Department of Electrical Engineering

Laboratory	Professor / Associate Professor	Theme of research
Energy Device Engineering (Micro-energy device) (High Frequency Nano-Magnetics)	Yasushi ENDO, Professor Sho MUROGA, Associate Professor	To develop innovative techniques for the realization of the carbon neutral and to work on their early social implementation are important. In our laboratory, for the creation of the passive elements with small size and high efficiency, the next-generation electromagnetic noise suppressors, and the energy saving type next-generation spin functional devices, the soft magnetic materials consisting of the ribbon, the particle, and the film shapes and their processes are totally research and developed, and the base electric/magnetic measurement techniques are also established. (1) Study on submicron sized soft magnetic particles and soft magnetic ribbons with loss losses and high saturation magnetization (2) Study on soft magnetic thin films constituting new high frequency magnetic devices (3) Development of new electromagnetic measurement techniques for the super-high-frequency range (4) Development of core loss measurement techniques for MHz range (5) Development of electromagnetic noise suppressors and wave absorbers (6) Study on measurement and characterization of electromagnetic noise
Energy Device Engineering (Green Power Electronics)	Tetsuo ENDOH, Professor	To realize a low-power society (low carbon society) in the future, high-efficiency power device technology, power conversion circuit technology and power management technology are very important as they can effectively convert and supply electrical energy. Moreover, the semiconductor integrated circuit technology combining hardware and software builds the indispensable foundation for the next-generation advanced information society. In this laboratory, named green power electronics laboratory, aiming to facilitate further progress of low-cost, low-power, high-performance semiconductor devices and integrated systems, the research and development on device technology, circuit technology and system architecture technology are conducted systematically and coherently with the following five topics. (1) Research on the low-cost and high-efficiency GaN/Si hybrid power device (2) Research on the high-efficiency power supply circuit and system to realize intelligent power management (3) Research on the green semiconductor integrated circuits (logic and memory) for AI/ IoT applications (4) Research on the real-time image recognition LSI for next-generation automotive/robotic applications (5) Research on the high-performance device/circuit with novel architectures and principles, such as 3D structures
Energy Device Engineering (Ubiquitous Energy)	Shin YABUKAMI, Professor (Graduate School of Biomedical Engineering) Akihiro KUWAHATA, Associate Professor Hanae AOKI, Senior Assistant Professor	Due to the close relationship between biological activities and magnetic/electromagnetic waves, it is important to utilize biomagnetic fields for the elucidation of biological activities and the development of medical systems. In our research laboratory, we are advancing the development of minimally invasive medical diagnostic and treatment techniques using electromagnetic phenomena, the development of measurement and transmission technologies for biological information both inside and outside the body using electromagnetic fields, furthering research in quantum life science, and aiming to develop new medical devices as well as welfare and nursing devices for implementation in our society. (1) Development and application research of a low-invasive cancer treatment and diagnostic system utilizing magnetism (2) Development of a detection system for proteins, viruses, and bacteria using magnetic nanoparticles (3) Development of a biomagnetic information measurement system using ultra-high sensitivity magnetic sensors (4) Development of a magnetic thin film evaluation device for ultra-high sensitivity magnetic sensors (5) Diamond solid-state quantum sensor for biomedical applications (6) High-efficiency magnetic heating using magnetic pulse energy

Laboratory	Professor / Associate Professor	Theme of research
Electrical Energy Systems Engineering (Applied Electrical Energy System) (Energy Storage System)	Makoto TSUDA, Professor Yoh NAGASAKI, Associate Professor	Effective utilization of renewable energy is essential to realize a sustainable society in the future. To realize this, it is necessary to construct new electric energy systems that are not bound by conventional concepts, and superconductivity and energy storage technologies are important fundamental technologies that will support electric energy systems in the future. In this laboratory, we are conducting research aimed at constructing various electric energy systems for the realization of a sustainable society in the future. (1) Electricity and hydrogen combined energy storage systems for adjusting electricity supply and demand (2) High-capacity power transport systems using superconducting cable (3) Wireless power transmission system using superconducting coil (4) Next-generation MRI and accelerator for cancer treatment using superconducting coil (5) Magnetic levitation type seismic isolation system using superconductor (6) Next-generation space propulsion system using superconducting coil
Electrical Energy Systems Engineering (High Density Energy Control)	Kazunori TAKAHASHI, Associate Professor	High density plasma physics has crucial roles in advanced science and engineering such as space propulsion and fusion plasmas. Understanding and control of linear/nonlinear plasma responses to electromagnetic fields and resultant plasma transport would yield a various engineering applications. Here research and development ranging from space development to terrestrial industrial applications are performed based on fundamental studies on high-density plasma production and control. (1) Fundamental studies on high-density plasmas. (2) Advanced high-power electric space propulsion devices (3) New electric propulsion devices for small satellites (4) Plasma source and equipment for material processing (5) Laboratory experiments simulating space/astrophysical phenomena (6) Fundamental studies relating to thermonuclear fusion plasmas
Electrical Energy Systems Engineering (Electric Power Network System)	*Hiroumi SAITOH, Professor	In order to prevent global warming and to realize safe societies, renewable energy resources (RES) such as wind power generation and photovoltaic generation need to be integrated into existing AC power network systems of which the stability is maintained by controllable generation such as large scale thermal and hydro power plants. The most important goal in this century is to make such integrated electric power networks and to deliver clean and affordable electric energy with high quality to all consumers. We are studying the following issues in order to construct sustainable power networks by use of information and communication technologies and optimization techniques. (1) Power system control and operation utilizing ultra-distributed power resources in demand side (2) Application of multi-agent system technologies such as consensus control to power systems (3) Optimization of power systems to integrate RES into existing AC networks (4) Enhancement of stability of the RES integrated power networks by wide-area synchronized measurement

Laboratory	Professor / Associate Professor	Theme of research
Research Institute of Electrical Communication (Electromagnetic Bioinformation Engineering)	Kazushi ISHIYAMA, Professor Taichi GOTO, Associate Professor	This field aims to create and control electromagnetic information in living organisms and their living environments, conducting research based on magnetic phenomena. It involves developing magnetic and strain interactions to capture electromagnetic fields emitted by living organisms or electrical equipment as information and utilizing magnetic and optical interactions for sensing systems. Additionally, it focuses on developing new devices that utilize magnetic phenomena for efficient control and developing nano-micro magnetic materials necessary for realizing these devices. (1) Development of compact, ultra-high sensitivity strain sensors for biological electromagnetic measurement. (2) Research on high-sensitivity electromagnetic field measurement and systems for electrical equipment. (3) Development of magnetic-based environmental power generation devices and materials. (4) Development of low-heat spin wave circuits and control techniques. (5) Development of magneto-optical devices and materials for bioenvironmental hygiene. (6) Development of functional magnetic materials.
Research Institute of Electrical Communication (Real-World Computing)	Akio ISHIGURO, Professor	Animals exhibit surprisingly adaptive and resilient behaviors under unpredictable and unstructured real world environments. In order to understand the control principles underlying such behaviors, we employ a synthetic approach based on robotics, biology and mathematics. We are currently focusing on the following animals: (1) Legged animals (quadrupeds, myriapods, etc.) (2) Snakes (3) Extinct animals (4) Social animals (vampire bats, etc.)
Cyberscience Center (Cyber-physical System)	Norihiro SUGITA, Professor	We are conducting a study on the analysis, evaluation, and modeling of biological systems using methods that integrate biological sensing, artificial intelligence, and system control theory. We aim to propose theories about cyber–physical systems in medicine, health, and welfare and develop advanced techniques for social implementation. (1) Cyber health management systems (2) Contactless human sensing (3) Virtual reality systems for medicine, health, and welfare (4) Assessment of digital content using biological signals (5) Computational intelligence for computer-aided diagnosis and treatment systems
Advanced Power Engineering	*Hiroumi SAITOH, Professor (Hiromi YAMAMOTO, Visiting Professor)	The power and energy sectors are required to respond to load curve changes and power surpluses caused by the large-scale introduction of variable renewables that are unevenly distributed and to aim for carbon neutrality in the future. To Solve these subjects, we need a viewpoint of optimization of the overall energy chains, from energy production to conversion and energy service supply. Electric power chains from low carbon power to energy application with high efficiency such as electric vehicles and heat pumps would replace existing fossil energy chains. Based on these backgrounds, Advanced Power Engineering Laboratory has established the following research topics. (1) Projection of energy demands based on the diffusion of renewable energies, demographics, and other factors. (2) Optimization of the formation and operation of power-related facilities. (3) Analysis of shapes of the low-carbon energy chains considering the shift to the electric power chains.

◎Meaning of the symbols in the table
〔Faculty member〕
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Department of Communications Engineering

Laboratory	Professor / Associate Professor	Theme of research
Intelligent Communication Network Engineering (Human Interface) (Multimedia Communication)	Akinori ITO, Professor Takashi NOSE, Associate Professor	Human beings transmit the intention using speech, letters, facial expression or gestures, and the receiver interprets the intention by combining the multi-modal information. It is strongly desired for a machine to exploit this kind of flexible interpretation in a human-machine communication. This laboratory aims to research the mechanism of human communication and apply that for the engineering purpose. (1) Development of recognition, understanding and synthesis method using a specific medium (2) Development of multi-modal intelligent communication system (3) Development of multi-media network and coding technologies
Communication Systems Engineering (Image Information Communications)	Shinichiro OMACHI, ProfessorTomo MIYAZAKI, Associate Professor	In this laboratory, a wide range of researches from basics to applications on technologies for effective processing and communication of multimedia information such as images are conducted. In particular, we focus on novel algorithms for image recognition, understanding and coding, and efficient information processing and communication algorithms for IoT. (1) Image recognition and understanding (2) Image processing (3) Image and video coding (4) Deep learning (5) Internet of Things (IoT)
Communication Systems Engineering (Information Measurement and Processing)	Yuji MATSUURA, Professor (Graduate School of Biomedical Engineering)	We handle general optical applications for the minimally invasive diagnosis and treatment. In addition to investigating the optical characteristics of various biological tissues, we will conduct research and development on diagnosis and healthcare monitoring devices that use laser light and the other various light sources emitting light with wavelengths from soft X ray to terahertz wave. (1) Research on infrared remote spectroscopy system for medical diagnosis (2) Development of laser medical optical fiber and transmission system (3) Research on healthcare monitoring devices using ultraviolet and infrared light (4) Research on optical transmission devices that apply the photonic band gap
Communication Systems Engineering (Communication Systems)	Hiroki NISHIYAMA, Professor	We are engaged in researching technologies involved in a huge variety of communication systems for CPS/IoT. Especially, we aim to develop communication technologies based on the new concept of autonomous decentralized cooperation, which is totally different from the existing centralized and distributed systems. (1) Locally centralized communications (2) Next generation mobile communication systems (3) Wireless communication systems using moving entities (4) Energy efficient communication systems (5) Resilient communication systems

Laboratory	Professor / Associate Professor	Theme of research
Wave Communication Engineering (Electromagnetic Wave)	Qiang CHEN, Professor Keisuke.KONNO, Associate Professor	The electromagnetic wave is widely used not only in the communications and broadcasting, but also in the measurement, imaging, wireless power transfer and so on. Both fundamental and applied researches on the antennas and wireless systems for various applications of electromagnetic wave are undertaken in this laboratory. (1) Antennas and array antennas (2) Reconfigurable reflecting surface of radio wave (3) Wireless power transfer (4) Radar and wireless sensor network (5) Large-scale and multiphysics computational electromagnetics
Wave Communication Engineering (Microphotonics)	Nobuyuki MATSUDA, Associate Professor	We conduct research and development of silicon photonic devices and their applications, aiming to realize next-generation information processing and communication technologies. Research topics include quantum information processing, quantum internet, quantum sensing and high-capacity optical communication devices. (1) Quantum computing and quantum information technologies using photonic integrated circuits (2) Optical communication devices using photonic integrated circuits (3) Quantum internet and quantum sensing
Wave Communication Engineering (Acoustic Physics Engineering)	Shin YOSHIZAWA, Professor	Minimally invasive treatments have been required to sustain quality of life in the aging society. For the clinical use of noninvasive ultrasound treatments, we are developing novel methods for therapeutic ultrasound focusing and noninvasive monitoring and targeting by ultrasound imaging. (1) Therapeutic ultrasound transmission method and sequence for ultrasound-guided ultrasound treatment (2) Ultrasound imaging to monitor tissue change in real time (3) Measurement method of medical ultrasound pressure field
Research Institute of Electrical Communication (Ultrahigh-speed Optical Communication)	Toshihiko HIROOKA, Professor Keisuke KASAI, Associate Professor	We are engaged in research on ultrahigh-speed optical transmission, digital coherent optical transmission, and high-speed and spectrally efficient optical transmission by combining these two approaches. With a view to supporting innovative new ICT services such as 5G and IoT, our goal is also to develop novel transmission schemes integrating optical and wireless communications. (1) High-speed and spectrally efficient optical transmission and signal processing (2) Digital coherent optical transmission and its integration with wireless communications (3) Frequency-stabilized lasers and their applications to metrology and microwave photonics (4) Multi-core fibers and other innovative fibers with new functionalities

Laboratory	Professor / Associate Professor	Theme of research
Research Institute of Electrical Communication (Advanced Wireless Information Technology)	Noriharu SUEMATSU, Professor	Toward the realization of a next-generation broadband wireless network, we are actively engaged in the research work on dependable and low power consumption advanced wireless ICT. We cover the whole technical fields from the lower to higher layers, i.e., signal processing, RF/Mixed signal device, antenna, modem and network technologies. (1) 1-chip transceiver for heterogeneous wireless communication (2) Digital RF transceiver (3) Millimeter wave and submillimeter wave beamforming antenna and device (4) Wireless systems and devices for in-vivo communication (5) Location and short message communication using quasi-zenith satellite system (6) Terrestrial and satellite integrated wireless communication network (7) Digital signal processing for broadband wireless communication
Research Institute of Electrical Communication (Information Storage Systems)	Simon John GREAVES, Associate Professor	The amount of big data generated in the form of multimedia, IoT and AI information increases dramatically every year. Toward the next generation advanced ICT system, information storage system with high performance, high capacity and intelligence are required. We are conducting research into high density information storage based on perpendicular magnetic recording and magnetic devices invented in this laboratory. Magnetic materials and devices are modelled using micromagnetic simulations. The aim is to maximize the density and speed of the devices. In addition, we are conducting advanced information storage and computing systems to handle Peta byte class mass data analytics by closely unifying both data store and processing. (1) Develop micromagnetic models of storage systems and devices (2) Research on high-density and high-speed data storage systems (3) Research on high density perpendicular magnetic recording device (4) Research on large capacity information storage system (5) Research on advanced data analytical platform in close proximity to storage
Research Institute of Electrical Communication (Ultra-Broadband Signal Processing)	Akira SATOU, Associate Professor Tsung-Tse LIN Associate Professor	The electromagnetic spectrum of several hundreds to several tens of microns in wavelength located between the radio waves and light waves is called the terahertz band. The realization of ultrahigh-speed, large-capacity wireless communications utilizing the broadband features of the terahertz band is indispensable for future advanced information communication technology society. In this laboratory, we are conducting the research on the creation of ultra-broadband signal processing semiconductor devices, circuits, and systems that can operate in this unexplored area, and their applications to the next generation information communication and measurement systems. (1) Research on Ultra-broadband signal processing devices and integrated circuits utilizing two-dimensional plasmons (2) Research on ultra-broadband optoelectronic convergence devices and systems that seamlessly link optical communications and millimeter-/terahertz-wave wireless communications (3) Research on new principle terahertz functional devices and integrated circuits using van der Waals heterostructures based on graphene and other two-dimensional atomically-thin materials

Laboratory	Professor / Associate Professor	Theme of research
Research Institute of Electrical Communication (Environmentally Conscious Secure Information System)	Naofumi HOMMA, Professor	We are pursuing research and development on the fundamental technologies and their applications for building secure information communication systems in the next-generation information environments and applications. In particular, we are exploring the design and analysis technologies of cryptographic systems. (1) Hardware algorithms for next-generation cryptographic technologies (2) Secure implementation of embedded systems (attack and defense) (3) Security design and evaluation technology of cyber physical systems (4) Security-oriented information processing (5) Theory of AI/mobility/avionics security (6) Creation of security functions for next-generation devices
Research Institute of Electrical Communication (New Paradigm VLSI System)	Takahiro HANYU, Professor Masanori NATSUI, Associate Professor Naoya ONIZAWA , Associate Professor	To meet the expectations of artificial intelligence (AI) hardware, we achieve high functionality and multi-functionality at the device and circuit level, and develop a systematic design methodology for high-performance, ultra-low energy VLSI systems based on sophisticated hardware algorithms. This aims to establish a new paradigm VLSI computing that overcomes the performance limits of the current VLSI systems. Specific research subjects are as follows: (1) Nonvolatile logic-in-memory VLSI processors and their applications, (2) New paradigm VLSI integrated-circuit technologies and their AI applications, (3) Design of IoT-oriented AI hardware based on new paradigm VLSI architecture, (4) Establish new paradigm VLSI-computing architecture based on intelligent device modeling, (5) Design of probabilistic computing and its application to network-on-chip (NoC) systems, and (6) Design of adaptively controlled and/or resilient VLSI processors.

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Department of Electronic Engineering

Laboratory	Professor / Associate Professor	Theme of research
Microelectronics Engineering (Spin Material Electronics) (Spin Correlation Electronics)	Shin SAITO, Professor Tomoyuki OGAWA, Associate Professor	Magnetic material is one of the most significant elements playing a functional role in electronic devices, and their nanostructure influences on the performance of devices directly. In our laboratory, Extreme high performance for spin controlled electronic device is created through fabrication and synthesis of magnetic thin film, metallic nanoparticles and powders under sophisticated clean process. (1) Granular magnetic thin films for energy assisted hard disk device. (2) Enhanced magneto-optical and magneto-refractive effects with surface plasmon resonance for magnetic thin film. (3) Soft magnetic properties of magnetic micron particles for high frequency devices towards the next generation. (4) New magnetic powder synthesized by solid phase-gas phase reaction of reduction, nitridation, and carbonization. (5) Iron nitride nano particles contributing to rare-earth free magnets (6) Fe-based nanoparticle hybrid materials for GHz-band devices.
Electronic Control Systems (Electronic Control Systems)	Mototaka ARAKAWA, Associate Professor (Graduate School of Biomedical Engineering)	We are studying medical diagnosis using ultrasound in cooperation with graduate school of biomedical engineering in our university. Especially, the high-speed and high-resolution ultrasonic imaging and the dynamic and function measurements of biological tissues and organs are main topics. To achieve them, novel ultrasonic measurement methods and digital signal processing technologies are researched and developed while manufacturing electric control systems. The current main subjects are as follows: (1) High-speed and high-resolution ultrasonic imaging. (2) Evaluation of function and viscoelasticity of biological tissues and organs by accurately measuring their dynamics. (3) Microstructure estimation of biological tissues and organs by spectrum analysis of ultrasonic signals. (4) Development of new ultrasonic diagnosis equipment by ultrasonic electronics and electronic control.
Materials Engineering (Plasma Science Engineering) (Plasma Electronics)	Toshiro KANEKO, Professor Toshiaki KATO, Associate Professor	We will investigate the distinguishing properties of plasmas which could create interdisciplinary frontier science related to space, energy, material, environment, and life science. We will also develop the next-generation energy technology and nano-bio-medical science technology by intellectualizing the plasma generation and control. (1) Elucidation of nonlinear, transport, and interface phenomena in the frontier plasmas. (2) Creation of next-generation energy sources using plasmas (solar cell, nuclear-fusion power generation) (3) Synthesis of novel nano materials (nanoparticle, fullerene, nanotube, graphene, atomically-thin layered materials) using plasma technology. (4) Development research on new-functional nano-electronics devices using plasma technology. (5) Development research on advanced bio-devices using plasma-bio fusion technology (new-generation gene transfer device, future-oriented plant factory).

Laboratory	Professor / Associate Professor	Theme of research
Materials Engineering (Thin Films Materials Electronics)	Takeru OKADA, Associate Professor	Electronics, including novel materials and functional devices, are one of important basic technology to realize safe, secure, and comfortable society. The objects in our laboratory are to study the development of multi-functional thin films and novel devices using specific phenomena at phase boundaries. (1) Fabrication of oxide-based functional thin films and their device application. (2) Development of novel materials for environment protection, resource development, and energy generation. (3) Basic researches on electronics at phase boundaries and their device applications.
Materials Engineering (Photonic Devices Engineering)	Kyoko KITAMURA, Professor	Photonics is key technology for future society that is developed by cyber-physical system. In particular, the on-demand/tailored control of photons by using semiconductor based nano-structure is expected to apply variety of fields such as communication, material processing, quantum information, sensing, and so on. We study to contribute such fields by developing novel photonic devices based on designing semiconductor based nano-structures. (1) Study on optical sources that enables to generate spatially controlled physical quantities. (2) Study on on-chip optical propagation control devices (3) Study on creation of cyber-physical system on fabrication processes of photonic nano-structures
Electronic Systems Engineering (Image Science and Information Display) (Display Devices Engineering)	*Hideo FUJIKAKE, Professor	Electronic image display devices featuring thinness, lightness, bending and high image quality must change future information-based society and lifestyle. In the field, we will research and develop innovative optical and electronic functions by self-assembly of anisotropic organic materials (liquid crystals, polymers, organic semiconductors, etc.) and by advanced control of molecular arrangement based on various surface effects. We intend to create next-generation flexible printable electronics. (1) Study on image quality improvement in flexible liquid crystal displays (2) Study on high functionality of electronic displays using liquid crystal and polymer properties (3) Study on coatable organic semiconductors using liquid crystal or crystal properties (4) Study on next-generation fast response liquid crystal materials and devices
Electronic Systems Engineering (Electronic Devices Engineering)	Eiji HIGURASHI, Professor	Heterogeneous integration technology that enables us to construct innovative functional devices (electronic and optical devices, sensors and actuators, etc.) by combining various materials with different functions and characteristics is essential for the development of future electronic systems. We are currently engaged in research related to the heterogeneous integration technology and its application to novel electronic devices. (1) Study on advanced room-temperature bonding technologies (2) Study on control of bonding interfaces and 3D integration (3) Application to high heat-dissipation structures for electronic devices (4) Application to MEMS packaging (5) Study on short-pulse generation from gain-switched laser diodes for biomedical imaging

Laboratory	Professor / Associate Professor	Theme of research
Electronic Systems Engineering (Biomedical Electronics)	Tatsuo YOSHINOBU, Professor (Graduate School of Biomedical Engineering) Ko-ichiro MIYAMOTO, Associate Professor	Chemical sensors based on semiconductor devices are advantageous for miniaturization and integration with peripheral circuits, which promoted the development of various measurement systems. The laboratory of biomedical electronics is engaged in the development of the chemical imaging sensor, which can detect specific ions or molecules in a spatially resolved manner and generate chemical images and movies. Our projects include (1) development of high-performance chemical imaging sensors, (2) development of analytical chips combined with MEMS technology, (3) application to the study of material surfaces, and (4) application to cell analysis
Research Institute of Electrical Communication (Solid State Electronics System)	Hirokazu FUKIDOME, Associate Professor	TBA
Research Institute of Electrical Communication (Dielectric Nano-Devices)	Kohei YAMASUE, Associate Professor Yoshiomi HIRANAGA, Associate Professor	We are expanding the frontiers of nanotechnology and nanoscience especially in the field of dielectrics. In more precise, we have been developing our unique microscopy method called scanning nonlinear dielectric microscopy (SNDM) with the highest measurement performance in dielectric polarization imaging in the world. Based on this outstanding technique, we are carrying out innovative research on a super-high density ferroelectric data storage system for ongoing explosive data growth, an advanced nanoscale measurement and analysis for emerging semiconductor materials and devices, novel electronic devices based on ferroelectric nano-domain engineering, and so on. I Atomic resolution SNDM: (1) Atomic dipole imaging by ultra-high vacuum (UHV) SNDM (2) UHV multifunctional scanning probe microscopy system achieving simultaneous SNDM/STM/NC-AFM imaging II Ferroelectric data storage system: (1) HDD-type super-high density data storage system (2) High-speed data reading and writing technologies III Advanced measurement and analysis of semiconductor materials and devices: (1) High-performance miniaturized semiconductor devices (2) Next generation power devices such as SiC and GaN (3) Post-Si materials such as graphene and other two-dimensional materials.
Research Institute of Electrical Communication (Materials Functionality Design)	Masafumi SHIRAI, Professor Kazutaka ABE, Associate Professor	The research objectives in our laboratory are theoretical analyses of quantum phenomena in materials used in the next-generation devices, computational design of materials which possess new functionalities, and development of advanced materials design scheme utilizing high performance computers. (1) Theoretical design of spintronic materials based on first-principles calculation and machine learning (2) Theoretical analysis of transport properties in spintronic devices (3) Development of simulation methods for design of materials and device functionalities (4) Matter in high densities (5) Metallization and superconductivity of hydrogen and hydrides Development of first-principles structural search methods

Laboratory	Professor / Associate Professor	Theme of research
Research Institute of Electrical Communication (Spintronics)	Shunsuke FUKAMI, Professor Shun KANAI, Associate Professor	Towards new electronics, spintronics, in which charge and spin of electrons are jointly used, researches on development and understanding of spintronics materials and devices, fabrication and characterization of quantum- and nano-structures, and their application to electronics are conducted. (1) Research on spintronics (2) Research on physical properties of spintronics materials and devices (3) Research on control of magnetization of magnetic metals for applications to functional devices (4) Research on functional spintronics devices and their application to low-power semiconductor circuits, artificial intelligence hardware, and probabilistic computers. (5) Research on spin based quantum functional devices.
Research Institute of Electrical Communication (Nano-Integration Devices and Systems)	Shigeo SATO, Professor Masao SAKURABA, Associate Professor Hideaki YAMAMOTO, Associate Professor	To develop the next generation information technology, we study on device and process technology for new Si based devices realized by ultimate resolution control, its application to brain computing system, and also the mechanism of information processing in the brain. (1) Study on neuromorphic devices (2) Study on neuromorphic integrated circuits (3) Study on plasma CVD process of group IV semiconductors (4) Study on group IV semiconductor quantum nanodevices (5) Study on information processing in biological neuronal networks (6) Study on biomimetic neurocomputing systems
Research Institute of Electrical Communication (Applied Quantum Optics)	Masato YOSHIDA, Associate Professor Nobuhide YOKOTA, Associate Professor	Novel functional photonic devices including high function semiconductor laser sources, photonic devices and monolithically integrated semiconductor photonic circuits are being investigated to realize photonic functional devices based on new principle and explore new-generation photonic network systems. Main research themes are listed below. (1) Ultra-high speed control of semiconductor photonic devices by signal light injection (2) Highly functional semiconductor light sources (3) Highly functional semiconductor optical modulators (4) Novel functional semiconductor photonic integrated circuits
Research Institute of Electrical Communication (Quantum Devices)	Tomohiro OTSUKA, Associate Professor	In solid-state nanostructures, exotic phenomena like quantum effects occur. We are exploring interesting properties of the nanostructures and developing new devices utilizing artificial nanostructures. We will contribute to new information processing and communication technologies through quantum and nanoelectronics. (1) Electronic properties of nanostructures and nanodevices (2) Quantum devices utilizing nanostructures (3) Informatics approaches in material and device science
Research Institute of Electrical Communication (Nano-Bio Hyrid Molecular Devices)	Ayumi HIRANO-IWATA, Professor	We are working on development of novel devices based on the combination of nanotechnology and biomaterials that have highly sophisticated functions. (1) Development of novel electronic/ion devices based on artificial cell membranes. (2) Development of microfabricated silicon chips for detecting drug side effects. (3) Construction of artificial neuronal networks based on cultured neurons. (4) Modelling of biosystems and neuronal circuits.

Laboratory	Professor / Associate Professor	Theme of research
Frontier Research Institute for Interdisciplinary Sciences (FRIS), Advanced Interdisciplinary Research Division (Nano Intelligent System)	Takehito SHIMATSU, Professor	We have been conducting two research efforts based on sputter film deposition in a UHV atmosphere: development of room-temperature bonding techniques of wafers and fabrication of magnetic films for use in future high-capacity magnetic storage and memory devices. The former study examines atomic diffusion bonding of two flat wafers with thin films. This technique is gaining wider use for electrical and optical devices fabrication. The latter study is aimed mainly at energy-assisted magnetization switching of granular magnetic films for use for future ultra-high-density recording media for hard disk drives.
New Industry Creation Hatchery Center （New Fundamental Electronics Creation)	Rihito KURODA, Professor	Toward creation of a safe, secure and sustainable society, we are conducting research on advanced electron devices such as high functionality image sensors and applications thereof. Based on the semiconductor integrated circuit technology, our research field covers material, process, device, circuit, systems and their total optimization: (1) High speed and high precision measurement and analysis technologies of advanced semiconductor and memory devices (2) Wide spectral response, high precision and intelligent image sensor technology (3) High speed and high time resolution images sensor technology (4) Realtime and high precision proximity capacitance image sensor technology (5) Non-destructive and non-invasive sensing technology toward smart manufacturing, medical and agricultural applications
Green Goals Initiative Research Center for Green X-Tech (Next-Generation Spintronics Materials Engineering)	Masakiyo TSUNODA, Professor	Functional thin film is one of the most important factors in electronics devices, and its nanostructure directly influences the device performances. In this laboratory, thin film fabrication processes for spin controlled electric device with high functionalities are investigated, based on understanding of electronic physics. (1) Spin electronics devices and spin transport properties (2) Development of thin film materials for high-performance spin electronics devices (3) Study of interface spins by synchrotron radiation
Center for Innovative Integrated Electronic Systems(CIES) (Nano- Spin Memory)	Shoji IKEDA, Professor	TBA
Biomedical Engineering for Cancer	Tetsuya KODAMA, Professor (Graduate School of Biomedical Engineering)	Most cancer cells are invasive and metastatic, and they become disseminated to distant anatomical site by invasive-metastasis cascade. We will develop diagnosis and treatment methods of lymph node metastasis at the early stages. Our research is interdisciplinary or integrated research based on fluid dynamics, optics, molecular cell biology, oncology, and pathology. Our research subjects are as follows. (1) Mechanisms of lymph node metastasis (2) Drug delivery system (DDS) targeted for lymph node metastasis using nano-particles (3) Assessment of treatment for lymph node metastasis using noninvasive multimodal *in vivo* imaging techniques such as high-frequency ultrasound, bioluminescence and micro-CT.

Laboratory	Professor / Associate Professor	Theme of research
Biomedical Nanoscience	Makoto KANZAKI, Professor (Graduate School of Biomedical Engineering)	The recent progress in molecular biology has greatly contributed to revealing the biological properties of individual molecules. The Kanzaki Lab focuses on understanding how the supra-molecular complexes (biological nano-systems) achieve diverse physiological and pathophysiological events by employing a cutting-edge bio-imaging techniques. (1) Live-imaging analysis and Biomedical Nanoscience (2) Cell/Tissue Engineering for the next generation medical applications (3) Biological Nano-system and their impairments in life-style-related diseases (4) Plasma Medicine
Neural Electronic Engineering	Takashi WATANABE, Professor (Graduate School of Biomedical Engineering)	We are conducting studies on therapeutic and rehabilitation systems, neural prosthesis, assistive technology for motor and sensory disabilities focusing on electronic external control of the neuromuscular system, and measurement and evaluation of motor function. (1) Movement control of paralyzed limbs using functional electrical stimulation (FES) (2) Estimation of evaluation index of motor function by machine learning (3) Prediction and control of movements by machine learning (4) Neurorehabilitation system for motor relearning

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