardiovascular, respiratory and digestive systems 3. Large scale GPU computing of biological cells, such as micro algae and cancer cells 4. Transdermal absorption of medicine enhanced by mechanical stimulations
<Cooperative Laboratories> Fracture and Reliability Research Institute, [Division of Strength Reliability for Advanced Energy and Enviromental Materials, FRRI] (Laboratory for Prediction and Prevention of Fractures)	Professor Hideo MIURA Associate Professor Ken SUZUKI	New methods for predicting and preventing fractures of various devices, products, plants, and materials have been developed based on the explication of atomic-scale mechanism of characteristics and long-term reliability of materials. Main research topics are as follows. 1. Elucidation of the nature of advanced materials using quantum molecular dynamics 2. Development of highly sensitive sensors for detecting various external and internal loads in nano-scale 3. Evaluation of the damage of materials during the operation of various products by using electron microscope
<Cooperative Laboratories> Fracture and Reliability Research Institute, [Division of Advanced Electric Power Technologies, FRRI] (Joint Reserch with Tohoku Electric Power co., Inc.)	Professor (Concurrent post) Hideo MIURA Associate Professor Yoichi TAKEDA	With aiming to establish sustainable operation of the energy conversion systems, investigations related to improvement of efficiency in the turbine system and degradation mechanisms of structural materials in electric power generation plants are carried out. 1. Advanced technology for improving the efficiency of fossil fueled power generation 2. Advanced technology for distributed energy system using micro-gas turbine system 3. Improvement of efficiency and reliability of the turbine systems in fossil and nuclear power plants

Laboratory	Professor / Associate Professor	Theme of research
<Cooperative Laboratories> Nanoscale Flow Research Division, Institute of Fluid Science (Molecular Heat Transfer Laboratory, IFS)	Professor Taku OHARA	Molecular-scale thermophysical phenomena such as transport of thermal energy and mass, and interfacial phenomena among various phases play important roles in advanced technologies including biotechnology, design of thermal fluid and nanoscale fabrication process. Basic mechanism of the elementary process is being studied, which leads to the cutting-edge applications in mechanical engineering and thermal engineering. 1. Molecular-scale transport phenomena in liquids and solid-liquid/ liquid-gas interfaces 2. Analysis and control of molecular-scale transport phenomena of thermal energy and momentum aiming at the design of thermal fluids with required thermophysical properties 3. Study of advanced coating 4. Thermal and mass transport characteristics in molecular membranes such as cell membrane 5. Basic studies for biomimetic fluid machinery
<Cooperative Laboratories> Nanoscale Flow Research Division, Institute of Fluid Science (Molecular Composite Flow Laboratory, IFS)	Professor (Concurrent post) Taku OHARA Associate Professor Gota KIKUGAWA	From nanoscale to macroscale, various thermal and fluid phenomena, in which composite molecular-scale physics is integrated, are of critical importance in the wide range of engineering and industrial processes. In particular, an essential understanding of these phenomena is indispensable to improve the performance of next-generation semiconductor devices or to explore and develop novel polymeric substances. By using large-scale numerical simulations such as the molecular dynamics method, we investigate heat and mass transfer phenomena in the thermal and fluid engineering from the microscopic viewpoint. The underlying microscopic mechanisms governing macroscale thermofluid properties are examined as well. Moreover, industrial applications based on this knowledge are also explored. 1. Molecular-scale mechanisms governing macroscale thermofluid properties 2. Development of molecular dynamics analyses in the thermal and fluid engineering 3. Control of interfacial transport properties by surface modification techniques such as self-assembled monolayer (SAM) 4. Microscopic mechanism of interface affinity and wettability on the surface of organic molecular films 5. Multiscale analyses regarding design of transport properties for polymeric materials
<Cooperative Laboratories> Nanoscale Flow Research Division, Institute of Fluid Science (Non-Equilibrium Molecular Gas Flow Laboratory, IFS)	Professor (Concurrent post) Taku OHARA Associate Professor Shigeru YONEMURA	In rarefied gas flows around space vehicles, and in cold plasmas for semiconductor manufacturing or for an ion thruster, and in microscale gas flows in the neighborhood of MEMS/NEMS, the mean free path of gas molecules becomes as large as characteristic lengths of gas flows. Such gas flows are in strong nonequilibrium due to a lack of intermolecular collisions and cannot be treated as a continuum, but should be treated from the viewpoint of atoms, molecules, ions and electrons. Due to the developments of recent microfabrication technology, the industrial importance of such gas flows has increased year by year. We study physical phenomena in such flows and use the knowledge obtained here in industry. 1. Study on transport of a microscale object driven by Knudsen force peculiar to micro/nanoscale gas flow 2. Study on transport phenomena in nanoscale gas flows in porous media 3. Study on nanoscale gas lubrication by molecular gas dynamics approach 4. New numerical solution of the Boltzmann equation 5. Study on structure and behavior of cold plasmas

Laboratory	Professor / Associate Professor	Theme of research
<Cooperative Laboratories> Nanoscale Flow Research Division, Institute of Fluid Science (Quantum Nanoscale Flow Systems Laboratory, IFS)	Professor Takashi TOKUMASU	In the flow phenomena of fluid, it is often seen that the "chemical reaction" which occurs at the atomic/molecular scale affects much on the macroscopic "diffusion phenomena" of fluids. Moreover, very light atoms, such as hydrogen, cannot be regarded as a mass point and its effect sometimes appears at the phase diagram of this substance. When we analyze the mechanism by which the characteristics appears or behaviors of nanoscale flow systems which consists of such substances, it is necessary to analyze them by the method in which the "quantum effect" of the substances is considered because the conventional molecular dynamics method cannot treat such characteristics accurately. This laboratory treats the system in which the quantum effect of such fluid affects on the flow phenomena, and conducts research on clarification of its physical mechanism by various methods with considering the quantum effect and its application for engineering aspects. 1. Study for the transport phenomena of materials in polymer electrolyte fuel cell 2. Study for the effect of quantun characteristics of hydrogen atom/molecule on thermal properties of liquid hydrogen. 3. Modeling of proton transfer by quantum/molecular dynamics simulation.
<Cooperative Laboratories> Innovative Energy Research Center, Institute of Fluid Science (Green Nanotechnology, IFS)	Professor Seiji SAMUKAWA	Nano-process is getting more and more important to realize fabrication of ultrafine three-dimensional structures and novel functional films in the field of nanotechnology including semiconductor devices, MEMS/NEMS, optical devices, and biotechnology. We are studying on novel nanomaterials and nanofabrication processes by systematic investigation on physics and chemistry of interaction between particles such as atoms, molecules, electrons, ions, and photons and solid, liquid, and gas. 1. Novel devices fabricated by fusion of biotechnology and nanotechnology 2. Ultra-high-quality processes (etching, deposition) for leading-edge semiconductor devices 3. Precise plasma process system by fusion of plasma monitoring and computer simulation 4. Low environmental impact gas processes
<Cooperative Laboratories> Creative Flow Research Division, Institute of Fluid Science (Integrated Simulation Biomedical Engineering Laboratory, IFS)	Professor Toshiyuki HAYASE Associate Professor Kenichi FUNAMOTO	Understanding mechanisms leading to diseases and disorders is essential for establishment of prevention and treatment procedures for them. We are conducting research based on the integrated methodology of experimental measurement and numerical simulation aiming at precise elucidation of dynamics *in vivo* and development of a novel diagnostic methodology. 1. Understanding biofunctions by measurement-integrated simulations. (Hayase & Funamoto) 2. Development of novel medical instruments by measurement-integrated simulation. (Hayase) 3. Investigation of mechanical interaction between blood cells and blood vessels in microvasculature. (Hayase) 4. Development of microfluidic device to reproduce *in vivo* microenvironment. (Funamoto) 5. Elucidation of cellular behaviors and interactions. (Funamoto)
<Cooperative Laboratories> Creative Flow Research Division, Institute of Fluid Science (Biomedical Flow Dynamics Laboratory , IFS)	Professor Makoto OHTA	We have a high motivation for leading researches for medical device with medical doctors. Our topics and topics are the followings. 1. Development of in-vitro model for supporting evaluation of new medical device and education. 2. Computational simulation for treatiment with medical devices 3. Optimization of medical devices 4. Analyses of cell responses with medical devices 5. Contribution to standardization for medical devices

Laboratory	Professor / Associate Professor	Theme of research
<Cooperative Laboratories> Division of Measurements, Institute of Multidisciplinary Research for Advanced Materials, (Surface Physics and Processing, IMRAM)	Professor Yuji TAKAKUWA	Solid surfaces are ideal templates, where exotic atoms are arranged or stacked artificially, to fabricate novel nano materials that exert unique functionality. In order to understand the surface processes, we study the fundamental properties of the solid surfaces and the reaction mechanism on the surfaces. We use a unique Photoemission-Assisted Plasma-Enhanced CVD method to grow thin films on the substrate. 1. Study of the formation mechanism of ultra-thin silicon dioxide 2. Synthesis of graphene, DLC and diamond films and understanding their growth processes. 3. Study of the surface and interface structures for nano devices. 4. Development of techniques for the direct visualization of surface and interface structures.

Note: For more detailed information, please contact the director. (Professor Kazuo HOKKIRIGAWA , TEL +81-22-795-7000)

Department of Robotics

Laboratory	Professor / Associate Professor	Theme of research
Robot Systems (System Robotics)	Professor Kazuhiro KOSUGE Associate Professor Shogo ARAI	A robot is a system, which consists of hardware, such as mechanical elements, actuators, sensors, and CPUs, and software, which generates intelligent behavior of the robot based on algorithms implemented in the CPUs. System robotics is a new field of robotics dealing with both hardware and software related to robotics in real environments. The research topics include but not limited to 1. Physical Human-robot Interaction 2. Assistive Robot Systems 3. Robotics Technology Applications to Real World
Robot Systems (Intelligent Mechatronics)	Professor Mitsuhiro HAYASHIBE Associate Professor Dai OWAKI	Recently, the current era is refered as a century of robotics. However, there are still a lot of things we need to deeply learn from advanced and robust motor control and sensory functions which humans have, for next step forward. Robotics is also useful as computational tool to understand human motor learning mechanism. We study on neuroscience for robotics and robotics for neuroscience as “Neuro-Robotics”. 1. Study of human motor control, learning mechanism 2. Modeling and identifying biological signals and functions 3. Development of robot technology to Neuro-Rehabilitation
Robot Systems (Design of Intelligent Machines)	Professor Yasuhisa HIRATA	We expect to utilize robot systems not only the industrial fields but also the fields such as home, office, and hospital in cooperation with human. Our laboratory focuses on the human-robot cooperation system for supporting human being based on the physical interaction. Especially, we develop the passive robots which do not have active actuators, and the motion is controlled based on brakes and violation motors. The passive robots are intrinsically safe because they cannot move unintentionally with driving force. We also extend the passive robot concept for realizing the high-efficiency and wide-area surveillance system based on formation control of multiple passive vehicles. 1. Welfare Robot Systems 2. A Haptic Feedback Device for Guiding Human Motion 3. Formation Control of Multiple Mobile Robots
Nanosystems (Molecular Robotics)	Professor Satoshi MURATA Associate Professor Shinichiro NOMURA	Thanks to the progress of molecular biology and other life sciences, the mechanisms of biological molecular machineries have been elucidated in considerable detail. This knowledge is now ready to apply to various fields of engineering, such as fabrication of complicated nanostructures and functional molecular devices. In our laboratory, we are focusing on design and fabrication of nanostructures and molecular devices utilizing biomaterials such as DNA, lipid and proteins. Further, we seek for a systematic methodology called “molecular robotics”, to integrate them into a consistent system with desired autonomy. 1. Design and fabrication of nanostructures made of nucleic acids and lipids. 2. Design and fabrication of molecular devices for computation, sensing and actuation. 3. System integration of those structures and devices into a functional molecular robot or an artificial cell.

Laboratory	Professor / Associate Professor	Theme of research
Nanosystems (Smart System Integration)	Professor Shuji TANAKA Associate Professor Takashiro TSUKAMOTO	Interface between “machines” and human is getting more important to consider the applications of advanced mechanical systems. Also, future “machines” will have advanced control, autonomy and functions as networked systems, as is the case with next-generation robots. This laboratory is studying “smart systems” enabling such advanced “machines” by integrating functional components in a small size. Our research interests include material development, process development, device fabrication and system demonstration (see examples below), all of which are necessary to implement “smart systems.” Through such a synthetic approach, high-level education and research in the field of Nanosystems are conducted. 1. Sensors for human-friendly robots 2. Wireless communication devices 3. Bio-sensors for medical diagnostics 4. System integration 5. Integration and packaging technology 6. Fundamental technology for sensors and actuators
Nanosystems (Informative Nanosystems)	Professor Yoshiaki KANAMORI	To realize freely light controlling on demand, manufacturing technologies of metamaterials (artificial optical material with sub-wavelength structures smaller than light wavelength as unit element) by micro/nano processing technologies, reconfigurable metamaterial that changes their optical properties, and applications of metamaterial have been developed. Also, highly efficient nano-optical devices by applying biomimetics has been studied. It is expected to be widely applied in the fields of information, energy, environment, medical care, welfare, etc. 1. Development of ultra-small spectroscopy system using metamaterials and high sensitivity biosensors. 2. Study of high efficiency color filters and anti-reflection structures that imitate peacock’s wings and moth-eyes. 3. Research on force sensor and wavelength selective control with integrated micromachines. 4. Research on polarization and absorption control technology of terahertz wave.
<Collaborative Chair (Graduate School of Biomedical Engineering) > Biomedical Engineering for Health and Welfare (Medical Welfare Engineering)	Professor Mami TANAKA （Department assigned：Graduate school of Biomedical Engineering） Associate Professor Takeshi OKUYAMA	With low birthrate and aging, staying healthy and the maintenance and improvement of the quality of life (QOL) are strongly desired. To stay healthy, early detection and treatment of diseases is important. In order to solve these, we treat the advanced mechatronics and signal processing technologies, and develop sensor/actuator systems for medical welfare apparatus. The topics are as follows: 1. Intelligent artificial finger 2. Development of a palpation sensor system 3. Elucidation of mechanism of human tactile and touch feeling 4. Measurement and analysis of human hand/finger motion
<Collaborative Chair (Graduate School of Biomedical Engineering) > Biomechanical Engineering (Nanodevice Engineering)	Professor Yoichi HAGA （Department assigned：Graduate school of Biomedical Engineering）	Minimally invasive medicine with less injury to the body, and healthcare devices which promote and maintain health are becoming more important in medical field. Using microfabrication technologies including MEMS (Micro Electro Mechanical Systems) technologies, research and education to develop novel and useful medical devices and healthcare devices are conducted. Our studies range from basic research and development of fabrication process to clinical application and practical research. 1. Minimally invasive medical diagnostic and therapeutic divices with high-performance and multi-function. 2. Novel healthcare devices using new structure or principle. 3. Development of nonplanar microfabrication technology which is suitable shape for insertion and use in the living body.

Note: For more detailed information, please contact the director. (Professor Shuji TANAKA , TEL+81-22-795-6934)

Department of Aerospace Engineering

Laboratory	Professor / Associate Professor	Theme of research
Aeronautical Engineering (Aerodynamic Design)	Professor Soshi KAWAI	Our research draws from theoretical analysis, computational physics, data science, and high-performance computing to develop novel high-fidelity numerical simulation techniques for uncovering the basic physics underlying complex compressible, multiscale and multiphysics flows in aerospace engineering and for next-generation aircraft aerodynamic design tools. 1. High-fidelity numerical methods based on computational physics 2. Wall modeling in LES for realistic high Reynolds number flows 3. Aerodynamic prediction methods over the whole aircraft flight envelope 4. High-fidelity modeling of turbulent combustion in engine combustors 5. Accurate/fast hierarchical Cartesian flow solver toward exascale computer
Aeronautical Engineering (Computational Aerodynamics)	Professor Keisuke SAWADA	Studies are conducted to develop highly accurate numerical methods for computational aerodynamics, and to apply those developed methods for various problems in aerospace engineering: 1. Develop kinetic energy and entropy preserving (KEEP) schemes for unstructured mesh 2. Laminar-turbulent transition modeling based on directed percolation model 3. Application of aerospace CFD methods to high-speed train aerodynamics 4. Computational aerodynamics for hypersonic flows
Aeronautical Engineering (Smart Systems for Materials and Structures)	Professor Tomonaga OKABE Associate Professor Go YAMAMOTO	This research group is developing and implementing a variety of numerical failure modeling tools for the advanced composites as follows; 1. Numerical method for failure simulation of fiber-reinforced composites 2. Multi-objective design of composite aircraft structures 3. Virtual testing of composite aircraft structures 4. Multi-scale modeling of advanced composite structures 5. Atomistic simulation of advanced composite materials
Aeronautical Engineering (Experimental Aerodynamics)	Professor Keisuke ASAI Associate Professor Taku NONOMURA	In developing next-generation aircrafts, it is indispensable to understand the air flow around the vehicle and clarify the aerodynamic characteristics of it. In our laboratory, we study the aerodynamics by simulating real flow conditions using experiments and by visualizing the flow fields using optical means. Our objective is “to create, measure, and control flows.” A particular emphasis has been placed on the development of various advanced wind-tunnel testing techniques and the study of aerodynamics in low-speed to hypersonic regimes by using windtunnel testing. 1. Advanced measurement techniques (PSP/TSP, GLOF, etc) 2. Dynamic wind tunnel testing using new-generation magnetic suspension and balance system (MSBS) 3. Radical improvements of aerodynamic characteristics by flow control 4. On-flight flow diagnosis by combining experiments and simulation
Astronautical Engineering (Propulsion Engineering)	Professor Naofumi OHNISHI Associate Professor Masayuki TAKAHASHI	New propulsion schemes by plasma, hypersonic flow dynamics, nonequilbrium gas dynamics, and numerical techniques for them are investigated by computer simulations for future aerospace engineering applications. 1. Feasibility study of beamed energy propulsion 2. Plasma acceleration analysis and improvement on electric propulsion 3. Proposal of advanced flow control technique by unsteady plasma 4. Prediction of nonequilibrium radiation from hypersonic flow 5. Numerical simulations relevant to astrophysical flow

Laboratory	Professor / Associate Professor	Theme of research
Astronautical Engineering (Space Exploration)	Professor Kazuya YOSHIDA Associate Professor Toshinori KUWAHARA	We are working on space robotics technology for application to various space exploration and space development missions. 1. Study on core technologies for space robotics and space flight systems, such as motion dynamics and control, sensing and navigation, teleoperation and autonomy 2. Dynamics and control of free-flying space robots for operation in orbital or micro-gravity environment 3. Research and development of exploration robots for the surface of Moon, planets and asteroids 4. Research and development of micro-satellites for scienctific observation, remote sensing and disaster monitoring missions
Astronautical Engineering (Space Structures)	Professor Kanjuro MAKIHARA	We are engaged in analytical and experimental research on dynamics, aeroelasticity and shape control for space structures, such as space stations, lunar bases, and artificial satellites. 1. Self-powered vibration control for space structures 2. Autonomous energy-harvesting using smart devices 3. Impact-proof tether systems for debris removal 4. Modeling for Mars-airplane with folding wings 5. Dynamics analysis and construction for large space structures
<Cooperative Laboratories> Creative Flow Research Division, Institute of Fluid Science (Aerospace Fluid Engineering, IFS)	Professor Shigeru OBAYASHI Associate Professor Koji SHIMOYAMA	We are working on experimental fluid dynamics, computational fluid dynamics, and their integration for the innovation, safety, and creation of aerospace systems. 1. Innovative design and manufacturing assisted by “Multi-Objective Design Exploration” and “Uncertainty Quantification” (SHIMOYAMA) 2. Innovative engineering design driven by “Data Assimilation” (OBAYASHI) 3. Innovative aerospace plane experimented by “Magnetic Suspension and Balance System” and “Ballistic Range” (OBAYASHI)
<Cooperative Laboratories> Complex Flow Research Division, Institute of Fluid Science (High Speed Reacting Flow, IFS)	Professor Hideaki KOBAYASHI	Combustion phenomena represented by gas turbine combustion of aircraft engines are highly complicated where turbulent flows interact with chemical reactions in extreme conditions. In this lab, researches on high-speed combustion phenomena and new combustion technologies with globally low environmental impact are performed using advanced laser diagnostics and numerical simulations. 1. Turbulent combustion in a high pressure and high temperature environment 2. High-pressure spray combustion in gas turbine combustor conditions 3. Supersonic combustion phenomenon and its control 4. Laser diagnostics for rocket engine combustion 5. Combustion technology of carbon-free and carbon neutral fuels
<Cooperative Laboratories> Complex Flow Research Division, Institute of Fluid Science (Complex Shock Wave, IFS)	Professor (Concurrent post) Hiroki NAGAI Associate Professor (Concurrent post) Kiyonobu OHTANI	We are working on study of complex propagation phenomena of shock wave in gas-liquid-solid three-phase for understanding a fundamental mechanism and its interdisciplinary application 1. Study on shock wave propagation phenomena for human body tissue protection 2. Establishment of shock wave pressure active control method 3. Studyn on supersonic free-flight projectile for artodynamics

Laboratory	Professor / Associate Professor	Theme of research
<Cooperative Laboratories> Creative Flow Research Division, Institute of Fluid Science (Spacecraft Thermal and Fluids Systems Laboratory, IFS)	Professor Hiroki NAGAI	We are working on study of thermal and fluids system for spacecraft, and development of their control technique. 1. Study on aerodynamic characteristics and heating when space vehicle enters into planet having atmosphere 2. Study on thermal control system and device for next-generation spacecraft 3. Study on airplane which flies in planet having atmosphere 4. Research and development of novel optical measurement technique for thermal and fluid dynamic phenomena
<Collaborative Laboratories> Next Generation Space Transportation System, JAXA ※Note	Professor Sadatake TOMIOKA (Visiting member) Professor Hideyuki TANNO (Visiting member)	Collaborative laboratories with the Japan Aerospace Exploration Agency (JAXA). Research activities are at JAXA's Kakuda Space Center. Research on liquid rocket engine technologies, airbreathing engine technologies and hypersonic vehicles (includes entry and reentry vehicles) are underway in following fields; 1. Advanced rocket engine elements and aribreathing engine elements / systems (Tomioka Labo.) 2. Hypersonic vechicle elements and systems (Tanno Labo).

Note: For more detailed information, please contact the director. (Professor Naofumi OHNISHI, TEL+81-22-795-6919)

※Note: Candidates with a foreign nationality need to contact with theprospective academic supervisor prior to submitting application documents, and take the entrance examination for Special Selection Program for Foreign Students, Special Selection Program for Working Adults, or Graduate Course of International Mechanical and Aerospace Engineering (IMAC-G).
JAXA only accepts students in Master's course this year.If you are planning to go to Doctoral course as well, please talk to the prospective academic supervisor in advance.